REPUBLIC of CROATIA
Ministry of Economy and
Sustainable Development

Republic of Croatia 2024 informative inventory report (1990 – 2022)

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REPUBLIC OF CROATIA 2024 INFORMATIVE INVENTORY REPORT (1990 – 2022)
Submission under the Convention on Long-range Transboundary Air Pollution (CLRTAP)
And National Emission Ceilings Directive (NECD 2016/2284/EU)

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REPUBLIC OF CROATIA 2024 INFORMATIVE INVENTORY REPORT (1990 – 2022)

Work package 2, delivery V of the public procurement contract "Service for the preparation of expert basis for the needs of air pollutants emissions report in accordance with the requirements of the LRTAP Convention and the NEC Directive for the years 2023 and 2024"

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Executive summary

Annual report

This report is Croatia´s annual Informative Inventory Report 2024 (for period 1990 – 2022) (hereinafter referred to as IIR2024) under the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (CLRTAP) and the following acts of the European Union: Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants (OJ L 309, 27.11.2001) and Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (OJ L 344, 17.12.2016) (hereinafter NEC Directive).

National legislation in the field of air protection, namely the Low on Air Protection (OG 127/19, 57/22) and the Regulation on national obligations to reduce emissions of certain air pollutants in the Republic of Croatia (OG 76/18) (hereinafter: NEC Regulation) contain provisions that are in accordance with the aforementioned acts of the European Union.

IIR2024 follows recommended structure for the IIR[1] and covers all years in period from 1990 to 2022.

The air pollutants reported are main pollutants (SO_2, NOx, CO, NMVOC and NH_3), particles (TSP, PM_{10} and $PM_{2.5}$), black carbon (BC), heavy metals (Cd, Pb, Hg, As, Cr, Cu, Ni, Se and Zn) and persistent organic compounds (PCDD/PCDF, PAHs (benzo (a) pyrene, benzo (b) fluoranthene, benzo (k) fluoranthene and indeno (1,2,3-cd) pyrene), HCB and PCBs).

The Croatian air pollution inventory is reported in Nomenclature for Reporting format[2], revised 25.9.2019 (hereinafter referred to as NFR 2019-1). The Republic of Croatia reports emission inventories for all years since 1990 and submits them in digital form.

The Croatian air pollution inventory has been prepared in accordance with standard methods and procedures in accordance with the EMEP / EEA air pollutant emission inventory guidebook 2023 (hereinafter GB2023) and other available technical guidance.

Information on previous estimations and submissions is available to the public on the Ministry of Economy and Sustainable Development[3] (MESD) website, at the links:

- https://mzoe.gov.hr/o-ministarstvu-1065/djelokrug-4925/okolis/zrak/emisije-u-zrak/1312 (annual IIRs, annual programme for activity data collection, the QA/QC plan and link to GB2023),
- https://emep.haop.hr/ – Spatial distribution portal, interface with air pollutants emissions overview maps in the Republic of Croatia for the years 1990, 1995, 2000, 2005, 2010, 2010, 2015 and 2019 according to the GNFR, NFR and SNAP source categories.

The national IIR, NFR tables, emission projections, spatially disaggregated emission inventories, and large point source inventories are also available on the Centre on Emission Inventories and Projections (CEIP) website, at the link: https://www.ceip.at/status-of-reporting-

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[1] Annex II of 2014 Reporting guidelines (ECE/EB.AIR.125)

[2] Annex I of 2014 Reporting guidelines (ECE/EB.AIR.125)

[3] In accordance with the status changes defined in Article 34 and Article 35 of the Act on the Organization and Scope of State Administration Bodies (Official Gazette 85/20), the Ministry of Environmental and Energy will continue to operate as the Ministry of the Economy and Sustainable development. Ministry of the Environment and Energy, pursuant to Article 73, paragraph 3 of the Law on Amendments to the Environmental Protection Act (OG 118/18 of December 27, 2018) and deletion of the Croatian Agency for Environment and Nature (CAEN) from the court register (January 17, 2019) assumed the Agency's employees, jobs, rights and obligations, as well as assets, equipment, records and other documentation.

and-review-results and on the Eionet central data repository on links: http://cdr.eionet.europa.eu/hr/un/clrtap/ and http://cdr.eionet.europa.eu/hr/eu/nec_revised/.

Responsible executor

In accordance with the national law governing air protection, the competent authority for ensuring the preparation of national inventories, annual emissions inventories, emission projections, spatially disaggregated emission inventories, large point source inventories, adjusted emissions inventories (as necessary) and informative inventory reports is MINGOR, which delivers them in accordance with international obligations. The aforementioned activities are carried out by "authorized persons"[4] in accordance with the law governing environmental protection. State administration bodies and legal entities with public powers are responsible for securing data on activities and emissions by sector, necessary for the preparation of the mentioned jobs. The authorized person is, based on the Public Procurement Agreement for MESD[5], "Service of creating an expert basis for the needs of reports on emissions for the air pollutants in accordance with the requirements of the LRTAP Convention and the NEC Directive for the years 2023 and 2024" record number: 800/02-23/22JN, company EKONERG - institute for energy and environmental protection ltd. from Zagreb. Experts from EKONERG participate in the meetings of the UNECE Working Group on Emission Inventories and Emission Projections and related expert panels, at which the parties to the CLRTAP prepare guidelines and methodologies for the preparation of inventories.

Summary of the main differences in the inventory since the last submission

The main differences in the inventory since the last submission concern new sources, new or updated applied methods, new / revised collected data on activities and updated emission factors in accordance with GB 2023.

In the Energy sector, emissions from category 1.A.3.b. Road transport were recalculated due to the transition to a new version of the COPERT model (5.7.2) in which all emission factors were revised, which led to the recalculation of the emissions of all relevant pollutants for the entire historical series. In addition to the above, in the COPERT database, for the series 2012-2021, additional vehicles were added in the category of light duty vehicles N2 (which are characterized in the MI vehicle database as light duty vehicles with a carrying capacity above 3.5 t), and electric vehicles were added to the passenger car category, which led to an increase in relevant emissions. In category 1.A.2.c Fuel combustion in industry and construction: Chemicals for the 2019-2021 period the consumption of wood biomass was lacking, so it was added. In category 1.A.2.e Fuel combustion in industry and construction: Food, drink and tobacco, an error was observed when entering liquid fuel in 2021 in the CollectER database, so it was corrected. Emissions from category 1A4bi Residential were recalculated due to the update of EFs in GB 2023 for fossil fuels, i.e. natural gas, working gas, LPG (reduced Tier 1 FEs for As, Hg, and for PCDD/F and PAH were removed from the inventory), for solid fuels in boilers (reduced Tier 1 EFs for Cd) and biomass – wood-based fuels (reduced Tier 2 FEs for NH_3). For category 1.A.3.d.ii, the emissions of heavy metals for 2021 were recalculated due to the correction of the AD for lubricants, and the emissions of all pollutants were recalculated for the year 2007 due to the corrections of the AD for diesel fuel, which resulted in a reduction of

[4] An authorized person is a legal or physical person - a craftsman who has permission to perform professional work in the field of environmental and nature protection (Article 1, paragraph 48 of the Law on Environmental Protection (OG 80/13, 153/13, 78/15, 12/18, 118 /18)

[5] Contracting authority in the procurement process, responsible for the annual preparation and submission of the annual IIR and NFR tables to the UNECE-LRTAP Convention and the European Commission.

emissions. In the fugitive emission sector, a recalculation has been carried out due to the change in factor according to the new GB2023. The recalculation refers to the entire time series from 1990 until 2022, for the purpose of calculating diffuse emissions in NFR category 1.B.2.a.iv, for the relevant SNAP code 0401. A recalculation from 2017 until 2022 has been also carried out due to implementation of emission control measures (VRU) when loading road tankers, rail tankers and marine tankers, which reduced emissions in NFR category 1.B.2.a.v, for relevant SNAP codes 0505.

In the IPPU sector, category 2.A.5.b, emissions of $PM_{2,5}$, PM_{10} and TSP were recalculated for the whole time series due to updated activity data. In the category 2.D.3.h, NMVOC emissions were recalculated for the whole time series due to the implementation of the Tier 2. In the category 2.H.1, SO_2, NOx, CO and TSP emissions were recalculated for the whole time series due to the implementation of GB2023.

In the Agriculture sector, NH_3 emissions from category 3.B were recalculated for 2020 and 2021 due to the transition to DZS data for the number of animals on farms of laying hens, fattening pigs and sows, which resulted in a reduction in emissions. In category 3.D.a.2.a, NOx and NH_3 emissions were recalculated for the period 2019-2021 due to FE corrections for sows and fattening pigs, which resulted in a reduction of emissions. In category 3.D.e, NMHOS emissions for the period 2015-2021 were recalculated due to changes in activity data, which resulted in an increase in emissions.

In the Waste sector, in categories 5.A and 5.B emissions were recalculated due to the use of new activity data collected by the project to improve the GHG emission inventory „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950“[6]. In category 5.A, PM emissions were recalculated for the period 1990 - 2012, while NMVOC emissions were recalculated for the period 1990 - 2021 due to the use of new country-specific emission factors for degradable organic carbon (DOC), which affects the calculation of CH_4 emissions from which NMVOC emissions are calculated. NH_3 emissions were recalculated in category 5.B.1 for the periods 2011 - 2012 and 2020 - 2021, and in category 5.B.2 for the period 2013 - 2021. Emissions in category 5.C were recalculated for the entire reporting period due to the use of new emission factors from GB2023: PCDD/F emissions in category 5.C.1.b.i; emissions of NO_x, CO, SO_2, TSP, PM_{10}, $PM_{2.5}$, heavy metals and PCDD/F in category 5.C.1.b.iii and PAH emissions in category 5.C.2.

Explanation of significant changes in emission trends

Emissions of all pollutants decreased in the period 1991 - 1995, when the war for Croatian independence took place, which caused a decrease in fuel consumption, a drop in overall production in all sectors, and a halt in the production of certain industrial plants. The economic crisis of 2007-2009 also caused a decrease in all emissions, which was followed by an increase until the economy recovered in 2011. The decrease in emissions in the period 2019-2020 is the result of the impact of isolation and accompanying measures caused by the pandemic of the disease COVID-19, which was registered in Croatia at the end of February 2020, which had an impact on the reduction of fuel consumption in road transport, an increase in the demand for energy in the household sector, and a reduction in consumption in industry and construction, as

[6] „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950“, Client: Ministry of Economy and Sustainable Development, Executor: Bidders Association - EKONERG d.o.o., IPZ Uniprojekt TERRA d.o.o., 2022 - 2023 (in Croatian)

well as in consumption for the production of energy and heat. An explanation of significant changes in emission trends by pollutant is given below.

Main pollutants

Emissions of the main pollutants have been significantly reduced since 1990. The SO_2 emission in 2022 amounted to 5.56 kt and was reduced by 96,7% compared to 1990, when it amounted to 170.21 kt. This decline is mainly caused by the reduction of sulphur content in liquid petroleum fuels (according to the Croatian regulation on the quality of liquid petroleum fuels), the installation of desulphurization units in plants (according to the Croatian regulation on the limit values of air pollutant emissions from stationary sources) and the increased use of low-sulphur fuels (e.g. natural gas). The emission of NOx in 2022 amounted to 45.75 kt, which is a decrease of 55.5% compared to 1990, when it amounted 102.91 kt. The reason for this decrease is mainly the result of the reduction of emissions from road transport due to the introduction of three-way catalytic converters in cars and, consequently, successively stricter emission standards. The emission of NH_3 in 2022 amounted to 26.92 kt, which is a decrease of 46.7% compared to1990, when it amounted 50.46 kt. The majority of NH_3 emissions come from the agricultural sector. The reduction in emissions is mainly the result of a reduction in the number of animals, intensification of measures related to the prevention of nitrogen loss in agricultural production, efficient feeding, increased application of measures related to animal housing systems (e.g. floor design, drinking systems, ventilation, intensity of manure removal), as well as measures related to the handling, storage and application of fertilizers. In 1990, the emission of NMVOC amounted to 173.9 kt and by 2022 it was reduced by 64.9% to 61.11 kt. The reduction is more noticeable in road transport due to the increased use of energy-efficient vehicles and the introduction of new requirements for exhaust gas emissions (eg three-way catalytic converters in cars). The decrease in the solvent sector (2.D) was achieved due to the Croatian regulation on the limit values of air pollutant emissions from stationary sources and the regulation on the limit values of the content of volatile organic compounds in certain paints and varnishes used in construction and vehicle finishing products. The CO emission in 1990 amounted to a record 564.2 kt and by 2022 was reduced by 63.3% to 206.79 kt. This reduction is mainly the result of the reduction of emissions from road transport (introduction of three-way catalytic converters and renovation of the vehicle fleet).

Particles

Particulate matter emissions in Croatia mainly originate from the combustion of wood biomass in the residential combustion devices, road transport and construction activities and road paving with asphalt in the Industrial processes sector. Since 1990, TSP emissions have been reduced by 43.2%, PM_{10} by 38.4%, $PM_{2.5}$ by 34.4%, and BC by 33.9%. Particle emission trends are quite fluctuating with a tendency to decrease, which, in addition to the war for Croatian independence and economic trends, was also influenced by the consumption of heating biomass in the residential combustion devices, which is related to climatic conditions. The reduction was contributed by the introduction of biomass combustion techniques with lower particle emissions in residential combustion devices and the introduction of stricter standards for particle emissions in road transport (Euro 4, Euro 5, Euro 6 vehicles equipped with catalysts, diesel particulate filters (DPF) and the addition of additives).

Priority heavy metals

Emissions of priority heavy metals Pb, Cd and Hg are mainly the result of fuel combustion and compared to 1990 they have decreased, Pb by 98.4%, Hg by 68.8% and Cd by 34.3%. The significant reduction in Pb emissions was mainly influenced by road transport and the ban on lead in gasoline. The decrease in Cd emissions, apart from the war for Croatian independence, is mainly the result of reduced fuel oil consumption and a simultaneous increase in natural gas consumption. The reduction of Hg emissions in 1993 is the result of the installation of a technical unit for the removal of mercury from natural gas extraction and processing activities (1B2bi). The increase in Hg emissions since 2000 occurred due to the commissioning of the second of two coal-fired thermal power plants in Croatia, whose reduced operation caused a drop in emissions in 2017 and 2019.

Other heavy metals

Emissions of other heavy metals have decreased since 1990, As by 95.8%, Cr by 49.9%, Ni by 82.9%, Se by 13.7% and Zn by 8.2%, only the emission of Cu increased by 81.7%. A significant reduction in As emissions is the result of stopping the steel production process in Siemens-Martin furnaces, and as a consequence of the war for Croatian independence. The significant reduction in Cr and Ni emissions is mainly the result of a reduction in fuel oil and coal consumption in the energy sector. The increase in Cu emissions occurred due to the increase in tire and brake wear in road transport (1A3bvi) as a result of the increase in the number of vehicles and kilometers travelled. The high levels of emissions in 2002-2005, as well as in recent years, were caused by the increased use of fireworks and signal rockets (2G, SNAP 060601). The reduction of Se emissions is not large because in Croatia this emission mainly originates from the production of glass and mineral wool, which after a significant drop in production because of the war and recovery, depends on economic circumstances. The decrease in Zn emissions is not significant because the source of the emission of this metal is the combustion of wood biomass in the residential sector, which primarily depends on climatic conditions.

Persistent organic pollutants (POPs)

Emissions of all persistent organic pollutants have decreased since 1990, PCDD/PCDF by 70.1%, PAH by 42.9%, HCB by 95.5% and PBC by 35.1%. A significant reduction in PCDD/PCDF emissions is the result of education of agricultural producers and their penalization (that is, reduction of state subsidies per unit of agricultural area), burning of crop residues (3F) in the agricultural sector. Fluctuations in the trend of PCDD/PCDF emissions until 2008 are related to changes in the area under corn whose harvest residues are burned, and changes in corn yield. The reduction of PAH emissions in the 90s is the result of stopping the process of aluminium and iron production, and as a consequence of the war for Croatian independence, it is also related to the reduction of coal consumption in the household sector. The trend of PAH emission fluctuates depending on the climatic conditions and the related consumption of wood biomass in home fireplaces. A significant reduction in HCB emissions is associated with the ban on the use of pesticides with a high level of HCB impurities in active substances in the agricultural sector and pesticide use activities in agriculture and forestry (3Df). The reduction of PCB emissions in the 90s is related to the consequences of the war for Croatian independence, when iron production was suspended and the production and use of energy sources was reduced. The trend of PCB emissions in Croatia is mostly dependent on the use of coal in the energy sector, category electricity and heat production (1A1a), from where the increase in 2000, after the second coal-fired thermal power plant came into operation, and the decrease in 2017, after the first thermal power plant reduced production and went out of operation in 2018.

Information about the incompleteness or time-series inconsistency in the estimates

Regarding the time-series inconsistencies in the estimates, it can be observed that they do not exist in the inventory for any source category. In the inventory, Croatia uses the same data sources for the entire time series for all categories from which polluting substances are emitted into the air.

Information on priorities for improvement

The Croatian pollutant emissions inventory is subject to a process of constant improvement resulting from annual recalculations (see sector chapters 3-7, and chapter 8). Recalculations result either from the results of annual reviews of national inventories according to the UNECE Convention LRTAP (Stage 3 (in-depth) review) and the NEC Directive (Article 10 of Directive 2016/2284), the availability of new versions of the EMEP/EEA manual, the availability of higher quality activity data or includes, observed errors during data manipulation and the like. The activity of recalculations is prescribed by the NECD Regulation, into which the NECD was transposed and amended Gothenburg Protocol. The improvements aim to increase the transparency, accuracy, consistency, comparability and completeness of the information provided. Planned improvements are presented in section 8.2. The priorities for improvement can be considered those improvements concerning the transition to a higher budget level (level 2 or 3) for key category, harmonization with the latest version of the EMEP/EEA guidebook, and the implementation of recommendations of international review processes. A description of prioritization for improvement is given in section 1.2.2.

Information on recalculation

For this year's submission, the emissions of almost all pollutants were recalculated in the entire observed period of 1990-2021. years. The description and impact of recalculations on the total inventory and trends is shown in chapter 8. Quantitative differences between the last and previous submissions per pollutant and for every 5th year in the historical trend, including the penultimate historical year, are shown in table 8.1-1. The list of all performed recalculations, improvements and other activities that led to changes in the emissions of individual source categories are shown in table 8.1-2. Additionally, attachment 7 shows the impact of recalculations of emissions for each historical year in the trend and for each pollutant and by NFR / SNAP97 sector.

Information on which source sectors include the condensable component of PM_{10} and $PM_{2.5}$ and reference to relevant chapters/appendices of the report

Source categories that include the condensable component of PM_{10} and $PM_{2.5}$ are as follows: four categories of road transport (1A3b(i-iv)) calculated using the COPERT V model, mobile combustion in the manufacturing industry and construction (1A2gvii), Residential: Mobile (1A4bii), Agriculture/Forestry/Fishing: Off-road vehicles and other machinery (1A4cii), Residential: Stationary - technologies using biomass (1A4bi) and Road paving with asphalt (2D3b) for which estimates are given using EMEP/EEA GB2023 Tier 2 emission factors.

A summary tabular presentation of information on PM emission factors by source category on inclusion/exclusion of the condensable component is provided in Appendix 2 of this report. Additionally, Appendix 6 provides a summary of information on source categories whose PM emission factors include a condensable component.

Explanation of differences between reported national totals presented in Annex I to the 2023 Reporting Guidelines

An explanation is provided here for the differences in the reported national totals shown in Annex I of the reporting guidelines. Croatia reports on the national total based on fuel sold. The geographical area of the national total corresponds to the geographical scope of the EMEP. The national total for compliance and verification calculations according to UNECE CLRTAP for Croatia is the same as the national total based on fuel sold because the calculation is automated although it does not follow the prescribed in the amended Gothenburg Protocol, where the national total for European Union member States is corrected for the subtraction of sector 3D for NOx (only from 2020 onwards and for the year 2005 as a basis for calculating the obligation to reduce emissions), according to revised GP, table 3 Annex II. The national total amount for compliance with the NECD for Croatia includes the national total amount based on the fuel sold corrected for the subtraction of sectors 3B + 3D for NOx and NMVOC (only from 2020 onwards and for the year 2005 as a basis for calculating the emission reduction obligation), according to the NEC Directives, Article 4, paragraph 3, point (d). Croatia does not report the sum of approved adjustments or the sum of approved adjustments and other flexibilities (negative value) according to the NEC Directive, Article 5/2-4 from Annex VII (CLRTAP).

Clarification of the reason for differences in reported national totals for the entire territory with NECD and UNFCCC reports

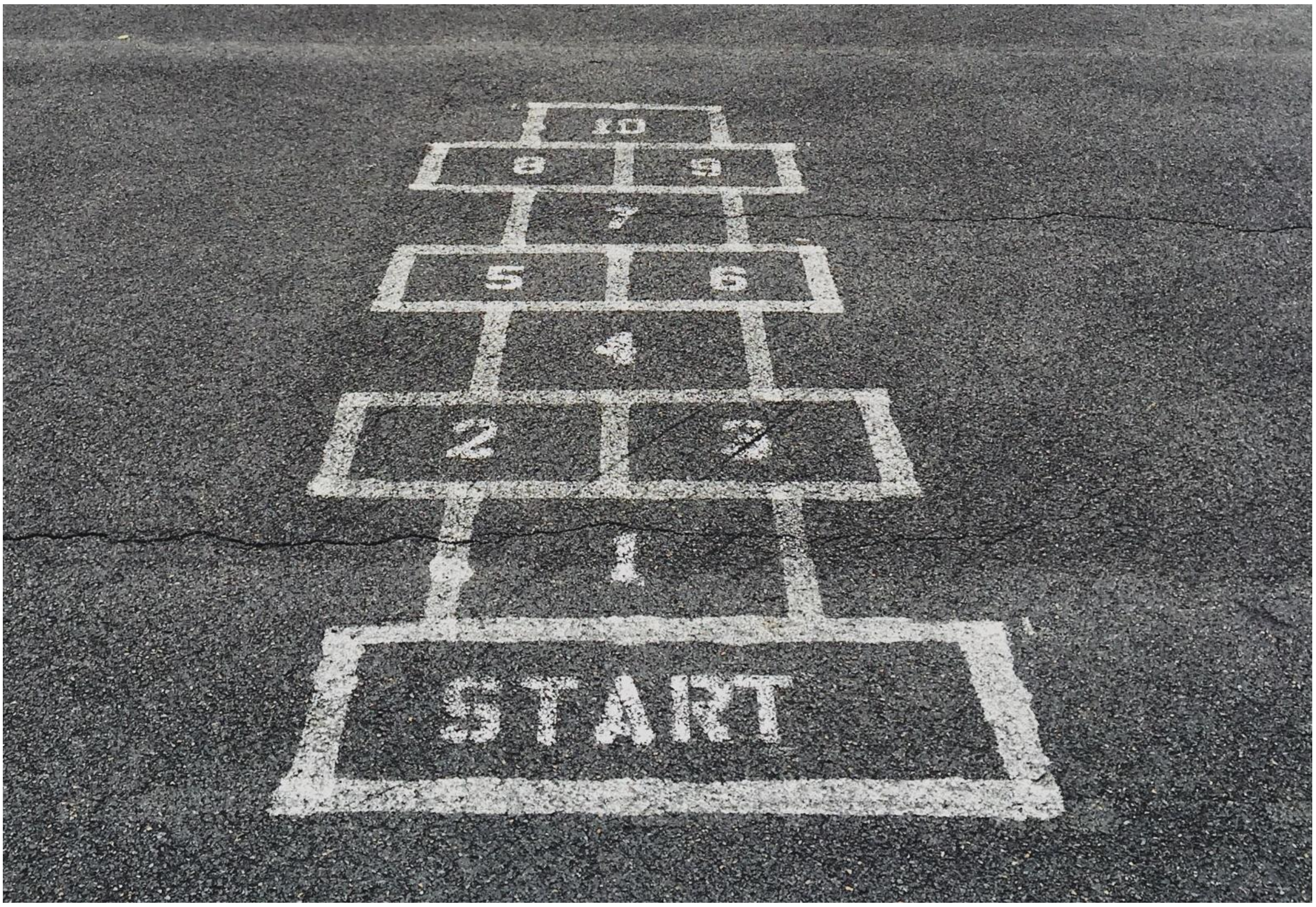
Annual greenhouse gas reporting under the United Nations Framework Convention on Climate Change (UNFCCC) also requires reporting of indirect greenhouse gas emissions (NOx, CO, NMVOC) and SO_2 based on fuel sold.

The main differences in the reported national totals for the entire territory with the UNECE CLRTAP / NECD and UNFCCC reports are in the different calculation of emissions from air and maritime transport according to the territorial perspective. Unlike the UNFCCC requirements, emissions from air transport according to CLRTAP and NECD include domestic LTO and cruises. Also, international navigation on inland waterways (ship bunkers) is covered under CLRTAP and NECD. The mentioned differences are shown in Table S-1.

Table S-1 Major differences in reporting under the CLRTAP, NECD and UNFCCC in perspective of accounting in the national totals

Source category	CLRTAP and NECD	UNFCCC
Domestic aviation (landing and take-off phases - LTO)	YES	YES
Domestic aviation (cruise phase - cruise)	memo	YES
International aviation (landing and take-off phases - LTO)	YES	memo
International aviation (cruise phase- cruise)	memo	memo
Domestic inland shipping	YES	YES
International inland shipping	YES	memo
International maritime shipping	memo	memo

YES - reported emissions are included in national total reported emissions under different legislative requirements.
memo - reported emissions are not included in national total reported emissions, and are reported as memo items.



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1. Introduction

1.1. National Inventory Background

This report is Croatia´s annual Informative Inventory Report 2024 (for period 1990 – 2022) (hereinafter referred to as IIR2024) under the UNECE - Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (hereinafter: CLRTAP) and Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (OJ L 344, 17/12/2016) (hereinafter referred to as NECD).

National legislation in the field of air protection, namely the Air Protection Act (Official Gazette 127/19, 57/22) and the Regulation on national obligations to reduce emissions of certain pollutants in the air in the Republic of Croatia (Official Gazette 76/18) (hereinafter: NEC Regulation) contain provisions that are in accordance with the aforementioned acts of the European Union.

The IIR 2024 follows recommended structure for the IIR[7], and covers all years in period from 1990 to 2022.

The air pollutants reported are main pollutants (SO_2, NOx, CO, NMVOC and NH_3), particles (TSP, PM_{10} and $PM_{2.5}$), black carbon (BC), heavy metals (Cd, Pb, Hg, As, Cr, Cu, Ni, Se and Zn) and persistent organic compounds (PCDD/PCDF, PAHs (benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene and indeno(1,2,3-cd) pyrene), HCB and PCBs).

In addition to the report form, the annual emission inventories are submitted to the Secretariat of CLRTAP and EEA in the default format for reporting, i.e. Nomenclature for reporting[8] revised on 25/09/2019. (hereinafter: NFR19-1). Croatia submits IIR and reporting formats in digital form.

The Croatian air pollution inventory has been prepared in accordance with standard methods and procedures in accordance with the EMEP / EEA air pollutant emission inventory guidebook 2023 (hereinafter referred to as GB2023) and other available technical guidance.

1.1.1. National and international reporting requirements: CLRTAP and NECD

This section provides a summary of national and international reporting requirements in accordance with CLRTAP and NECD, as well as information on the fulfilment of these requirements by the Republic of Croatia. The requirements include obligations and deadlines that the Republic of Croatia must fulfil on an annual, two-year and four-year basis.

According to the NEC Regulation (Article 16), the informative inventory reports are prepared in accordance with the latest adopted guidelines for reporting emissions and projections data under the LRTAP Convention. The 2014 Reporting guidelines (ECE/EB.AIR.125)[9], prepared by the Task Force on Emission Inventories and Projections and approved by the Executive Body, are adopted for application in 2015 and subsequent years.

The CLRTAP (and the NECD) based on 2014 Reporting guidelines prescribes use the methodologies in the latest version of the EMEP/EEA Guidebook, as approved by the Executive Body to estimate emissions and projections for each source category. Parties can use, as an

[7] Annex II of 2014 Reporting guidelines (ECE/EB.AIR.125)

[8] Annex I of 2014 Reporting guidelines (ECE/EB.AIR.125)

[9] Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution, TFEIP, March 2014, https://www.ceip.at/fileadmin/inhalte/ceip/1_reporting_guidelines2014/ece.eb.air.125_advance_version_reporting_guidelines_2014.pdf

alternative to the EMEP/EEA Guidebook, national or international methodologies that they consider better able to reflect their national situation, provided that the methodologies produce more accurate estimates than the default methods, are scientifically based, are compatible with the EMEP/EEA Guidebook and are documented in their IIRs.

The Republic of Croatia (i.e. MESD) is in accordance with the Air Protection Act and Article 12 of the NEC Regulation and as a party to the CLRTAP, the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP Protocol) and the remaining seven protocols and as a full member of the EU, is required to submit to the relevant body of the CLRTAP and to the European Environment Agency (EEA/EIONET) emission inventory and projections, spatially disaggregated emission inventories, large point source inventory and the informative inventory report by deadlines and for certain pollutants as required by Annex I of the Regulation on NEC and other deadlines for reporting purposes under the obligations of the CLRTAP.

One of the obligations of the Parties to the CLRTAP is also the annual verification of submitted reports (estimates/inventories) and emission projections by the Parties to the CLRTAP in parallel with the verification of the report in accordance with the new NECD. The annual review of the emissions in accordance with the CLRTAP is carried out by appointed experts of the parties (the so-called ROSTER list of all appointed experts who can participate in the review). The expert review teams (ERTs) are established by the EMEP CEIP for every annual review. Croatia has, so far, nominated one national expert for the ROSTER list. Each year, independently of the ERTs review, the European Commission conducts its own review of the inventory of EU Member States pursuant to the new NECD by a team of technical review experts (TERTs). For this activity, the Member State is required to nominate experts for the national expert team who will respond to all the TERT observations. The experts of the national expert team should be the same persons responsible for the preparation of the inventory of pollutant emissions in accordance with the contract between MESD and the responsible executor EKONERG ltd.

The UNECE CLRTAP is a framework agreement and the first international legally binding instrument by which States have committed themselves to combating air pollution. The aim of the CLRTAP is that Parties shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution by developing policies and strategies to combat the discharge of air pollutants through exchanges of information, consultation, research and monitoring. The CLRTAP entered into force in 1983 and currently has a 51 Party. The CLRTAP has been extended by 8 protocols (1985 – 1999) that are the key assets/legal instruments for reducing air pollution. The Protocols identify specific measures to be taken by Parties to cut their emissions of air pollutants - sulphur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOC), heavy metals (HMs) and persistent organic pollutants (POPs).

The Republic of Croatia is a party to the UNECE CLRTAP and its 7 related protocols (Table 1.1-1). Pursuant to the above, the Republic of Croatia is internationally obliged to observe the obligations stipulated by the CLRTAP and its protocols.

Table 1.1-1 Status of ratification of international treaties under the CLRTAP

Treaty	Signed by the Parties	In force since	Number of Parties	Ratified[10] by Croatia	Official gazette, No.
Convention on Long-range Transboundary Air Pollution (CLRTAP)	1979	1983	51	1992	OG-IT 12/93
Protocol on Long-term Financing of the Cooperative Programme for Monitoring and evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)	1984	1988	45	1992	OG-IT 12/93
Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent	1985	1987	25	-	OG-IT 17/98
Oslo Protocol on Further Reduction of Sulphur Emissions	1994	1998	28	1998	OG-IT 3/99
Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes	1988	1991	35	2007	OG-IT 10/07
Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes	1991	1997	24	2007	OG-IT 10/07
Aarhus Protocol on Persistent Organic Pollutants/revised in 2009	1998	2003	33	2007	OG-IT 05/07
Protocol on Heavy Metals/revised in 2012	1998	2003	33	2007	OG-IT 05/07
Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (GP)	1999	2005	28	2008	OG-IT 07/08
GP as amended on 4 May 2012 (amended GP)	2012	2019	23	2019	-

Obligations and deadlines for reducing emissions according to the protocols under CLRTAP, and NECD

According to 1994 Oslo Protocol on further reduction of Sulphur emissions (hereinafter: the Oslo Protocol) of the Convention on LRTAP, the Republic of Croatia has undertaken the obligation to control and reduce its sulphur emissions in order to protect human health and the environment from adverse effects, in particular acidifying effects. Accordingly, Croatia has committed itself to a national sulphur emission ceiling no greater than the lesser of its 1990 emissions or its obligation in the 1985 Helsinki Protocol on the Reduction of Sulphur emissions or their transboundary fluxes by at least 30 %, as indicated in annex II of the Oslo Protocol, whose emission ceilings for Croatia are presented in Table 1.1-2.

The Gothenburg Protocol to abate acidification, eutrophication and ground-level ozone in the context of the CLRTAP (hereinafter: GP) promotes an approach that takes into account the multiple effects of certain pollutants in order to prevent or to minimize exceedances of critical loads of acidification, nitrogen loads and critical levels of ozone for human health and vegetation. For this purpose, national emission quotas must be set, which each Party shall keep below the defined value until 2010 and in the following years, for the following pollutants: SO_2, NOx, NH_3 and VOC. For the Republic of Croatia, the prescribed quotas are shown in Table 1.1-2. In the legislation of the European Union (EU) and then in the national legislation, the GP was largely transposed by Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on large combustion plants and Directive 2001/81/EC of the European Parliament and Council of 23 October 2001 on the national emission ceilings for certain pollutants (old NECD).

[10] Ratification, Acceptance (A), Approval (AA), Accession (a)

Table 1.1-2 Emission quotas for certain pollutants for Croatia and deadlines achieving them

Emission quotas	Deadline	SO_2	NOx	NH_3	NMVOC
Gothenburg Protocol (GP)	2010 - onwards	70 kt	87 kt	30 kt	90 kt
Amended GP	2010 - 2020 for parties that ratified the GP before 2010 (Annex II ECE/EB.AIR/114)				
Directive 2001/81/EC	1. July 2013				
Protocol on further reduction of Sulphur emissions	2000	133 kt	-	-	-
	2005	125 kt	-	-	-
	2010	117 kt	-	-	-

The GP was amended in 2012 by Executive Body decisions 2012/1 and 2012/2 to include national emission reduction commitments to be achieved by 2020 and beyond. Amended GP version entered into force on October 7, 2019 and established emission reduction commitments (so-called ERCs) for 2020 for five pollutants: NOx, SO_2, NMVOC, NH_3 and $PM_{2.5}$ (table 1.1-3). The same ERCs for 2020 were agreed in Directive 2016/2284/EU (NECD). ERCs are expressed as a percentage of the reduction commitment in 2020 compared to the level of emissions in 2005. The NECD sets emission reduction commitments for two periods: from 2020 to 2029 and from 2030 onwards, which are listed for Croatia in table 1.1-4.

The definitions of what counts for the purposes of checking compliance with the amended Gothenburg Protocol and the NECD differ. For the NECD, NOx and NMVOC emissions from NFR categories 3B and 3D are excluded when determining compliance (Article 4, paragraph 3, NECD). The above is also calculated as part of the NFR template, line 154 (Annex 1 to the reporting guidelines). For reporting under amended GP, UNECE, NOx emissions from NFR category 3D are excluded from the reduction obligation (Article 4 paragraph 3(d) NECD).

It should be noted that the template NFR line 152 (Annex I to the reporting guidelines) does not correctly calculate the total compliance for NOx according to the GP, UNECE (Table 3 of Annex II of the revised GP) because it does not take into account that NOx from the NFR category 3D should be excluded for EU parties. Therefore, the NOx numbers shown in Table 1.1-3 differ from the total compliance calculated in the NFR template.

Table 1.1-3 Emissions, achieved reduction and reduction commitments in accordance with GP, UNECE (ECE/EB.AIR/114)

Pollutant	Emission, kt				Reduction achieved			Reduction commitment compare with 2005
	2005	2020	2021	2022	2020	2021	2022	for 2020 and onwards
SO_2	58,7	6,1	5,6	5,5	-90%	-90%	-91%	-55 %
NOx*	78,9	40,9	42,0	42,1	-48%	-47%	-47%	-31 %
NH_3	39,7	31,1	29,8	26,9	-22%	-25%	-32%	-1 %
NMVOC	113,5	69,2	67,5	61,1	-39%	-41%	-46%	-34 %
$PM_{2.5}$	43,4	27,8	29,1	26,2	-36%	-33%	-40%	-18 %

* Emissions from soil are not included in the calculation for the year 2005 for the member states of the European Union (according to table 3 of Annex II of the revised GP). Emissions from soils are emissions from NFR 3D.

Table 1.1-3 shows that Croatia has fulfilled the ERC according to UNECE for all pollutants.

So far, Croatia has not submitted a request for adjustment for any pollutant (Chapter 11).

Table 1.1-4 Emissions, achieved reduction and reduction obligations in accordance with NECD (2016/2284/EU)

Pollutant	Emission, kt				Reduction achieved			Reduction commitment compare with 2005	
	2005	2020	2021	2022	2020	2021	2022	for 2020 to 2029	for 2030 onwards
SO_2	58,7	6,1	5,6	5,5	-90%	-90%	-91%	-55 %	-83 %
NOx*	78,5	40,8	41,9	42,1	-48%	-47%	-46%	-31 %	-57 %
NH_3	39,7	31,1	29,8	26,9	-22%	-25%	-32%	-1 %	-25 %
NMVOC*	104,0	60,2	58,7	52,7	-42%	-44%	-49%	-34 %	-48 %
$PM_{2.5}$	43,4	27,8	29,1	26,2	-36%	-33%	-40%	-18 %	-55 %

* In order to comply with the emission reduction targets, emissions of nitrogen oxides and non-methane volatile organic compounds resulting from activities covered by categories 3B (manure management) and 3D (agricultural soils) of the nomenclature for reporting (NFR) from 2014 are not taken into account, as foreseen By the LRTAP Convention, Article 4, Paragraph 3(d) of the NECD

Table 1.1-4 shows that according to the NECD, Croatia has fulfilled the ERC for all pollutants.

The the Protocol on Persistent Organic Pollutants (hereinafter: POPs Protocol) entered into force for the Republic of Croatia on December 6, 2008. Pursuant to paragraph 5(a) of Article 3 (Principal Obligations), "each party shall reduce its total emissions of each of the substance listed in Annex III of the POPs Protocol to the emission level in the reference year, which is determined in accordance with the same Annex, by taking effective measures, appropriate for each of the listed substances." The reference year for the Republic of Croatia in terms of all POPs is 1990. Therefore, Table 1.1-5 provides an overview of emission levels for individual POP, up to which it is necessary to reduce emissions if they currently exceed that level.

Table 1.1-5 Emission levels for certain POPs according to POPs Protocol

Pollutant		Emission		Reduction achieved
		1990*	2022	2022
Polycyclic aromatic hydrocarbons (PAHs)**	t	83,8	25,0	-70%
Dioxins and furans (PCDD/PCDF)	g I-TEQ	23,3	13,3	-43%
Hexachlorobenzene (HCB)	kg	7,1	0,3	-95%
Polychlorinated biphenyls (PCBs)	kg	5,0	3,2	-35%

* according to Annex III, POPs Protocol
** For the purposes of emission inventories, the following four indicator compounds shall be used: Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene and Indeno(1,2,3-cd)pyrene

Table 1.1-5 shows that according to the POPs Protocol, Croatia has fulfilled the ERC for all persistent organic pollutants: PAH, HCB, PCB and PCDD/PCDF.

In accordance with CLRTAP Executive Body's Decision 2002/10[11], on emission data reporting under the CLRTAP and the Protocols in force, Croatia is obliged to report on air emissions in line with Emission Reporting Guidelines[12] and methodology described GB2023. Specifically, the application of annual emissions under the CLRTAP consists of the preparation of NFR formats (emission inventor) and Informative Inventory Report (IIR). Croatia, as a Party to the

[11] Decision 2002/10 on emission data reporting under the Convention and the Protocols in force, ECE.EB.AIR/77/Add.1, 2002
[12] Emission Reporting Guidelines, ECE/EB.AIR/80, 2003

UNECE CLRTAP and its Protocols, in 1998, submitted its first national emission calculation and IIR for emissions in 1996.

Reporting obligations and deadlines according to CLRTAP and NECD are as follows:

- Emission inventories (full time series of emissions and activity data) (Annex I) annually by 15 February
- Informative Inventory Report (IIR) (Annex II) annually by 15 March
- CLRTAP only: emission projections (Annex IV) 2015 onwards every four years by 15 March
- NECD only: emission projections (Annex IV) 2017 onwards every two years by 15 March
- Spatially-disaggregated emission inventory (gridded data) (Annex V) 2017 onwards every four years by 1 May
- Large point source inventories (LPS information) (Annex VI) 2017 onwards every four years by 1 May
- CLRTAP only: notification on new adjustment application (if applicable) by 15 February
- CLRTAP only: supporting documentation for new adjustment application by 15 March
- NECD only: National air pollution control programmes 2019 onwards every four years by 1 April.

A summary of the annual reporting requirements for estimating and reporting emissions under the national NEC Regulation, international CLRTAP and European NECD is given in Table 1.1-6, and a summary of two yearly and four yearly reporting requirements in Table 1.1-7.

Table 1.1-6 Summary of annual reporting requirements for estimating and reporting emissions under the national Regulation on NEC, international the CLRTAP and European NECD

Group	Pollutant	Required reporting years	Reported years in 2024 Croatia submission
Main Pollutants	Nitrogen Oxides	1990 – reporting year minus 2	1990-2022
	Sulphur Dioxide		
	Non-Methane Volatile Organic Compounds		
	Ammonia		
Other	Carbon Monoxide	1990 – reporting year minus 2	1990-2022
Particulate Matter	Particulate Matter < 10 µm	2000 – reporting year minus 2	1990-2022
	Particulate Matter < 2.5 µm		
	Total Suspended Particulates (voluntary reporting)		
	Black Carbon (voluntary reporting)		
Priority Heavy Metals	Lead	1990 – reporting year minus 2	1990-2022
	Cadmium		
	Mercury		
Additional Heavy Metals	Copper (voluntary reporting)	1990 – reporting year minus 2	1990-2022
	Zinc (voluntary reporting)		
	Nickel (voluntary reporting)		
	Chromium (voluntary reporting)		
	Arsenic (voluntary reporting)		
	Selenium (voluntary reporting)		

Group	Pollutant		Required reporting years	Reported years in 2024 Croatia submission
Persistent Organic Pollutants	PCDD/ PCDF (dioxins/ furans)		1990 – reporting year minus 2	1990-2022
	PAHs	Benzo[a]pyrene		
		Benzo[b]fluoranthene		
		Benzo[k]fluoranthene		
		Indeno(1,2,3-cd)pyrene		
		Total 1-4		
	Hexachlorobenzene			
	Polychlorinated Biphenyls			
Activity data by NFR source category and by SNAP category in IIR	Liquid Fuels		1990 – reporting year minus 2	1990-2022
	Solid Fuels			
	Gaseous Fuels			
	Biomass			
	Other Fuels			
	Other activity			

Table 1.1-7 Summary of two yearly and four yearly reporting requirements under the national Regulation on NEC, international the CLRTAP and European NECD

Element	Pollutant	Mandatory reporting years	Mandatory in the 2024 submission
Gridded data in the new EMEP grid (0.1° × 0.1° long-lat) by source category (GNFR)	SO_2, NO_x, NH_3, NMVOC, CO, PM_{10}, $PM_{2.5}$, BC (voluntary reporting), Pb, Cd, Hg, PCDD/PCDFs, PAHs, HCB, PCBs	Every four years for reporting year minus 2 (X-2) as from 2017	Not mandatory
Emissions from large-point sources (LPS) by source category (GNFR)	SO_2, NO_x, NH_3, NMVOC, CO, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, PCDD/PCDFs, PAHs, HCB, PCBs	Every four years for reporting year minus 2 (X-2) as from 2017	Not mandatory
Projected emissions by aggregated NFR	SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$, BC (voluntary reporting)	CLRTAP: report every 4 years from 2015 onwards, for years 2025, 2030, (2040, 2050 if available) NECD: report every 2 years from 2017 onwards, for years 2025, 2030, (2040, 2050 if available)	Not mandatory, but reported, since it is not 2023.
Projected activity parameters	-	Reported for the projection target year and the historic year chosen as the starting year for the projections	Not mandatory, but reported, since it is not 2023.

The national inventory is updated annually in order to reflect the availability of new information, sectoral improvements, implementation of higher Tier (e.g. Tier 2), change in methodology used, identification of time series inconsistency, the accuracy of the estimates, inclusion of technical corrections or recommended revised estimates by teams for revision under the CLRTAP and the NECD and the reduction of the uncertainty. Recalculations are applied retrospectively to earlier years, which accounts for any difference in previously published data. Conducted recalculations are described in detail in Chapters from 3 to 7, and in the section 8.1 with their summary. Additionally, Appendix 8 shows the impact of all recalculations carried out by pollutant, year and NFR/SNAP97 sector.

The default NFR nomenclature (CLRTAP) is fully consistent with the CRF nomenclature under the UN Framework Convention on Climate Change (UNFCCC), with the overall aim of harmonization reporting formats.

Required source categories, i.e. sectors reported in the national air pollutant emissions inventory

The Croatian national inventory of air pollutant emissions, in accordance with international guidelines on emission inventory reporting (ECE/EB.AIR.125), contains emission calculations from all sources of emissions that exist and/or have existed in the territory of the Republic of Croatia since 1990. Sources of emissions are grouped into NFR categories in accordance with the prescribed methodology. One NFR source category contains one or more SNAP sources, which are considered the lowest, i.e. the most detailed, level at which emissions are calculated. One SNAP source or a group of identical SNAPs constitutes a single NFR source category, and a group of several identical NFR categories constitutes one sector (or sub-sector). The main sectors (and sub-sectors) are:

- NFR 1 Energy
    - NFR 1A Combustion
    - NFR 1B Fugitive emissions from fuels,
- NFR 2 Industrial processes and product use,
- NFR 3 Agriculture
- NFR 5 Waste
- NFR 11 Natural sources (not included in the national total).

The link between the categories of different reporting formats (*NACE*, *SNAP*, *NFR*, *CRF*, *E-PRTR*, *GAINS/RAINS*) is given in the so-called "Mapping Table" created by a team of Finnish and Estonian emission experts and available at the web link: https://www.ceip.at/reporting-instructions.

The sources that are excluded from the the inventory emission estimates in accordance with the EMEP/EEA methodology are:

- Natural sources are not included in the national totals but estimates of some sources and pollutants are made (e.g. forest fires) and reported as memo items.
- Secondary emission sources to atmosphere such as, re-suspension of particulate matter is not included in the national totals.
- Secondary pollutants, such as tropospheric ozone, is also not included in the national totals.
- Cruise emissions from civil and international aviation are made and reported as memo items (i.e. excluded from the Croatia national totals).
- Estimates of "International" emissions such as shipping are made and reported as memo items (i.e. excluded from the Croatia national totals).

1.2. Institutional and organizational arrangements for inventory preparation

1.2.1. Institutional responsibilities for the inventory planning, preparation and management

An important pre-condition for efficient data management system and development of the inventory is a clearly defined organization, competences and responsibilities of institutions involved in the process of developing the inventory, which includes a number of steps to be taken in the collection and processing of data, calculation, control and verification of emission inventories and documentation and communication to competent international bodies.

In terms of organizational arrangements, Croatia uses decentralized model in which particular tasks of inventory preparation is delegated to domestic public and professional institutions.

In accordance with the national law governing air protection, the competent authority for ensuring the preparation of national inventories, annual emissions inventories, emission projections, spatially disaggregated emission inventories, large point source inventories, adjusted emissions inventories (as necessary) and informative inventory reports is MESD, which delivers them in accordance with international obligations. The aforementioned activities are carried out by “authorized persons”[13] in accordance with the law governing environmental protection. State administration bodies and legal entities with public powers are responsible for securing data on activities and emissions by sector, necessary for the preparation of the mentioned jobs. The authorized person is, based on the public procurement agreement for MESD[14], “Service of creating an expert basis for the needs of reports on emissions for the air pollutants in accordance with the requirements of the LRTAP Convention and the NEC Directive for 2023 and 2024“, No: 800/02-23/22JN, company EKONERG ltd. from Zagreb.

For a summary of all data providers to the preparation of air pollution inventory, see section 1.4.1. The key official data providers are:

- The Ministry of Economy and Sustainable development[15] with assistance of Energy Institute Hrvoje Požar that prepares the national annual energy balance and is competent for the Environmental Pollution Register (EPR[16]) and for “the Volatile Organic Compounds”[17] web database (hereinafter: HLAP database);
- The Central Bureau of Statistics (Business Statistics Sector) that, on the basis of the statistic survey programme, collects data on the amounts of raw materials and products relating to activities defined by the National Classification of Business Activities and provides statistical databases;
- The Ministry of Interior keeps data on number of registered road vehicles and off-road vehicles, and fire records;

[13] Authorized person is a legal or physical person-craftsman who has permission to perform professional work in the field of environmental and nature protection (Ar. 1, par. 48 of Environmental Protection Law (OG 80/13,153/13,78/15, 12/18, 118/18)

[14] Contracting authority in the procurement process, responsible for the annual preparation and submission of the annual IIR and NFR tables to the UNECE-LRTAP Convention and the European Commission.

[15] Since December 2011 Ministry of Economy, since 19 October 2016 Ministry of Environment and Energy, since 22 July 2020 Ministry of Economy and Sustainable development.

[16] EPR – Environmental Pollution Register: set of data on sources, type, amount, manner and place of discharge, transfer and pollutants and waste disposal into environment based on the *Ordinance on the Environmental Pollution Register (OG 3/22)*

[17] The "Volatile Organic Compounds" database consists of two databases: "Volatile Organic Compounds in Paints and Varnishes" and "Emissions of Volatile Organic Compounds". The database "Volatile organic compounds in paints and varnishes" was established in accordance with the Regulation on limit values for the content of volatile organic compounds in certain paints and varnishes used in construction and vehicle finishing products (OG 86/21). The "Emissions of volatile organic compounds" database meets the requirements of the Regulation on limit values for emissions of pollutants into the air from stationary sources (OG 42/21).

- The Ministry of Agriculture; provides data from its records in the field of animal husbandry, plant protection products, hunting, and provides expert support with data on current practices in Croatian agriculture (such as assessment of burning, etc.)
- The EUROCONTROL data;
- The EUROSTAT data.

Activity data provided through questionnaires completed directly by individual emission sources or other specialized institutions are used in the development and improvement of the inventory to calculate and check the data provided by official publications and data bases.

The Figure 1.2-1 shows the structure and components of the Croatian national system for emissions inventories, stakeholders and their responsibilities and obligations. The figure also illustrates the flow of data from official data providers and datasets, other data provider sources through the data collection system and national databases to the main reporting outputs.

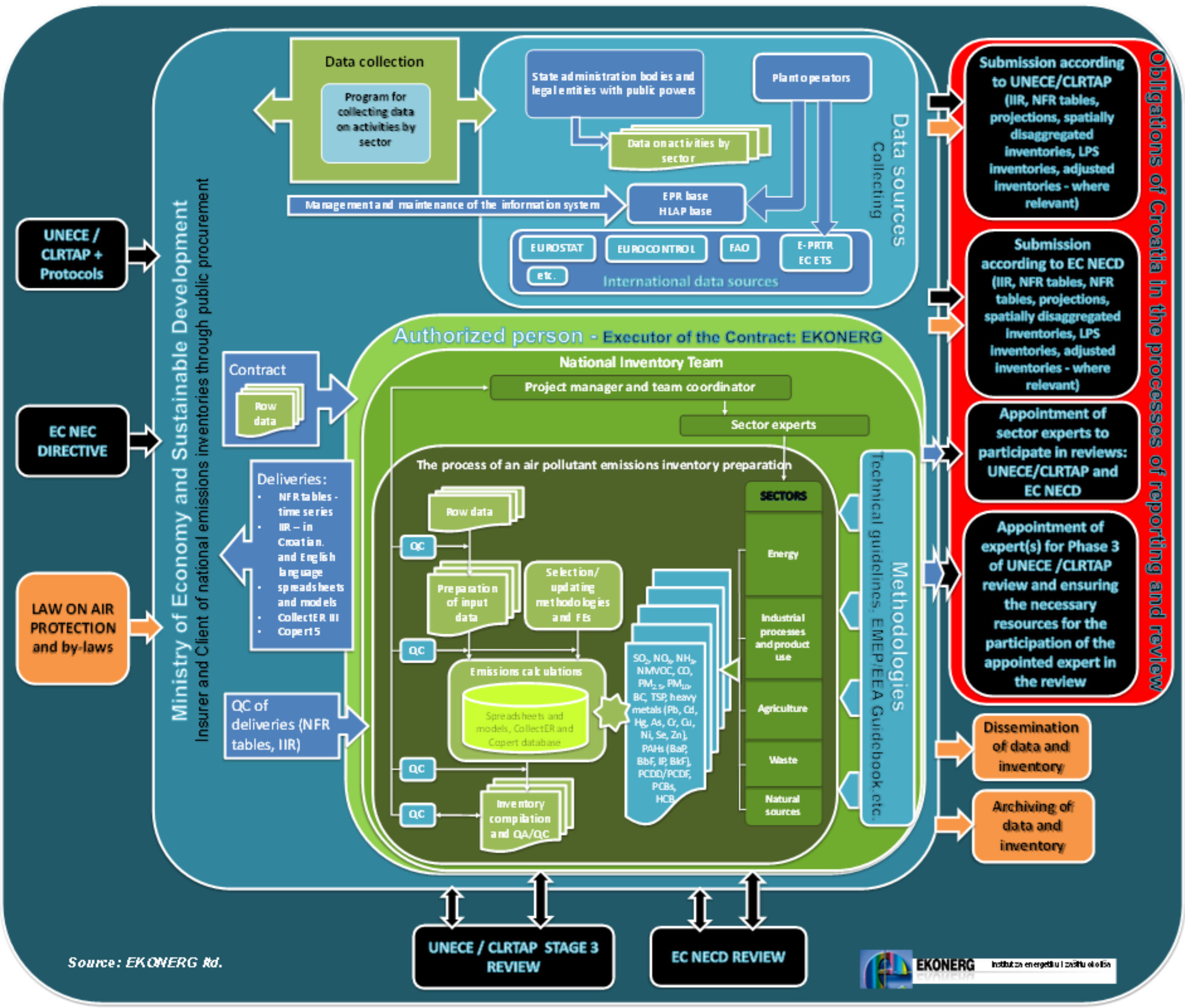


Figure 1.2-1 Croatian national system for the air pollutant emissions inventory

It is also necessary to highlight the responsibilities of MESD for the review process (see Figure 1.2-1). Namely, parties to the CLRTAP are responsible for nominating national expert(s) for phase 3 of the audit for the annual inventory review process in accordance with CLRTAP and providing the necessary resources so that the appointed expert(s) can participate in the audit. The list of appointed party experts who can participate in the in-depth S3 annual inventory review in accordance with CLRTAP is the so-called ROSTER. Each year, the expert review teams (ERT) in terms of selecting experts from the ROSTER are established and implemented by EMEP CEIP.

The responsibility and obligation for the audit process derives from 7 (b) II. ECE/EB.AIR/GE.1/2007/16, Responsibilities for the review process, EB.AIR/GE.1/2007/16 (methods and procedures for the technical review of air pollutant emission inventories reported under the convention and its protocols).

1.2.2. Inventory improvement process

The goal of the inventory improvement process is to ensure the best possible quality of data on emissions for the national, EU and international levels as support for decision-making on environmental protection. Therefore, activities that continuously improve the quality of the inventory, i.e. its transparency, accuracy, completeness, comparability and consistency, are carried out regularly on an annual basis.

The inventory improvement process is part of the inventory preparation process. During the inventory preparation process, the inventory team documents all findings from the QA/QC process and the findings of the TERT and ERT review bodies and provides a list of planned and implemented improvements (see chapter 8). In addition, the inventory team determines the priorities for future improvements. Details on the annual revisions that the national emission inventory undergoes can be found in section 1.6.1.

The implementation of priority improvements depends on securing the financial and time frame and technical details related to the development, which is the responsibility of MESD, and technical support, which depends on the public procurement process and its timely implementation.

Description of prioritization of improvements

Priority improvements are determined based on the analysis of key categories (see section 1.5). According to the EMEP/EEA methodology, all key categories must be calculated using the Tier 2 or 3 method. This means that if the country uses the Tier 1 method, the uncertainty of the inventory for that category is high, that is, the emissions for that category are either underestimated or overestimated. The review reports that are submitted to the state after the detailed in-depth annual reviews are completed contain a list of findings and recommendations (see section 8.3) that the inventory team must include in the list for improvement. A priority improvement is, for example, alignment with the newer version of the EMEP/EEA guidebook if the emission estimation methodology for a key category has changed significantly, whether it is a change in the emission factor or a request to provide more detailed activity data. For the preparation and implementation of priority improvements, a shorter period is proposed and planned, usually a period of one to two years.

Inventory improvements for non-key categories are of lower priority and a longer timeframe for implementation and implementation is planned for them.

The inventory team assesses the technical requirements for the development, preparation and implementation of individual improvements and informs MESD about this, which then plans the resources and ensures the timeliness of the implementation of the improvements. If it is an improvement that refers, for example, to the correction of existing activity data or emission factors for one or more years, then it is carried out in the cycle of the annual preparation of the inventory and does not require the provision of an additional financial and time frame. Such improvement can also be prioritized if the category is key category.

1.3. The process of inventory preparation

The process of inventory preparation has three main phases: planning, preparation and reporting and archiving described below.

1.3.1. Planning

Planning phase includes activities related to organizational, technical and financial, and timeframe aspects of inventory preparation. In the national level management and planning process the MESD has following main roles and responsibilities:

- planning financial resources and time frame for the implementation of the activities required in the next reporting year: annual preparation of emission inventories, improvement of emission inventories, emission projections, spatially disaggregated inventories, large point sources inventories, if appropriate adjusted emission inventories, and informative inventory reports;
- preparation of tender documentation (inclusion of timetable according to EMEP/EEA reporting programme);
- signing the contract with the executor (Authorized company - company authorized for annual emission inventories, improvement of emission inventories, emission projections, spatially disaggregated inventories, large point sources inventories, if appropriate adjusted emission inventories, and informative inventory reports;
- procurement and management of contracts which deliver and report for annual emission inventories, improvement of emission inventories emission projections, spatially disaggregated inventories, large point sources inventories, if appropriate adjusted emission inventories, and informative inventory reports;
- nomination of the national experts for the member state review team for communication and responding to observations (comments) of TERT and ERT review bodies in annual reviews by the EC in accordance with NECD and by CLRTAP;
- nomination of the national expert(s) for the ROSTER (a list of appointed experts of the parties who can participate in the annual review of the emissions in accordance with the CLRTAP). The expert review teams (ERTs) are established by the EMEP CEIP for every annual review.
- preparation of the annual data collection programme
- planning data collection with other data providers and in doing so cooperate with the data providers to ensure that the collected data or data sets are suitable for use.

Executive authorized company in accordance with the law governing environmental protection has the following main roles and responsibilities:

- overview of existing / updated reporting guidelines and guidebooks (reporting requirements, submitting deadlines, latest methodology)
- analysis of recommendations for inventory improvement from previous submissions or gave by expert review teams if such exists,
- assessment of required development actions,

- scheduling of tasks and responsibilities of the personnel involved in emission inventory to ensure timely and accurate delivery of contracted outputs,
- scheduling of activities for data QA/QC (Appendix 5).

1.3.2. Inventory preparation

Inventory preparation phase is a central phase in the process. The roles and responsibilities are divided between MESD and contracted authorized company. In inventory preparation process MESD is responsible for:

- collection of activity data according to the annual data collection program, which includes requests to data suppliers by letter, e-mail, phone, and delivery of the collected data to the contracted authorized company,
- conducting QA/QC procedures of delivered inventories and IIR reports, their confirmation and submission to CLRTAP and NECD.

Contracted authorized company is responsible as follows:

- managing and conducting of QA/QC procedures and activities across all aspects of the inventory preparation process,
- identification and updating of emission sources according to last NFR format,
- analysing and processing of raw activity data,
- updating the whole timeseries to take account of improved data and any advances in the methodology used to estimate the emissions,
- emissions calculations and recalculation (if necessary) of all NFR source categories at the SNAP level, with the use of CollectER III and COPERT databases and engineering mathematical models and submodels for calculations using a higher tier methodology (Tier 2 and 3) performed in Excel,
- maintaining the databases (CollectER III and COPERT V), additional tools and mathematical models and submodels,
- preparation and delivery of the contracted tasks (IIR, associated datasets and formats, and other contracting reports) on time and with quality,
- presentation of the prepared inventories to the Client, in which the key sources, implemented improvements and recalculations with their impact on emissions should be highlighted.

For each submission, databases and additional tools, models and submodels are linked and consolidated into an NFR reporting format. For details on the creation of the NFR reporting format, see section 1.4.

1.3.3. Reporting and archiving

The inventory preparation phase is followed by the reporting and archiving phase in which the MESD has following roles and responsibilities:

- submission of the annual emission inventories, emission projections, spatially disaggregated inventories, large point sources inventories, if appropriate adjusted emission inventories, and informative inventory reports,
- information dissemination,

- information archiving.

Contracted authorized company is responsible for:

- archiving of historic datasets (and ensuring the security of historic electronic data), activity data and emission factors are archived and stored in the CollectER III and COPERT V databases, as well as in mathematical models and submodels derived in the Excel interface with activity data owned by MESD;
- documenting QA/QC procedures and activities in the IIR;
- maintaining a reference literature.

The MESD is insuring the air emission inventory information dissemination to the public through the following websites:

- https://mzoe.gov.hr/o-ministarstvu-1065/djelokrug-4925/okolis/zrak/emisije-u-zrak/1312 for IIR, annual data collection programme, QA/QC plan and GB2023,
- https://emep.haop.hr/ - Croatia spatial distribution portal for spatially disaggregated emissions.

IIR and required reporting formats are available on CEIP website: https://www.ceip.at/status-of-reporting-and-review-results and in Eionet central data repository on links:

http://cdr.eionet.europa.eu/hr/un/clrtap/ and http://cdr.eionet.europa.eu/hr/eu/nec_revised/.

Submission of IIR and requested formats is carried out in accordance with the Guidelines for Reporting Emissions and Projections Data under the CLRTAP[18] in the prescribed deadlines and scope (Tables 1.1-5 and 1.1-6). Detailed and updated information related to the deadlines and scope of reporting are available on official EMEP[19] /CEIP[20] web page – www.ceip.at/, and on official EEA webpage: https://www.eea.europa.eu/themes/air/air-pollution-sources-1/national-emission-ceilings.

The Republic of Croatia electronically submits its data to the EMEP Centre for Emission Inventories and Projections (CEIP) (emep.emissions@,umweltbundesamt.at)) or alternatively to the EIONET Central Data Repository, maintained by EEA. Inform the UNECE secretariat of LRTAP Convention (krzysztof.olendrzynski@,iu'i.org) of the contents of its data submission by means of the enclosed notification form (but without sending the data files to the secretariat).

Reporting under the new NECD is fully consistent with reporting under the CLRTAP.

1.4. Used methods and sources of activity data

The methodology used for preparing the air pollutant emissions inventory is the recommended EMEP/EEA methodology, along with use of the EMEP/EEA GB2023 to the greatest extent possible for the 2024 submission.

For more details on methodology see section 1.4.2. and chapters 3-7.

Croatia uses the CollectER III and COPERT V databases to prepare the inventory. The CollectER III database supplements with additional mathematical models and submodels for

[18] ECE/EB.AIR/125, Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution, TFEIP, March 2014.

[19] EMEP European Monitoring and Evaluation Programme is a scientifically based and policy driven programme under the CLRTAP for international co-operation to solve transboundary air pollution problems.

[20] CEIP: The EMEP Centre on Emission Inventories and Projections hosted by the Umweltbundesamt, the Austrian Environment Agency, which became operational on 15 January 2008.

emission calculations using the higher tier methods (e.g. Tier 2) and additional tools (e.g. consolidation of activity data of different SNAP and NFR categories). The CollectER III database is also archive of used emission factors, activity data, data on large point sources (direct emissions) and resulted emissions for the entire historic trend. In this database, all activity data, emission factors and emissions are defined in SNAP source categories (Selected Nomenclature for Air Pollution) according the CORINAIR system. Emissions of individual SNAP source categories are aggregated to the NFR reporting structure (details available at: https://www.ceip.at/reporting-instructions) and exported from the CollectER database. Emissions and activity data for each year are exported from the COPERT V database in the original NFR table format, which are combined into a single Excel file containing all NFR categories for road transport for all years in a historical series. All mathematical submodels and tools contain prepared forms for entering emission data and activity data into the default NFR reporting format for all years in the historical series. Complete emissions inventories are prepared by combining exported NFR categories from the CollectER database, exported categories from the COPERT database and connecting them to the NFR format and connecting the NFR format to all models, submodels and tools.

For each submission, databases, additional submodels, working Excel tables (with graphics and tables) and the resulting NFR reporting format and the IIR are sent to the MESD who is responsible the archive process. Additionally, this material is placed on central EKONERG servers, which are subject to routine back-up services.

The following sections provide an overview of activity data used to prepare the emissions inventory and their sources (section 1.4.1) and details of the methods used to calculate emissions (section 1.4.2). For more details on sectoral methodologies, see Chapters 3-7.

1.4.1. Activity data sources

Activity data needed for emissions calculation are extracted from regular publications and databases of Central Bureau of Statistics and other relevant governmental organizations and ministries. For particular sub-sectors and source categories, data that are more detailed are required then those published in official statistical reports, such as disaggregated energy balance, vehicle fleet etc.). Beside official publications, MESD sends questionnaires directly to the LPS asking for activity data, which they use for emissions calculations in order to check consistency of data provided by different sources (see chapter on quality control). The Table 1.4-2 gives the overview of the official and other activity data sources in relation to the NFR sectors.

Table 1.4-2 Official and other activity data sources for NFR sectors

NFR Sector	Activity data	Source
1 Energy 1 A 1 Energy Industries	Fuel sold, fuel consumption and fuel characteristic data for thermal power plants	Energy balance, MESD with assistance of Energy Institute Hrvoje Požar
		EPR, MESD
		National electricity producer
	Sulphur content in fuel	Major national fuel producer
1 A 2 Manufacturing Industries and Construction	Fuel sold Fuel consumption	Energy balance and Industry analysis balance, MESD with assistance of Energy Institute Hrvoje Požar
		EPR, MESD
		Major national industry companies
	Sulphur content in fuel	Major national fuel producer

NFR Sector	Activity data	Source
1 A 3 Transport	Fuel sold	Energy balance, MESD with assistance of Energy Institute Hrvoje Požar
	Number of vehicles	Vehicle data base, the Ministry of Interior
	Annual mileage	Statistical yearbook, CBS
	Min. and max temperature for big towns	Statistical yearbook, CBS
	Sulphur content in fuel	Major national fuel producer
	Vapor pressure for petrol fuels	National regulations
	Annual national statistical data on the number of ship arrivals in Croatian ports (seaports and inland ports, ie river ports)	MESD, Ministry of Sea, Transport and Infrastructure, Survey requests to ports
	Number of flights and fuel amount by cycle and routes	EUROCONTROL data (from 2005)
	Annual take-off and landing number by aircraft type and at airports	Croatian Civil Aviation Agency
	Average flight time by type of aircraft for domestic aviation and international air transport. In respect of international air transport by category of flights shorter than 1,000 nm and for flights longer than 1,000 nm (km or nm of airline)	Croatian Civil Aviation Agency
1 A 4 Residential – public – commercial sector – agriculture / forestry / fishing	Fuel sold (except biomass – wood); Collected wood, i.e. wood directly cut from the forest outside of formal market activity	Energy balance, MESD with assistance of Energy Institute Hrvoje Požar
	Sulphur content in fuel	Major national fuel producer
1 B Fugitive Emissions from fuel	Amount of fuel treated, stored, distributed	Energy balance, MESD with assistance of Energy Institute Hrvoje Požar, Plinacro Ltd.
	Data on production and used inputs	MESD (survey request: oil refineries)
	Emission data	EPR, MESD
2 Industrial Processes and Product Use	Production/consumption data	Annual Report on Industrial Production – PRODCOM, CBS
		EPR, MESD
		MESD (survey requests to manufacturers)
		HLAP database, MESD
		Croatian Asphalt Association
	Import and export data	EUROSTAT database (from 2001)
	Fuel sold for non-energy consumption	Energy balance, MESD with assistance of Energy Institute Hrvoje Požar
	Population data	Statistical yearbooks, CBS
3 Agriculture	Number of animals	Statistical yearbook, CBS, The Single Register of Domestic Animals – Ministry of Agriculture, FAO
	Amount of N-fertilizers sold	MESD (survey requests to manufacturers)
	Nitrogen from a sewage sludge when used in agriculture	MESD
	Crop yield and harvested area	Statistical yearbook, CBS
	Data on crop yield and area of crop to be burned	Statistical yearbook, CBS, Ministry of Agriculture
5 Waste	Mass of waste disposed of at landfills	EPR, Waste Management Information System, MESD
	Mass of waste treated by composting	EPR, Composting facilities
	Mass of waste treated by anaerobic digestion	EPR, Biogas facilities
	Mass of waste incinerated and open burning of waste	EPR (waste incinerated) Ministry of Agriculture (MA),

NFR Sector	Activity data	Source
		APPRRR (compliance violations), CBS (open burning of waste)
	Statistical data related to living conditions in households	Censuses for 1981, 1991, 2001, 2011, 2021 - CBS
	Volume of treated wastewater	Statistical Reports and Releases, CBS
	Number of car and house fires	Ministry of Interior
11 Natural sources	Area of land burned and amount of wood burned	Statistical yearbooks and statistical data bases (HR-STAT), CBS
	Numerical status of wild animals by species, hunting statistic of wild animals by species, hunting area, population of the Republic of Croatia	Statistical yearbooks and statistical data bases (HR-STAT), CBS
	Numerical status of wild animals by species, hunting statistic of wild animals by species, animal weight by species	Ministry of Agriculture

1.4.2. Methodology

Emission estimation methods use for the preparation of the Croatian emission inventories follow the methodologies contained in the latest version of the EMEP/EEA Guidebook to the greatest extent possible. As an alternative to the EMEP/EEA Guidebook, in some cases, national methodologies or methodologies of neighbouring countries and/or comparable countries are used, considering the source category, and which are also compatible with the EMEP/EEA Guidebook. These methods are used in the case when the activity is not available for the application of the methodologies contained in the EMEP/EEA Guidebook or that is consider better able to reflect Croatian situation.

With trend consistency in mind, a complete time series, including the base or reference year and all other years for which emissions are reported, are calculated using the same methodology throughout the time series to ensure that the inventory reflects real changes in emissions rather than changes in methodologies. Therefore, any recalculations involving a change in methodology are applied to every year in the full time series to ensure consistency across years.

After all the available activity data have been collected, they are distributed according to NFR and SNAP source categories, sectors, sub-sectors and, together with the associated and updated emission factors, are entered into the CollectER III database (version of October 3, 2010), which, due to structural limitations, is mainly used for emission estimations with Tier 1 method and for large point sources (*DE* – direct emissions).

For the emission estimations with Tier 2 method and for certain more complex emission estimations using Tier 1 method, the engineering-mathematical models derived in the Excel interface are used (e.g. Non road mobile machinery (1.A.2.gvii and 1.A.4.ii), agriculture (3.B and 3.D), use of pesticides (3.D.f), Field burning of agricultural residues (3.F), small combustion - residential (NFR 1.A.4.b.i), waste, IPPU sector and others natural sources (11.C)).

The Tier 2/3 method is used for emission estimations from road transport, and is carried out in the program application COPERT 5 (v5.7.2 from 20.11.2023), that contains detailed data on the vehicle fleet and procedures for calculating emissions from fuel combustion and fugitive emissions.

Higher tiers method (Tier 2 and Tier 3) is used for emission estimations from key categories, to the greatest extent possible, while the Tier 1 method is mostly used for emission estimations of other categories. For certain key categories (the case for the IPPU - Solvents sector) the Tier

1 method is used, due to the unavailability of the detailed data required for the application of a higher tier method.

The methodology used for calculation of emissions ($E_{pollutant}$) with the Tier 1 method includes product of activity data (AD) (e.g. fuel consumption, the production statistics, use of product, number of animals, waste treated, etc.) and corresponding emission factor of pollutant ($EF_{pollutant}$), presented by the general equation:

$$E_{pollutant} = AD \times EF_{pollutant}$$

The Tier 2 method is similar to the Tier 1, and to apply it, both the activity data and the emission factors need to be stratified according to the different techniques that occur in the country presented by following general equation:

$$E_{pollutant} = \sum_{technologies} AD_{production\ technology} \times EF_{technology\ pollutant}$$

With that, the technology-specific emission factor for specific pollutants can be replace with an abated emission factor if a technology for reducing emissions of specific pollutant (BAT) with the default abatement efficiencies ($\eta_{abatement}$) is in use, as given in the formula:

$$EF_{technology\ abated} = (1 - \eta_{abatement}) \times EF_{technology\ unabated}$$

Tier 3 method is the use of facility-specific data where facility-level emission data of sufficient quality are available along with the available activity data. This Tier 3 method is used for reporting of the LPS emissions which cover more than 90% of the total national production for specific source category. Therefore, for the application of this Tier 3 method the condition that facility reports cover all relevant combustion or/and production processes in the country, which are also available in Croatian EPR database, should be met.

In combination with software tools, EMEP/EEA methodology aims to obtain consistency, completeness, comparability and transparency of the emissions estimates utilizing two basic methodological approaches:

- "Bottom-up" where total emissions from defined territory are determined by summing the measured/estimated emissions from all individual sources on defined territory. In case when one or more sources are missed out inventory is incomplete which leads to lower level of emissions.
- "Top-down" where total emissions from defined territory are determined from aggregate statistical data (for instance total fuel oil consumption or cement production) and average emission factors that give the best estimation of activities (sectors) under consideration.

Due to evident advantages and shortcomings of both approaches inventory agency in practice, utilize both of them with emphasis on achieving a balance between resources available and quality of estimations. For example, for the emission estimations from the large point sources, "bottom up" approach is used, and from all other sources by "top down" approach. That combination is reasonable because data for LPS are considered more reliable than other smaller sources.

The literature used to prepare Croatian emission inventories is:

- EMEP/EEA[21] Air Pollutant Emission Inventory Guidebook “Technical Guidance to Prepare National Emission Inventories” (2013, 2016, 2019);
- EMEP/CORINAIR Atmospheric Emission Inventory Guidebook 2007 (EMEP 2007);
- EMEP/CORINAIR Good Practice Guidance. Good practice for CLRTAP emission inventories (Tinus Pulles, John van Aardenne, 24 June 2004);
- EMEP/CORINAIR Atmospheric emission inventory guidebook, Second edition (September, 1999);
- Emission factor manual PARCOM-ATMOS, Emission factor for air pollution (1992),
- Bundesamt für Umwelt, Wald und Landschaft (BUWAL): Emissionsfaktoren für stationäre Quallen – HANDBUCH (1995);
- US EPA Compilation of Air Pollutant Emission Factors, Vol. 1: Stationary Point and Area Sources (1995);
- Corinair; Technical annexes, Volume 2, Default emission factors handbook (CORINE, 1992).

Emission factors not recommended in GB2023 are mainly taken from the sectoral guidelines for determining the emission of pollutants produced in the framework of the project *Reconstruction of the National Inventory System and enforcement of its implementation* (LIFE/TCY/CRO/00086).

Emission factors used are default, plant specific emission factors (calculated from direct emissions observed plants reported in the national EPR database) and country specific emission factors. Croatia uses country specific emission factor for SO_2 emission calculation. The list of emission factors that differ from the default emission factors from GB2023 are presented in sectoral chapters 3-7.

Information on the inclusion/exclusion of the condensable component from PM_{10} and $PM_{2.5}$ emission factors by NFR source category is given in Appendix 2 and 9 of this report.

A detailed description of the methodology used is shown in sectoral 3 - 7.

A summary of the methods used for NFR sectors is as follows:

1 ENERGY

- 1.A.1.a (Electricity production and Combined heat and power generation), 1.A.1.b, 1.A.2.f.i, 1.B.2.b.i: Tier 2 method. Emission factors: plant specific (DE – direct emissions from EPR) and emission factors from GB2023.
- 1.A.1.a (Heat plants), 1.A.1.c, 1.A.2.a, 1.A.2, 1.A.3.b.vii, 1.A.4.a, 1.A.4.c.i: Tier 1 EMEP/EEA methodology, along with the recommended Tier 1 emission factors from GB2023.

[21] Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) of the Convention on Long-range Transboundary Air Pollution provides scientific support to the Convention

- 1.A.3.a (Aviation (civil)), 1.A.3.a.i (i), 1A.3.a.ii (i), 1.A.3.a.i (ii), 1.A.3.a.ii (ii): Tier 1 EMEP/EEA methodology, along with the recommended Tier 1 emission factors from GB2013.
- 1.A.3.b (Road transport), 1.A.3.b.i 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv, 1.A.3.b.v, 1.A.3.b.vi, 1.A.3.b.vii: COPERT 5 (v 5.7.2) model
- 1.A.3.b.vii Road transport: Road abrasion: Tier 1 EMEP/EEA methodology, along with the recommended Tier 1 emission factors from GB2023.
- 1.A.3.c: Tier 1 EMEP/EEA methodology, along with the recommended Tier 1 emission factors from GB2023
- 1.A.3.d.ii: Tier 2 EMEP/EEA methodology, along with the recommended Tier 2 emission factors from GB2023;
- 1.A.3.d.i(i): Tier 1 EMEP/EEA methodology, along with the recommended Tier 1 emission factors from GB2023.
- 1.A.4.b.i, 1.A.2.g.vii, 1.A.4.b.ii, 1.A.4.c.ii: Tier 2 EMEP/EEA methodology, along with the recommended Tier 2 emission factors from GB2023
- 1.B.1.a, 1.B.1.b, 1.B.2.c.i – SO_2 and NMVOC, 1.B.2.c.ii: Tier 1 EMEP/EEA, along with the recommended Tier 1 emission factors from GB2023.
- 1.B.2.a.i, 1.B.2.a.iv, 1.B.2.a.v (except SNAP 0504), 1.B.2.b, 1.B.2.c.i (not including SO_2 and NMVOC): Tier 2 EMEP/EEA, along with the recommended Tier 1 emission factors from GB2023. For SNAP 0504 EFs are taken from Corinair (vol. 2, p. 57).

2 INDUSTRIAL PROCESSES AND PRODUCT USE

- 2.A.1: for PM_{10}, $PM_{2.5}$ and TSP (for 6 factories): Tier 2 EMEP/EEA, along with the recommended Tier 2 emission factors from GB2023. For BC, as well as for all emissions from one factory Tier 1 is used,
- 2.A.2: Tier 2 EMEP/EEA, along with the abated Tier 2 emission factors from GB2023.
- 2.A.3 (glass production only): Tier 1 EMEP/EEA, along with the recommended Tier 1 emission factors from GB2023; for rock wool production: Tier 3, with Tier 2 only for NMVOC emission from one plant.
- 2.A.5.a, 2.A.5.b: Tier 1 EMEP/EEA, along with the recommended Tier 1 emission factors from GB2023.
- 2.B.1, 2.B.2, 2.B.10.a (sulphuric acid, NPK fertilizers and urea): Tier 2 and Tier 3. Emission factors: plant specific (DE – direct emissions from EPR) and/or EMEP/EEA emission factors from GB2023.
- 2.C.1: Tier 2 EMEP/EEA, along with Tier 2 emission factors from GB2023.
- 2.C.2: Tier 1 EMEP/EEA, along with Tier 1 emission factors from GB2023.
- 2.C.3: Tier 2 EMEP/EEA, along with Tier 2 emission factors from GB2023.
- 2.D.3.a: Tier 2 EMEP/EEA, along with Tier 2a and 2b emission factors from GB2023.
- 2.D.3.b: Tier 2 EMEP/EEA, along with abated Tier 2 emission factors from GB2023.
- 2.D.3.c, 2.D.3.d: Tier 1 EMEP/EEA, along with Tier 1 emission factors from GB2023.
- 2.D.3.e: Tier 2 EMEP/EEA, along with Tier 2 emission factors from GB2023.
- 2.D.3.f: other (methodology suggested by the TERT; see Chapter 5.4).

- 2.D.3.g (not including polyester and PVC processing, for which Tier 1 approach and EFs from GB2023 are used): Tier 2 EMEP/EEA, along with Tier 2 emission factors (abated where applicable) from GB2023.
- 2.D.3.h: Tier 2 EMEP/EEA in accordance with GB2023, along with emission factors from EMEP/EEA Guidebook 2019, Additional Guidance: 2D3 Solvent and Product Use.
- 2.D.3.i (not including application of glues), 2.G: Tier 2 EMEP/EEA, along with Tier 2 emission factors from GB2023.
- 2.D.3.i (application of glues): Tier 2 EMEP/EEA approach and Tier 2 emission factors from GB2023, together with rates of penetration of abatement technologies from IIASA GAINS model.
- 2.H: Tier 2 EMEP/EEA, along with Tier 2 emission factors from GB2023.
- 2.I: Tier 1 EMEP/EEA, along with Tier 1 emission factors from GB2023.

3 AGRICULTURE

- 3.B: Tier 2 EMEP/EEA methodology and Tier 2 emission factors from GB2023 with national specifics for all animals except swine, broilers and laying hens, which were calculated using Tier 3 EMEP/EEA methodology with emission factors from GB2023 with national specifics and abatement measures.
- 3.D.1.a: Tier 1 EMEP/EEA methodology and Tier 1 emission factors from GB2019 for NOx and NMVOC, emission calculation, and Tier 2 EMEP/EEA methodology, along with Tier 2 emission factors from GB2019 for NH_3 emission calculation.
- 3.D.a.2.a: Tier 2 EMEP/EEA methodology and Tier 2 emission factors from GB2023 with national specifics.
- 3.D.a.2.b: Tier 1 EMEP/EEA methodology and Tier 1 emission factors from GB2023
- 3.D.a.3: Tier 2 EMEP/EEA methodology and Tier 2 emission factors from GB2023
- 3.D.c: Tier 1 EMEP/EEA methodology and Tier 1 emission factors from GB2023
- 3.D.e: Tier 2 EMEP/EEA methodology from GB2023
- 3.D.f: Tier 1 EMEP/EEA methodology and Tier 1 emission factors from GB2023
- 3.F: Tier 1 EMEP/EEA methodology and emission factors from GB2023

5 WASTE

- 5.A: Country-specific (CS) methodology was developed to estimate a NMVOC EF based on the CH_4 emissions estimated in the framework of the NIR report; $PM_{2,5}$, PM_{10} and TSP Tier 1 EMEP/EEA methodology, along with Tier 1 emission factors from GB2023.
- 5.B.1: Tier 2 EMEP/EEA methodology for NH_3 from GB2023.
- 5.B.2: Tier 2 EMEP/EEA methodology for NH_3 from GB2023.
- 5.C.1.b.i: Tier 1 EMEP/EEA methodology, along with Tier 1 emission factors from GB2023 and GB2009 (for emission factors not estimated in GB2023).
- 5.C.1.b.iii, 5.C.1.b.v: Tier 1 EMEP/EEA methodology, along with Tier 1 emission factors from GB2023.

- 5.C.2: Tier 1 and Tier 2 EMEP/EEA methodology for CO, NO_x, SO_2, NMHOS, TSP, PM_{10}, $PM_{2,5}$, BC, Cr, Cu, Zn, As, Se, Pb, Cd, benzo[b] fluoranthene, benzo[k] fluoranthene, benzo[a] pyrene and PCDD/F from GB2023 (Tier 1 - pruning residues from vineyards; Tier 2 - pruning residues from orchards and olive groves).
- 5.D.1, 5.D.2: Tier 2 EMEP/EEA methodology, along with Tier 2 emission factors from GB2023.
- 5.E: Tier 2 EMEP/EEA methodology, along with Tier 2 emission factors from GB2023.

11 NATURAL SOURCES

- 11.B Forest fires: EMEP/EEA methodology, along with Tier 1 emission factors from GB2023.
- 11.C Other natural sources: EMEP/EEA methodology, along with Tier 1 emission factors from GB2023.

1.5. Key categories

According to the EMEP/EEA Guidebook, a key category is a category that has priority in the national inventory system because it is significantly important for one or more air pollutants in the national inventory in terms of absolute level, trend or uncertainty in emissions.

In order to identify the source categories that contribute the most to the emissions of a particular pollutant, a key category analysis (KCA) is carried out in accordance with the methodology described in the EMEP/EEA Guidebook. It is good practice for each country to use the key category analysis as a basis for selecting emissions accounting methods, as such an approach will lead to improved inventory quality. This analysis helps to identify priority categories for which methods, activity data, emission factors and other parameters should be considered for regular updating, more rigorous verification and review and, where necessary or possible, improved (priority improvements).

For categories identified as key, Croatia makes effort to use a tier 2 methodology, including country-specific information.

The identification of key categories includes all NFR categories and all pollutants covered in this report.

1.5.1. The method for key category analysis (KCA)

The method of key category analysis (KCA) is described in GB2023, "2. Key category analysis and methodological choice" and follows the IPCC approach for determining pollutant-specific key categories and covers level and trend assessment.

KCA can be performed based on two approaches: in approach 1, categories are placed in descending order of contribution to the emission inventory or trend. In approach 2, this ranking is weighted by the uncertainty assigned to each category. Approach 1 highlights the categories that contribute most to emissions or changes in emissions, while approach 2 identifies the categories that contribute most to inventory uncertainty.

The Republic of Croatia calculatesd the key categories using approach 1 for level and trend assessment.

In Approach 1, key categories are identified using a predetermined threshold of cumulative emissions. Key categories are those that, when added in descending order of magnitude, cumulatively add up to 80% of the total level[22].

For Approach 1, the analysis is performed at the level of all NFR categories (in accordance with the reporting format, Annex 1 of the Reporting Guidelines) and for all reported pollutants including those for which voluntary reporting is required (TSP, BC, other TM).

All assessments of levels (L1) and trends (T1) for 1990 – 2022 and for all NFR categories of emission sources that make up 80% of the total national emissions (or the total national trend) were carried out using Approach 1.

In following section 1.5.2, a list of key categories by pollutant for 2022 (table 1.5-1) and summary results of level and trend assessment (approach 1) (table 1.5-2) is given.

In addition to the above, in the sectoral chapters 3-7, key categories regarding pollutants are listed for each sector.

The results of KCA analysis per pollutant using approach 1 are presented in Appendix 1.

1.5.2. List of key categories by pollutant

Detailed results of the key category analysis, approach 1, level and trend assessment of emissions, are listed in attachment 1, tables P1-1 to P1-22, where numerical values represent percentage contributions to the total assessment, for each pollutant.

The Table 1.5-1 shows the list of key NFR categories by pollutant for 2022 along with the contribution of each of the identified key categories to the national total emissions and the cumulative percentage contribution of all key categories to the national total emissions.

Table 1.5-1 Key source categories in 2022 for the Croatian emission inventory

Pollutant	Key source categories (poredano od najvećeg udjela prema najmanjem s lijeva na desno)											Total (%)
NO_x	1A3bi	1A3biii	1A4bi	1A1a	1A2f	1A3dii	3Da1	1A3bii	1A4cii			82.2
	24.8%	15.8%	9.2%	7.6%	6.2%	5.5%	5.0%	4.2%	3.9%			
NMVOC	1A4bi	2D3d	2D3a	2H2	3B1b	2D3i	3De	1B2av	3B1a	5A	1A3bv	82.0
	29.1%	17.6%	7.0%	5.7%	5.6%	4.5%	2.7%	2.7%	2.5%	2.3%	2.3%	
SO_2	1B2aiv	1A1b	1A2f	1A4bi	1A1a							87.0
	26.8%	21.5%	19.6%	11.4%	7.6%							
NH_3	3Da1	3Da2a	3B3	3B1b	3B1a							82.3
	40.5%	17.3%	14.2%	5.8%	4.4%							
$PM_{2.5}$	1A4bi	1A1a										85.3
	78.5%	6.9%										
PM_{10}	1A4bi	2A5b	3Dc	1A1a								82.4
	57.9%	12.6%	6.2%	5.8%								
TSP	1A4bi	2A5b	2A5a	1A1a								81.1
	41.8%	28.9%	5.9%	4.5%								
BC	1A4bi	1A3bi	2G									80.9
	68.5%	9.5%	2.8%									

[22] *02 Key category analysis and methodological choice, GB2023*: ey categories are those that, when summed in descending order of magnitude, add up to 80% of the sum of the assessment of all levels for source category x in the last inventory year. The rationale for choosing the 80% threshold for approach 1 is based on Rypdal & Flugsrud (2001) and is also presented in the IPCC Guidelines, Chapter 7, Subsection 7.2.1.1.

Pollutant	Key source categories (poredano od najvećeg udjela prema najmanjem s lijeva na desno)											Total (%)
CO	1A4bi	1A3bi	1B2aiv									86.2
	72.6%	7.0%	6.6%									
Pb	1A3bvi	2G	1A4bi	2A3								81.8
	41.1%	20.6%	13.7%	6.4%								
Cd	1A4bi	2G	2A3									80.5
	69.1%	6.2%	5.2%									
Hg	1A1a	1A2f	1A4bi	1B2aiv								86.4
	36.2%	35.1%	7.8%	7.3%								
As	1A1a	1A2f	2A3	1A3bvi								87.6
	43.1%	17.4%	16.4%	10.8%								
Cr	1A3bvi	1A4bi	1A1a									83.7
	44.9%	33.8%	5.0%									
Cu	1A3bvi											91.9
	91.9%											
Ni	1A1b	1A1a	1B2aiv	1A3bvi	2A3	1A4ai						80.9
	42.9%	14.1%	7.4%	6.7%	5.3%	4.6%						
Se	2A3	1A2f	1A4bi									83.2
	63.0%	14.8%	5.4%									
Zn	1A4bi	1A3bvi										80.3
	57.3%	23.0%										
Diox	1A4bi											82.7
	82.7%											
PAHs	1A4bi											90.8
	90.8%											
HCB	1A4bi	1A1a										88.9
	65.5%	23.4%										
PCBs	1A1a	2C1										87.4
	74.3%	13.1%										

The results of the KCA for each pollutant were finally aggregated into one list based on their weight contributions and shown in the Table 1.5-2.

The results show that a total of 45 key sources have been identified.

Table 1.5-2 Final ranking by key category for all pollutants considered in the analysis for level assessment (L1) and trend assessment (T1) in %

NFR	Category Name	% contributions to pollutant totals for key categories (cumulative 80 %)																																												Sum of KC % contributions	Rank
		NOx		NMVOC		SO2		NH3		CO		BC		PM2.5		PM10		TSP		Pb		Cd		Hg		PAH		DIOX		PCBs		HCB		As		Cr		Cu		Ni		Se		Zn			
		L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1		
1A1a	Public electricity and heat production	8	8	0	0	8	35	0	0	0	0	0	0	7	18	6	11	4	6	0	0	0	5	36	23	0	0	0	0	74	50	23	0	43	20	5	25	0	15	14	30	0	7	0	11	493	2
1A1b	Petroleum refining	0	4	0	0	22	8	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	16	0	16	0	9	119	8
1A2a	Iron and Steel	0	5	0	0	0	0	0	0	0	0	0	0	0	6	0	3	0	2	0	0	0	0	0	0	0	13	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	7	55	13
1A2c	Chemicals	0	5	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	34
1A2e	Food Processing, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	40
1A2f	Non-metallic Minerals	6	6	0	0	20	13	0	0	0	0	0	7	0	5	0	3	0	2	0	0	0	0	35	19	0	0	0	0	0	0	0	0	17	10	0	0	0	0	0	5	15	7	0	9	178	4
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	0	0	0	0	0	0	0	0	0	0	0	6	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	32
1A3bi	R.T., Passenger cars	25	0	0	18	0	0	0	0	7	36	10	17	0	4	0	3	0	2	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	164	5
1A3bii	R.T., Light duty vehicles	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	31
1A3biii	R.T., Heavy duty vehicles	16	14	0	0	0	0	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	18
1A3bv	R.T., Gasoline evaporation	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	45
1A3bvi	R.T., Automobile tyre and break wear	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0	5	0	4	41	22	0	0	0	0	0	4	0	0	0	0	0	0	11	0	45	32	92	45	7	9	0	7	23	31	385	3
1A3bvii	R.T., Automobile road abra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	44
1A3dii	National Navigation (Shipping)	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	29
1A4ai	Commercial/Institutional: Stationary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5	39
1A4bi	Residential: stationary	9	12	29	23	11	0	0	0	73	45	69	23	78	18	58	21	42	23	14	7	69	37	8	0	91	44	83	41	0	14	66	34	0	0	34	15	0	6	0	0	5	0	57	0	1157	1
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	4	9	0	0	0	0	0	0	0	0	0	16	0	7	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	46	16
1B2aiv	Refining / Storage	0	0	0	0	27	24	0	0	7	0	0	0	0	0	0	2	0	0	0	0	0	6	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	0	0	6	0	0	91	9
1B2av	Distribution of oil products	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	43
1B2b	Natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	15
2A3	Glass production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	5	0	0	0	0	0	0	0	0	0	0	0	16	9	0	0	0	0	5	6	63	36	0	0	148	6
2A5a	Quarrying and mining of minerals other than coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	24
2A5b	Construction and demolition	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	8	29	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	11
2B10a	Other chemical industry	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	30
2C1	Iron and Steel Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	7	0	0	13	0	0	0	0	50	0	17	0	0	0	16	0	0	0	12	140	7
2D3a	Domestic solvent use including fungicides	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	36
2D3b	Road paving with asphalt	0	0	0	0	0	0	0	0	0	0	0	5	0	2	0	5	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	21
2D3d	Coating applications	0	0	18	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	20
2D3e	Degreasing	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	33
2D3i	Other solvent use	0	0	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	35
2G	Other product manufacture and use	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	21	11	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	46	17

NFR	Category Name	% contributions to pollutant totals for key categories (cumulative 80 %)																																														Sum of KC % contributions	Rank
		NOx		NMVOC		SO2		NH3		CO		BC		PM2.5		PM10		TSP		Pb		Cd		Hg		PAH		DIOX		PCBs		HCB		As		Cr		Cu		Ni		Se		Zn			
		L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1	L1	T1		
2H2	Food and beverages industry	0	0	6	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	26
3B1a	Dairy cattle	0	0	2	0	0	0	4	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	23
3B1b	Non-dairy cattle	0	0	6	7	0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	22
3B3	Swine	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	27
3B4gi	Laying Hens	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	41
3B4giv	Other Poultry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	37
3Da1	Inorganic N-fertilizers	5	5	0	0	0	0	41	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87	10
3Da2a	Animal manure	0	0	0	0	0	0	17	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	19
3Dc	On-farm storage, handling and transport of agricultural products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	28
3De	Cultivated crops	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	42
3Df	Use of pesticides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	14
3F	Field burning of agricultural residues	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	0	0	0	9	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	12
5A	Solid waste disposal on lan	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	38
5C2	Open burning of waste	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	19	25

1.6. QA/QC and Verification methods

The QA/QC and verification methods complies with the guidance published in the latest EMEP/EEA Guidebook. Quality assurance and quality control procedures for inventory compilation and reporting are part of defined QA/QC plan. In 2009, EKONERG Ltd. for the MESD has prepared an internal document (the QA/QC plan) to organise and implement activities across all of the emissions inventory activities including involved stakeholders (e.g. suppliers of data, recipients, inventory compiling institution), data collection, data manipulation, inventory compilation, consolidating the inventory estimates (e.g. into a single national database) and reporting. The national air pollution emission inventory complies with the ISO 9001:2015 standard which results from the certification of the company that prepares it, which is presented in following.

EKONERG ltd. is fully certified to ISO 9001:2015, ISO 14001: 2015, ISO 45001:2018 and ISO 50001:2018 (see Box 1 below). This certification provides assurance that through application of the ISO 9001 standard by EKONERG, a consistent quality approach across all aspects of the inventory project is maintained, including conforming to good practice in project management. EKONERG Ltd. has the consent of the Ministry of Economy and Sustainable Development based on Article 42 of the Environmental Protection Act (Official Gazette 80/13, 153/13, 78/15, 12/18, 118/18) to perform professional environmental protection work (Article 40, paragraph 2. of the Act) which is issued for a period of five years. In addition to the authorized Ekonerg Ltd., permission to perform professional environmental protection work was also issued to employees of the authorized Ekonerg Ltd. in the role of head of professional affairs or professional associates.

EKONERG ltd. has, at the level of the whole organization, Integrated management system that consists of the following management systems:

- Quality, according to ISO 9001:2015 and 10 CFR 50 App. B.,
- Environmental, according to ISO 14001:2015
- Occupational health and safety, according to ISO 45001:2018 and
- Energy Management System according to ISO 50001:2018

EKONERG is certified that applies a management system in line with the above standards for the following scope: Research, development, consulting, engineering, design, inspection, and measurement in the field of energy, industry and environmental protection.

All these management systems are certified by an authorized institution TÜV NORD CERT GmbH and regular annual audits are being carried out.

TÜV NORD CERT GmbH carried out a three-yearly recertification audit of EKONERG which was completed in June 2022. EKONERG successfully passed the recertification, with no major non-compliances, and a new EKONERG certificate was issued in July 2022.

QA/QC activities performed for this inventory compilation is presented in Appendix 5 and these include checks in: data collection activities, activity data entry into databases, emission calculation, databases items, filling of emission reporting templates - NFR tables for 1990 - 2022, preparation of IIR.

The compiled national inventory is tested with the electronic RepDab-tool which check format, consistency and completeness before submitting it to UNECE/CEIP. RepDab is on-line available at the CEIP website (https://www.ceip.at/repdab). If needed, data is revised. When all formats passed all RepDab tests, then formats are submitted.

The following subchapters clarify the terms “quality control” and “quality assurance” as well as the activities and procedures used for verification purposes.

1.6.1. Description of used quality control (QC) and quality assurance (QA) methods

Quality Control (QC) is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- identify and address errors and omissions;
- document and archive inventory material and record all QC activities.

QC activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardized procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting.

In the inventory preparation process, general quality control procedures have been applied (see Appendix 5). In addition, some specific quality control procedures related to check of activity data and emission factors were applied in previous submissions with new or updated emission factors and activity data from other sources (e.g. Environmental Pollution Register, direct communication with operators). Application of quality control procedures have resulted in recalculations of emissions which is summarised in Chapter 8.

Specific quality control activities include technical reviews of emission sources, activity data, emission factors and emission determination methods. For example, control of bottom-up data for industry and energy sector from the National Environmental Pollution Register (EPR database) and data from the "Volatile Organic Compounds" database (HLAP database) is performed. The EPR is based on the Ordinance on EPR. According to that Ordinance the competent authorities, which are 21 counties, with in cooperation with the competent inspectorate, are responsible to assess the completeness, consistency and credibility of the data submitted by the operators, and they verified forms.

Data from EPR (direct pollutants emissions, fuel consumptions and productivity) by each individual plant are checking on consistency, transparency and completeness in the process of inventory preparation. If, by comparing previously reported data, there are significant decreases (dips) or significant increases (peak) in the reported emissions and/or fuel consumption and/or realized productivity, then it is checked whether the plant has introduced a new emission reduction technology (also part of the EPR system), new fuel or incorrect entry of certain data in the database occurred (the most common error is entering the data in another metering unit). In the next step, the inventory compiler informs the person in MESD responsible for air pollutant emission inventory work, who then informs the person responsible for databases EPR and HLAP. Further, person responsible for the EPR database notifies the competent authority in the county, who then informs the responsible person at operator about data inconsistency. The responsible person at operator then corrects or explains the inconsistency.

For the energy sector particularly for the sector of electricity and heat production, the total amount of fuel reported in the EPR database is compared with fuel sold amount by fuel type from the National Energy Balance. Last notation is also the part of yearly process of data collection.

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties, should be performed upon a finalized inventory following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions (and sinks) given the current state of scientific knowledge and data available, and support the effectiveness of the QC programme.

The quality assurance of the Croatian inventory of air pollutant emissions is regulated by the national law governing air protection. The responsibility for quality assurance, depending on the relevant competences, belongs to all stakeholders involved directly or indirectly in the preparation of the inventory. For details on shared responsibilities see section 1.2.

In the estimation process, a schedule of activities for quality control and assurance was applied (see Appendix 5). General and specific quality control procedures were applied in terms of checking data on activities and emission factors used in previous reports with new emission factors and data from other sources (e.g. EPR, direct communication with polluters). The application of quality control procedures led to the recalculation of emissions, which is presented in Chapter 8.

A number of specific international QA activities and procedures that the Croatian air emissions inventory goes through are:

- 2017-2022: Annual Review of National Air Pollutant Emission Inventory Data under Directive 2016/2284 (NECD): In-depth technical review under the EU NECD conducted by an expert team on behalf of the EC. Every year the main pollutants (SO_2, NOx, NMVOC, NH_3, $PM_{2.5}$) are reviewed, as well, a detailed review to verify that all of the recommendations, unquantified potential technical corrections, technical corrections and revised estimates, from previous review findings, have been integrated. On top of this each year the review focuses on different sections:
    - 2017 - Main pollutants
    - 2018 - Main pollutants, POPs and HM
    - 2019 - Main pollutants, POPs and HM + projections (submitted 2019)
    - 2020 – Main pollutants, PAHs (total and individual PAHs), dioxins/furans, PCBs, HCB, Cd, Hg, Pb + gridded data and LPS (submitted 2019)
    - 2021 – Main pollutants, PAHs (total and individual PAHs), dioxins/furans, PCBs, HCB, Cd, Hg, Pb, CO, PM_{10} and BC + gridded data and LPS + projections (all submitted 2021)
    - 2022 – Main pollutants: NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$ and PM_{10}.
    - Recommendations made in these reviews are considered in the Croatian improvement programme.
- Annual Stage 1 (S1) and Stage 2 (S2) CLRTAP review: The EMEP emission centre CEIP uses semi-automated routines to carry out annual initial check of submissions for timeliness, completeness and formats (S1 review). CEIP also compile an annual synthesis and assessment of all national submissions with respect to consistency, comparability, key category analysis (KCA), trends and IEFs of data with recommendations for data quality improvement (S2 review). Results are published before 15 March and updated by the end of March on the CEIP website. Rreview findings are considered for action within the Croatian improvement programme.
- 2011, 2014 and 2022: Stage 3 (S3) in-depth UNECE review - In-depth review of the Croatian air pollution inventory submitted under the UNECE CLTRAP and EU NECD (for 2014). The review was coordinated by the EMEP emission centre CEIP acting as

review Secretariat. Reviews in 2011 and 2014 have been concentrated on SO_2, NOx, NMVOC, NH_3, PM_{10} and $PM_{2.5}$ reflecting current priorities from the EMEP Steering Body and the TFEIP. HM and POPs have been reviewed to the extent possible. The review of data reported under CLRTAP is harmonised with those reported under the NECD. Review in 2022 was concentrated on emission from combustion in residential, and road transport with special emphasis on the condensing component of PM emission. Recommendations made in the S3 review were considered in the Croatian inventory improvement programme.

- 2004 – 2022: The in-depth UNFCCC review of annual GHG inventories, national communication (NC) and biennial reports (BR): The in-depth reviews of these reports are conducted by an international team of experts from Annex I and non-Annex I Parties, selected from the Roster of Experts, coordinated by the UNFCCC secretariat. The review of Croatian GHG inventories involve a desk-based study (so called centralized review conducted in years: 2005, 2006, 2009, 2010, 2011, 2013, 2014, 2016, 2020, 2022) and an in-country visit (so called in-country review conducted in years: 2004, 2007, 2008, 2012, 2018). Reviews highlight reporting issues of transparency, completeness, consistency, comparability and accuracy that need to be resolved by Croatia. These reviews are focussed on the GHG inventory rather than the air pollution inventory, but due to compatibility consistency among both inventories, areas for improvement related to both inventories are identified and implemented in both.
- 2013 - 2021: Annual review of GHG emissions (GHG inventory): This review is conducted by European Commission and the European Environment Agency (EEA) (which act as Secretariat for the reviews), support by a technical experts review team. The Secretariat may decide to organize an in-country visit, the desk-based or centralized review. These reviews are focussed on the GHG inventory, but due to compatibility consistency among GHG inventory and the air pollutant inventory, areas for improvement related to both inventories are identified and implemented in both.

The objective of these technical reviews is to provide elements for an improvement of transparency, consistency, comparability, completeness and accuracy of submitted data. These reviews contribute to establishing accurate, reliable and verified emission inventories for all the Parties under the CLRTAP, UNFCCC and the EU Member States.

1.6.2. Description of verification methods used

Verification activities are constituents of both QA and QC, related to use of independent information during the planning, development or after completion of an inventory, which aim to establish its reliability. Verification refers specifically to those methods that are external to the inventory and apply independent data, including comparisons with inventory estimates made by other bodies or through alternative methods.

Verification activities and procedures that are carried out, as appropriate, with data outside of the air pollutant inventory are following:

- In the process of improvement in specific source category (e.g. move to higher tier), different sets of activity data from the same and/or different data sources are compared before deciding to use it in the inventory. Along with that, if new emission factors are intended to be introduced into the inventory, or if the accuracy of the emission factor or data source is questioned in an internal or external review process, then the new emission factors are compared with the emission factors of other European countries before deciding to use them in the inventory.

- The air pollutant inventory is linked with the GHG inventory, so any verification checks and consequent improvement process regarding indirect GHG (CO, NO_X, NMVOC, SO_2) or activity data in the GHG inventory are also applied to the air pollutant inventory.
- The sector-specific verification processes are periodically carried out for individual source categories where higher tier for emission estimation is used by applying lower tier method.
- The report (IIR) and emission inventories need to be approved by the ministry, as is every inventory improvement with an impact on emissions.

1.7. General uncertainty evaluation

1.7.1. Description of methods used to assess uncertainty and the use of uncertainty analysis to prioritise inventory improvement

Emissions uncertainty analysis are calculated on the basis of the standard methods and procedures of:

- UNECE: Guidelines for Estimating and Reporting Emission Data under the Convention on Long Range Transboundary Air Pollution, Edition 2009 (UNECE 2009)
- EMEP/EEA air pollutant emission inventory guidebook (EMEP/EEA Guidebook).

The uncertainty estimations of total national emissions reporting to the CLRTAP for Croatia are developed to be in accordance with the Tier 1 methodology described in the EMEP/EEA Guidebook. The uncertainty estimates are based on emission data for the base year 1990 and last historic year 2022, and on uncertainties for activity rates and emission factors for NFR sectors. Estimated emissions for 1990 and 2022, the uncertainty introduced into the trend 1990-2022, and the uncertainty in total national emissions 2022 for all pollutants are shown in the Table 1.7-1. The uncertainty estimates include all NFR sectors on aggregated level Detail calculation sheets and results of Croatia uncertainty analyses are provided in Appendix 7.

The uncertainty in an emission can be propagated from uncertainties in the activity data and the emission factor through the error propagation equation (Mandel 1984, Bevington and Robinson 1992)[23]. This method is present in the EMEP/EEA Guidebook, where the conditions imposed for use of the method are:

- Input parameters (emission factor, activity data) have Gaussian (normal) distributions. Uncertainty is symmetric with respect to the mean value. The length of the range from mean to upper larger value (97.5% percentile) is equal to the length of the range from mean to lower, smaller value (2.5% percentile).
- The correlation between the input data in model does not exist. That is the main reason why is appropriate aggregation of data needed for the uncertainty analysis.
- Calculation of trend uncertainty using Tier 1 method is based on the essential assumption that the input uncertainty of emission factors and activity data for 1990 and 2020 are equal.

Under these conditions, the uncertainty calculated for the emission rate is appropriate.

[23] http://cxdd.broceliande.kerbabel.fr/?q=node/398/200

The Guidebook recommends that inputs (direct emissions[24], activity data and emission factors) are as far as possible statistically independent, e.g. that emission factors used in several source categories yield one uncertainty estimate on an aggregated level rather than using the same Figure for each source category.

Appropriate aggregation of data for the uncertainty analysis is important to avoid over- or underestimation of uncertainty due to correlations.

Assumptions used in NFR sectors aggregation are following:

- Emission factors are considered independent across the different sectors, technologies and fuel.
- Emission estimates of different pollutants are considered to be independent.
- Activity data are considered to be independent.

Assumptions used in uncertainty calculation are following:

- Emission factor uncertainties were in lower end of default range for all sources and pollutants (EMEP/EEA Guidebook, Part A - general guidance chapters, 5-Uncertainties, Table 3-2 and 3-3).
- Emission factor uncertainties have Type A sensitivities and activity data uncertainties have Type B sensitivities, as suggested in EMEP/EEA Guidebook.

Documentation of uncertainties

The uncertainty estimates for emission factors derive from expert judgments based on information on 95% confidence intervals in the EMEP/EEA Guidebook. The default uncertainties for emission factors are given in letter codes (Table 3-2, General guidance chapter 5 - Uncertainties EMEP/EEA Guidebook) representing an uncertainty range (Table 3-3, General guidance chapter 5 - Uncertainties EMEP/EEA Guidebook). In uncertainty analysis, the lower value of the default uncertainty range for emission factors was used for all sources and pollutants. For some pollutants and source categories, no information on default uncertainty ranges is available in the EMEP/EEA Guidebook and thus the uncertainty ranges from Switzerland´s IIR 2011 are applied when appropriate.

The uncertainty estimates for activity data derive from Croatia's greenhouse gas inventory (Croatian NIR), from expert judgment based on comparisons with available datasets of other countries and from EMEP/EEA Guidebook (Table 3-1, General guidance chapter 5 – Uncertainties) where appropriate (Table 1.7.2-1). For source categories where activity data uncertainty was taken from Croatian NIR, default uncertainty from IPCC guidance was used and average value from range of given uncertainty was set. For source categories, where activity data uncertainty was taken from other countries with available activity data uncertainty sheets, available data was compared and expert judgment was made to choose the most acceptable activity data uncertainty.

Sources of data used:

- uncertainty analysis of Croatia's greenhouse gas inventory – NIR (activity data),

[24] In this context direct emissions means emission data based on measurements or expert judgements reported e.g. by plants in EPR.

- uncertainties from France's, Finland's, Switzerland's and Danish's Informative Inventory Reports (emission factors and activity data),
- default values of EMEP/EEA Guidebook (activity data and emission factors).

Uncertainty ranges for activity data

Uncertainty rates for activity data in NFR sectors and used aggregation level are listed in Table 1.7.2-1.

Table 1.7.2-1 Applied uncertainty levels for activity data and data sources by NFR sector aggregation

NFR SECTOR AGGREGATION	%	DATA SOURCE
1A1, 1A2, 1A3b	3	National data in combination with comparisons with other datasets and other countries
1A3a	3	National data in combination with EUROCONTROL datasets
1A3c i 1A3d	5	National data in combination with comparisons with other datasets and other countries
1A4a	5	Expert judgment in combination with comparisons with other datasets and other countries
1A4b, 1A4c	3	National data in combination with Tier 2 methodology from GB2023
1B1, 1B2ai	10	Expert judgment in combination with comparisons with other datasets and other countries
1B2aiv, 1B2av, 1B2b,1B2c	3	Facilities - specific data in combination with Tier 2 methodology from GB2023
2A1, 2A2, 2A3	3	Facilities - specific data in comparison with national statistical data
2A5a	5	National data and comparison with other datasets and other countries
2A5b	325	National data in combination with Tier 1 methodology from GB2023
2B1, 2B2	3	Facilities - specific data in comparison with national statistical data
2B10a, 2H, 2I	5	National data and comparisons with other datasets and other countries
2C	7.5	Facilities specific data in comparison with national statistical data
2D3b	15.5	National data in combination with Tier 2 methodology from GB2023
2D3c, 2D3h	30	National statistical data and comparisons with other datasets and other countries
2D3g	32.5	National data in combination with Tier 2 methodology from GB2023
2D3a, 2D3i, 2G, 2D3d, 2D3e, 2D3f	10	National statistical data in combination with Tier 2 methodology from GB2023
3B1, 3B2, 3B4d, 3B4e, 3B4f	10	National statistical data in comparisons to National Central Register of Livestock under Croatian Agricultural Agency
3B3, 3B4g	50	National statistical data in comparisons to National Central Register of Livestock under Croatian Agricultural Agency
3D	5	Facilities - specific data in combination with Tier 2 from GB2023
3Df	3	National statistical sale data
3F	50	The default values are combined with national statistics
5A, 5B, 5C	5	National data from the EPR and Waste Management Information System under MESD, composting facilities, biogas facilities, MA, CBS
5D	30	National statistical data from Statistical Reports and Releases and from Census 1981, Census 1991, Census 2001, Census 2011 and Census 2021 (in combination with interpolation and extrapolation method) under CBS
5E	5	National base of accidental fire under Ministry of Interior

Uncertainty ranges for emission factors

The applied uncertainties are for most emission factors, default values referring to EMEP/EEA Guidebook. Guidebook doesn´t propose uncertainty for pollutants TSP, PM_{10}, $PM_{2.5}$, BC and NH_3 (regard some sectors) so in comparison with datasets of other countries, expert judgment is applied for TSP, PM_{10}, $PM_{2.5}$ and BC, or in the case of NH_3 the emission factors uncertainty from Danish IIR was applied (Table 1.7.2-3). Furthermore, for 1.A.4 subsectors the TSP, PM_{10} and $PM_{2.5}$ emission factors uncertainty from Switzerland´s IIR2011 was applied (Table 1.7.2-4). The applied uncertainties for emission factors are listed in Tables from 1.7.2-2 to 1.7.2-4.

Table 1.7.2-2 Applied uncertainty levels for SO_2, NO_2, NMVOC, CO, TSP, PM_{10}, $PM_{2.5}$, PAH, HCB, PCDD/PCDF (DIOX) emission factors by NFR category

NFR SECTORS	EMISSION FACTORS UNCERTAINTY RATES, %										
	SO_2	NO_2	NMVOC	CO	TSP	PM_{10}	$PM_{2.5}$	BC	PAH	HCB	DIOX
1.A.1, 1.A.2	10	20	50	20	50	50	50	50	100	100	100
1.A.3.b	20	20	20	20	100	100	100	100	400	400	400
1.A.3.a, c, d	20	100	100	100	500	500	500	500	400	400	400
1.A.4	20	50	50	50	x	x	x	x	400	400	400
1.B	50	50	50	50	50	50	50	50	400	400	400
2.A, 2.B, 2.C, 2.D, 2G	20	50	50	50	50	50	50	50	400	400	400
2.A.3	-	-	200	-	60	60	60	60	-	-	-
2.A.5.b	-	-	-	-	155	155	155	-	-	-	-
2.D.3.b, 2.D.3.g	-	-	200		200	200	200	-	-	-	-
3.B	-	100	-	-	100	100	100	x	400	400	400
3.D	-	100	100	-	50	50	50	x	400	400	400
3.D.f	-	-	-	-	-	-	-	-	-	30	-
3.F	50	50	50	17	25	25	25	25	100	100	50
5.A, 5.D	-	-	50	-	100	100	100	100	-	-	-
5.C	20	20	50	50	50	50	50	50	100	100	100

Source: GB2023, Part A - general guidance chapters, 5-uncertainties, Table 3-2 and 3-3, particulate matters – expert judgment

Table 1.7.2-3 Applied uncertainty levels for heavy metals, HCH and PCBs emission factors by NFR sectors

NFR SECTORS	EMISSION FACTORS UNCERTAINTY RATES, %										
	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	NH_3	PCBs
1.A.1, 1.A.2	100	100	100	100	100	100	100	100	100	1000	100
1.A.3.b	400	400	400	400	400	400	400	400	400	400	400
1.A.3.a, c, d	400	400	400	400	400	400	400	400	400	1000	400
1.A.4	400	400	400	400	400	400	400	400	400	1000	400
1.B	400	400	400	400	400	400	400	400	400	1000	400
2.A, 2.B, 2.C, 2.D, 2.G	400	400	400	400	400	400	400	400	400	400	400
3.B	400	400	400	400	400	400	400	400	400	100	400
3.D	400	400	400	400	400	400	400	400	400	100	400
3.D.f	-	-	-	-	-	-	-	-	-	-	-
3.F	100	100	100	100	100	100	100	100	100	100	-
5.B, 5.D, 5C	100	100	100	100	100	100	100	100	100	100	100

Source: GB2023, Part A - general guidance chapters, 5-uncertaintie, Table 3-2 and 3-3

Table 1.7.2-4 Applied uncertainty levels for $PM_{2.5}$, PM_{10} and TSP emission factors for NFR 1.A.4

NFR SECTORS	EMISSION FACTORS UNCERTAINTY RATES, %			
	$PM_{2.5}$	BC	PM_{10}	TSP
1.A.4.a	78.0	78.0	78.0	78.0
1.A.4.b.i	76.0	76.0	76.0	76.0
1.A.4.b.ii	50.0*	50.0*	50.0*	50.0
1.A.4.c.i	39.0	39.0	39.0	39.0
1.A.4.c.ii	80.0*	80.0*	80.0*	80.0

Source: Switzerland´s IIR 2011, (*) PM_{10}, $PM_{2.5}$, BC– expert judgment

1.7.2. Summary of uncertainties by pollutant and sector

Table 1.7.3-1 shows a summary of the uncertainty evaluation of Croatia total emissions 2022 and the trend uncertainties 1990-2022 by pollutant. Detail calculation sheets and results of Croatia uncertainty analyses are provided in Appendix 7.

Table 1.7.3-1 The summary of the uncertainty evaluation for Croatia and total emissions by pollutant in 2022

Pollutant	Total emission in 2022	Unit	Emission uncertainty	Trend	Trend uncertainty
			%	-	%
SO_2	5.6	kt	16.8	-96.7%	0.5
NOx	46.1	kt	18.5	-56.0%	3.2
NMVOC	68.4	kt	25.4	-60.3%	4.8
CO	228.7	kt	38.1	-60.0%	8.7
TSP	69.1	kt	151.9	-26.1%	141.5
PM_{10}	42.8	kt	83.6	-27.8%	66.6
$PM_{2.5}$	28.9	kt	62.0	-27.7%	10.6
BC	3.9	kt	57.5	-30.3%	6.5
PAHs	14.3	kt	378.4	-35.0%	32.1
HCB	0.3	kg	279.0	-95.3%	12.6
PCDD/PCDF	27.4	g I-TEQ	340.9	-69.3%	58.4
NH_3	32.3	kt	102.7	-39.2%	22.4
As	0.3	kt	89.7	-96.4%	12.8
Cd	0.8	kt	290.7	-30.0%	83.5
Cr	2.0	kt	220.8	-61.9%	61.6
Cu	9.8	kt	156.1	34.6%	60.3
Hg	0.4	kt	77.2	-67.2%	86.2
Ni	2.5	kt	83.3	-85.3%	8.6
Pb	6.3	kt	165.2	-98.8%	2.5
Se	0.4	kt	256.5	-19.3%	51.0
Zn	33.7	kt	285.9	-12.4%	45.7
PCBs	3.1	kg	94.3	-37.2%	52.9

The results of uncertainty analysis are interpreted in the manner provided below. For example, in Table 1.7.3-1 row with evaluated NO_2 emission uncertainty tells us that with certainty of 95 % total NO_2 emission for the year 2022 varies between [46.1*(1-p/100), 46.1*(1+p/100)], where “p” is emission uncertainty (18.5 %). With the same approach the 95% probability range for trend is between [-56.0 %-t, -56.0 %+t], where “t” is trend uncertainty (3.2 %).

High emission uncertainty for pollutants: PAHs, PCDD/PCDF, Cu, Pb, Se, PCBs, Zn, Hg is expected. The main reason is high default uncertainty of emission factors (400 %) that is given in Table 3.2 from GB2023. These are categories that have been classified at level E, which is an estimate of uncertainty based on assumptions and has unlimited range of uncertainty. For pollutants: PM_{10}, $PM_{2.5}$, BC and TSP uncertainty ranges in Table 3.3 from GB2023 are not defined. For pollutant, NH_3 range of uncertainty is classified in category D or E, where estimate of the uncertainty is based on assumption, so the range is not specified. As the total uncertainty would not be overestimated, for PM_{10}, $PM_{2.5}$, BC and TSP, the source category NFR 1.A.4 is divided into lower subcategories.

1.8. General assessment of completeness

According to reporting guidelines, in cases when methodological and data gaps exist in the inventory, parties to the Convention are required to inform and explain in a transparent manner the reason of their appearance, also the emission of certain emission sources from the inventory.

To accomplish this, Parties have to use designated notation keys, Explanation of the meaning and the purpose of notation keys are presented in the following sections. Notation keys are used in NFR19-1 emission tables for the NFR categories, from which emissions has not been quantitatively estimated.

1.8.1. List of emission sources not estimated (NE) in the inventory and reasons why NE are used with a qualitative assessment of their importance, currently and in future

Definition of Notation key "NE" is presented in following box:

Notation key	Meaning	Purpose
NE	Not estimated	Where emission occur, but have not been estimated or reported

The list of emission sources that were not estimated (NE) in the inventory and the reasons for not using them are listed in table 1.8.1-1.

Table 1.8.1-1 Explanation to the Notation key NE

NFR	Substance(s)	Reason for not estimated
1.A.1.b	NH_3, PCB, HCB	FEs are not available in GB2023
1.A.1.c	PCB, HCB	FEs are not available in GB2023
1.A.2.g.vii	PCB, HCB, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PCDD/PCDF, Hg, As	FEs are not available in GB2023
1.A.3.b.v	PCDD/PCDF, PCB	FEs are not available in GB2023, neither in COPERT 5 model
1.A.3.b.vi	PCDD/PCDF, PAUs, PCBs	FEs are not available in GB2023, neither in COPERT 5 model
1.A.3.b.vii	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAUs, PCBs	FEs are not available in GB2023, neither in COPERT 5 model
1.A.3.d.ii	benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene	FEs are not available in GB2023
1.A.4.b.ii, 1.A.4.c.ii	Hg, As, PCDD/PCDF, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, HCB, PCBs	FEs are not available in GB2023
1.A.4.c.i	HCB, PCBs	FEs are not available in GB2023
1.B.2.a.i	SO_2, PCDD/PCDF	FEs are not available in GB2023
1.B.2.c	NH3, PCDD/PCDF	FEs are not available in GB2023
2.B.1	SO_2, $PM_{2.5}$	FEs are not available in GB2023
2.B.2	NH_3, $PM_{2.5}$	FEs are not available in GB2023
2.C.3	HCB	FEs are not available in GB2023
2.K	PCB	GB2023 EFs are not suitable for national conditions
3.D.a.2.b	NH_3, NOx (1990 – 2004)	AD are not available
3.D.a.2.c	NH_3, NOx	AD are not available
3.D.a.4	NH_3, NOx	FEs are not available in GB2023
3.D.b	All relevant	There is no methodology.
3.D.d	All relevant	There is no methodology.
3.F	HCB, PCB	FEs are not available in GB2023
5.A	NH_3, CO, Hg	FEs are not available in GB2023
5.B.1	NO_x, CO, NMVOC, SO_2, TSP, PM_{10}, $PM_{2.5}$, BC	FEs are not available in GB2023
5.B.2	NO_x, CO, NMHOS, SO_2, TSP, PM_{10}, $PM_{2.5}$, BC, HCB, Pb, Cd, Hg, Cr, Zn, HCH, PCBs, PCDD/F, PAU	FEs are not available in GB2023
5.C.1.b.i	NH_3, Se	FEs are not available in GB2023
5.C.1.b.iii	NH_3, PM_{10}, $PM_{2.5}$, Se, Zn	FEs are not available in GB2023
5.C.1.b.v	BC	FEs are not available in GB2023
5.C.2	NH_3, Hg, Ni, indeno(1,2,3-cd)piren, HCB	FEs are not available in GB2023

NFR	Substance(s)	Reason for not estimated
5.D.1	TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	FEs are not available in GB2023
5.D.2	NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	FEs are not available in GB2023
5.E	NO_x, CO, NMHOS, SO_2, NH_3, BC, Ni, Se, Zn, PAU, HCB, PCBs	FEs are not available in GB2023

A qualitative assessment of the current and future relevance of non-estimated (NE) emission sources is given in Appendix 3.

1.8.2. List of sources included elsewhere in Annex I and not assigned to a specific NFR with the explanation of the decision

Definition of Notation key "IE" is presented in following box:

Notation key	Meaning	Purpose
IE	Included elsewhere	Where emissions for mentioned activity or process are calculated and included in inventory, but did not separately present for this source category / For emissions of pollutants which are calculated, but included elsewhere from expected source category in the inventory;

The list of sources included elsewhere (IE), the NFR category in which the source is included, the list of pollutants and the years/period for which the IE is used is given in table 1.8.2-1.

Table 1.8.2-1 Explanation to the Notation key "IE"

NFR	Substance(s)	Included in NFR	
1A2gviii	All relevant	1.A.2.f	1990 - 2022
1.A.3.d.i.(ii)	All relevant	1.A.3.d.i(i)	1990 - 2022
1.A.4.a.ii	All relevant	1.A.4.b.ii and 1.A.4.c.ii	1990 - 2022
1.A.4.c.iii	All relevant	1.A.3.d.ii (based on total amount of exhausted fuel for national navigation, maritime and river transport)	1990 - 2022
1.A.5.a	All relevant	1.A.4.a.i	1990 - 2022
1.A.5.b	All relevant	1.A.3.a, 1.A.3.b (i-iv), 1.A.3.d	1990 - 2022
2.A.1	All relevant for fuel combustion except for PMs	1.A.2.f	1990 - 2022
2.A.2	All relevant for fuel combustion except for PMs	1.A.2.f	1990 - 2022
2.A.3	All relevant for fuel combustion except for PMs	1.A.2.f	1990 - 2022
2.A.5.c	TSP, PM_{10}, $PM_{2.5}$	2.A.1, 2.A.2, 2.A.3, 2.A.5.a, 2.A.5.b	1990 - 2022
2.B.10.b	TSP, PM_{10}, $PM_{2.5}$	2.B.10.a	1990 - 2022
2.C.1	NH_3	1.A.2.f	1990 - 2000
		1.A.2.a	2001 - 2022
2.C.2	All relevant for fuel combustion	1.A.2.b	1990 - 2003
2.C.3	All relevant for fuel combustion	1.A.2.b	1990 - 1991
2.G	All relevant	2.D.3.a	1990 - 2022
3.D.a	NOx, NH_3, and other relevant	3.B source categories	1990 – 2022
3.D.b	PMs	3.D.a.1	1990 – 2022
3.D.c	PMs	3.B source categories, 3.D.a.1	1990 – 2022
3.D.e	PMs	3.D.a.1	1990 – 2022
5.B.2	All relevant for fuel combustion	1.A.1, 1.A.4	2009 – 2022

NFR	Substance(s)	Included in NFR	
5.C.1.b.i	All relevant for fuel combustion	1.A.2.f	2009 – 2022
5.C.1.b.ii	All relevant	5.C.1.b.i	1997 – 2002

1.8.3. Description and explanation of the use of other notation keys in the inventory

Definition of other notation keys in the inventory is presented in following box:

Notation key	Meaning	Purpose
NO	Not occurring	For activities or processes which do not exist in Republic of Croatia / for emissions by sources of compounds that do not occur for a particular compound or source category;
NA	Not applicable	When activity or process exist, but it is assumed that they do not result with emission / Is used for activities which are believed to result in emission which are insignificant to national totals;
C	Confidential	For emissions by sources of compounds which could lead to the disclosure of confidential information

The rationale for emission sources that are reported as “Other” in the reporting format (Annex 1 of the Reporting guidelines) needs to be explained in the IIR as set out in this section.

Table 1.8.3-1 provides a list of emission sources that are reported as "Other" with details of the included activities at the SNAP level (the most detailed reporting level), a list of pollutants as well as the years/periods to which this applies as well as a list of sources for which other notation keys are used in the inventory, i.e. "NO" and "C".

Table 1.8.3-1 Sub-sources accounted for in reporting codes “Other”

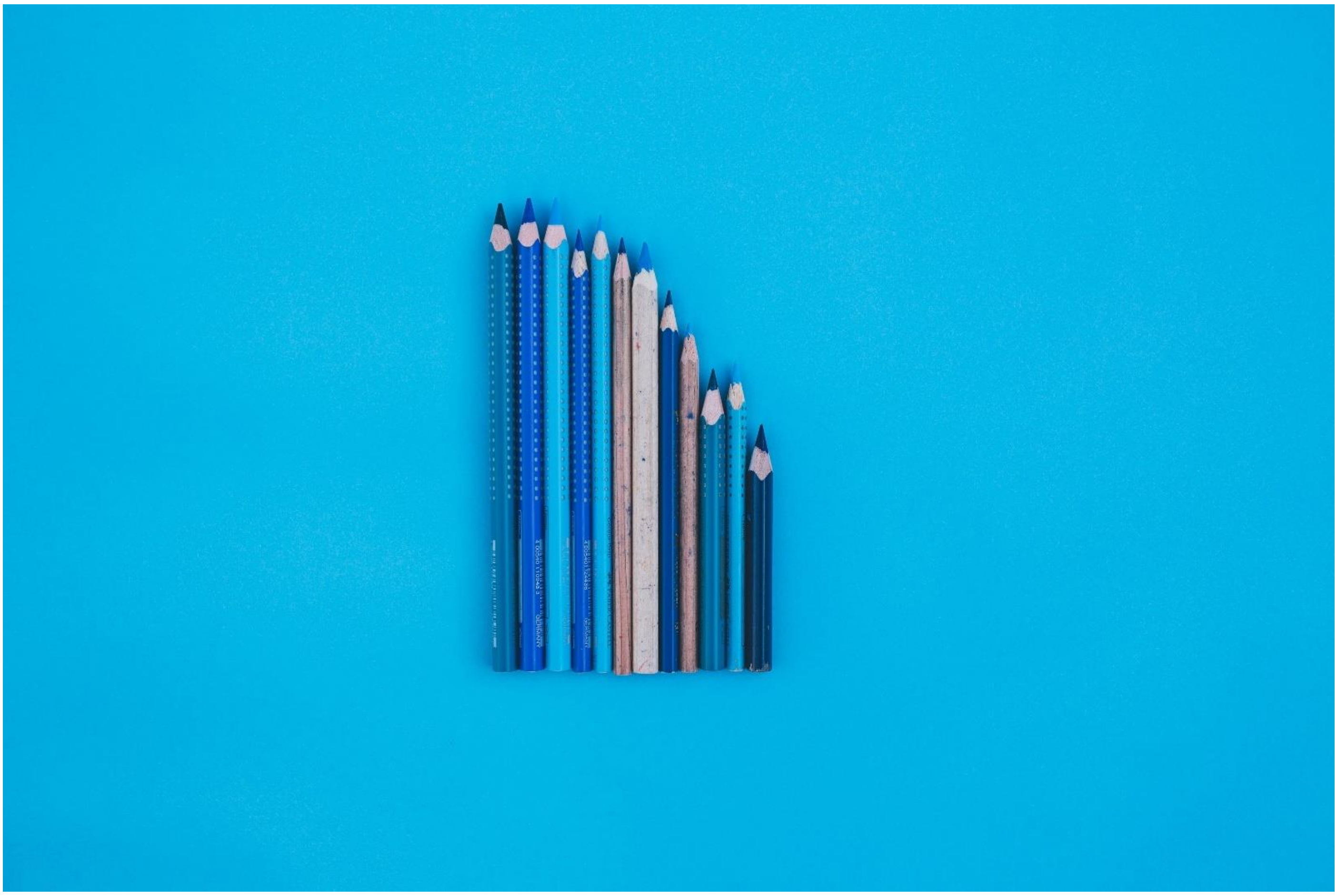
NFR	Substance(s) reported	Sub-source description	
1.A.5.a	All relevant	(C) - military, (IE) Combustion in commercial and institutional plants (NFR 1A4a and SNAP 020100)	1990 - 2022
1.A.5.b	All relevant	(C) - military, (IE) - Combustion in vehicles (sub-sectors 1A3b (i-iv)), other mobile combustion in NFR code 1A4ai	1990 - 2022
1.B.1.c	NO	-	1990 - 2022
1.B.3	NO	-	1990 - 2022
2.B.10.a	NOx, CO, NMVOC, SO_2, NH_3, PM_{10}, TSP, $PM_{2.5}$	Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polyvinylchloride (SNAP 040508), Styrene (SNAP 040510), Polystyrene (SNAP 040511) and Ethyl benzene (SNAP 040518)	1990
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polyvinylchloride	1991

NFR	Substance(s) reported	Sub-source description	
		(SNAP 040508), Polystyrene (SNAP 040511) and Ethyl benzene (SNAP 040518)	
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polyvinylchloride (SNAP 040508), Polystyrene (SNAP 040511)	1992 and 1993
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polyvinylchloride (SNAP 040508), Polystyrene (SNAP 040511), Formaldehyde (SNAP 040517) and Ethyl benzene (SNAP 040518)	1995 and 1996
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polyvinylchloride (SNAP 040508), Polystyrene (SNAP 040511) and Formaldehyde (SNAP 040517)	1994 and 1997 - 2000
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polystyrene (SNAP 040511) and Formaldehyde (SNAP 040517)	2001 and 2002
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers (SNAP 040407), urea (SNAP 040408), Ammonium phosphate SNAP 040406), carbon black (SNAP 040409), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Polyethylene LD (SNAP 040506), Polystyrene (SNAP 040511) and Formaldehyde (SNAP 040517)	2003 - 2009
		Processes in inorganic chemical industry - production of: NPK fertilizers (SNAP 040407), urea (SNAP 040408), and processes in organic chemical industry - production of: Ethylene (SNAP 040501), Propylene (SNAP 040502), Polyethylene LD (SNAP 040506), Polystyrene (SNAP 040511) and Formaldehyde (SNAP 040517)	2010 - 2011
		Processes in inorganic chemical industry - production of: sulphuric acid (SNAP 040401), NPK fertilizers	2012 – 2022

NFR	Substance(s) reported	Sub-source description	
		(SNAP 040407), urea (SNAP 040408), and processes in organic chemical industry - production of: Formaldehyde (SNAP 040517)	
2.C.7.c	NO	-	1990 - 2022
2.D.3.i	VOC, NOx, CO, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP, As, Cd, Cr, Cu, Hg, Pb, PCDD/PCDF, Total 4 PAH, benzo(a), benzo(b), benzo(k), Indeno	Fat, edible and non-edible oil extraction (SNAP 060404), Tobacco combustion (SNAP 060602), Preservation of wood with creosote preservative type / organic solvent borne preservative (SNAP 060406), Application of glues and adhesives (SNAP 060405) and conservation of vehicles (SNAP 060407)	1990 - 2022
2.H.3	NO	-	1990 - 2022
2.G	NMVOC	Use of pesticide, including fungicide	1990 – 2022
3.D.a.2.c	NO	-	1990 - 2022
5.E	All relevant	Detached house fire (SNAP 091010), undetached house fire (SNAP 091011), apartment building fire (SNAP 091012), industrial building fire (SNAP 091013) and car fire (SNAP 091009)	1990 - 2022

For now, the Republic of Croatia does not use the notation key "NR" in the inventory, the definition of which is given in the following box:

Notation key	Meaning	Purpose
NR	Not relevant	According to paragraph 9 in the Emission Guidelines, Emission inventory reporting should cover all years from 1980, Onwards, if data are available. Where emissions are not strictly required by the different Protocols, e.g. for some parties' emissions of NMVOC prior to 1988, and some emissions of PM_{10} and $PM_{2.5}$ prior to 2000.



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2. Explanation of key trends

This chapter presents an explanation of key trends with a line chart for the pollutant trend, a pie chart for the percentage of aggregated NFR categories in 1990 and 2022, a bar chart for the variation of aggregate NFR categories.

The considered NFR categories aggregated by emission are as follows:

- 1.A.1 Energy industries,
- 1.A.2 Industry and construction,
- 1.A.3.b Road transport,
- 1.A.3.a,c,d Non-road transport (LTO air, rail and domestic maritime)
- 1.A.4 Small combustion plants and Non-road mobile sources and machines,
- 1B Fugitive emissions,
- 2 Industrial processes and product use,
- 3 Agriculture
- 5 Waste.

Below the graphs are included tables showing the emissions of each pollutant by NFR category / sector for the years 1990, 2021 and 2022, changes in trends from 1990 to 2022 and 2021 to 2022, and the share in total emissions. The tables do not include NFR categories that are reported with a notation key for all years in a row, as well as NFR categories that, compared to others of the same pollutant, have significantly lower emissions.

Trends of all pollutants within the inventory of air pollutants in Croatia, as well as the acidification index, are considered, and are presented in Chapters 2.1 - 2.9. A description of time series inconsistencies is given if such exist in trend. Explain significant changes in the time trend for key categories (i.e. dips and jumps) and explain constant / permanent reductions or increases in emissions. The changes are mainly the result of changes in the activity / reduction / source process (e.g. shutdown or start-up of the plant) or in a specific situation in the country and world (e.g. the 1991-1995 war for Croatian independence, the world economic crisis, etc.). If the reason for the trend fluctuation is the result of different methods or source data used for different years, this is explained in Chapters 3 - 7 where sectoral methodologies are explained.

Emissions from the fuel combustion from mobile and stationary sources are calculated on the basis of “fuel sold” in Croatia.

2.1. Sulphur dioxide (SO_2)

National total emissions and trends (1990–2022) for air pollutants covered by the Gothenburg Protocol (SO_2, NOx, NMVOC, NH_3) and CO are shown in Table 2.1-1.

Table 2.1-1 National total emissions and trends 1990–2022 for air pollutants covered by Gothenburg Protocol and CO

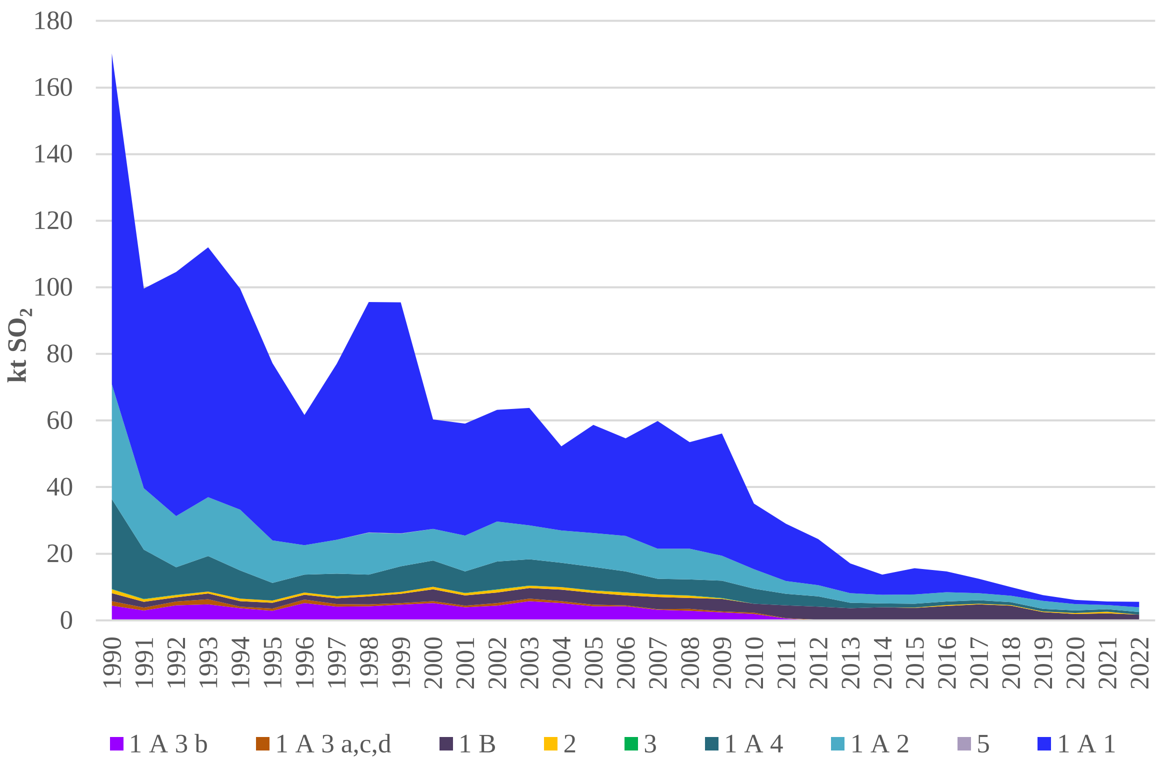
Year	Emission [kt]				
	NOx	NMVOC	SO_2	NH_3	CO
Trend 1990-2022	**-55.5%**	**-64.9%**	**-96.7%**	**-46.7%**	**-63.3%**
1990	102.91	173.90	170.21	50.46	564.20
1991	78.73	138.52	99.58	49.77	492.42
1992	74.00	104.96	104.64	45.20	404.66
1993	73.78	102.22	112.04	40.88	429.73
1994	76.01	99.43	99.61	40.01	422.95
1995	77.56	119.77	77.33	37.96	445.63
1996	82.80	122.26	61.74	37.83	473.61
1997	85.14	109.48	77.12	40.18	455.19
1998	87.80	108.45	95.59	36.14	466.85
1999	91.60	106.58	95.58	38.25	471.42
2000	85.93	104.11	60.43	38.95	465.72
2001	86.51	101.98	59.12	41.29	448.56
2002	89.20	104.51	63.26	40.05	428.56
2003	88.25	108.14	63.86	40.14	447.14
2004	86.26	112.56	52.31	42.47	427.13
2005	83.77	113.50	58.76	39.70	422.54
2006	83.76	113.82	54.70	39.49	407.96
2007	86.30	109.77	59.91	39.52	394.27
2008	82.14	108.31	53.51	41.85	349.55
2009	75.21	94.02	56.13	33.11	344.45
2010	67.75	91.03	35.09	35.44	333.84
2011	64.31	86.04	29.05	36.85	309.29
2012	58.72	80.77	24.42	35.35	293.79
2013	57.85	75.61	17.07	28.90	283.10
2014	54.38	69.58	13.78	27.80	250.29
2015	54.97	70.52	15.64	30.42	270.70
2016	53.64	71.77	14.66	28.69	260.50
2017	53.82	68.65	12.52	31.91	254.21
2018	50.14	69.08	10.01	32.10	233.49
2019	49.25	73.64	7.61	30.21	219.26
2020	44.92	69.19	6.16	31.12	214.61
2021	45.99	67.51	5.67	29.78	228.10
2022	45.75	61.11	5.56	26.92	206.79

The total sulphur dioxide (SO_2) emission in 2022 was amounted to 5.56 kt that is 2% lower than in 2021 (Tables 2.1-1 and 2.1-2). Moreover, the SO_2 emission in 2021 was decrease by 96.7% compared with 1990 (Figure 2.1-1). Of the total SO_2 emission in 2021, 98.4% is generated from Energy sector, from Energy Industries 29.2% (dominated by Petroleum refining (1.A.1.b)), Manufacturing industry and construction 26.3% (dominated by Non-metallic Minerals (1.A.2.f)), Fugitive emissions from fuels 30.1% (dominated by Refining / Storage

(1.B.2.a.iv)), Small combustion and mobile machinery 12.3% (dominated by Residential: stationary (1.A.4.b.i)) and Industrial processes and product use 1.5% (dominated by Other chemical industry (Sulfuric acid production) (2.B.10.a)).

Since 1990, emissions from the Energy Industries have declined by 98.4%, from the Manufacturing industry and construction by 95.8% and from Small combustion and mobile machinery by 97.5%, and from Fugitive emissions from fuels by 30.6%. Sulphur emissions from Industrial processes and product use sector, have also decreased, by 92.9% compared to 1990, due to a stopping of the aluminium production, pulp and paper production (Kraft process) and carbon black production and also due to great reduction in production of sulphuric acid. Increasing trend in SO_2 emissions has sector Refining/storage (1.B.2.a.iv) due to the installation of sulphur recovery plants (Claus plants), the first one in 1997 and second in 2008 within two refineries.

The great reduction of SO_2 emissions in the historic trend is the result of a transfer from fuels with high sulphur content to low-sulphur fuels, for both road transport and stationary combustion. In addition, the war for Croatian independence in the period 1991 – 1995 was the reason for the decline in fuel consumption and overall production in almost all sectors and as consequence the decline in emissions. Great decline in SO_2 emission trend can be observed in 2000 due to second coal thermal power plant (TPP) entering into operation in Croatia. Second TPP has a technique for reducing SO_2 emission (SO_2 scrubbing process) with efficiency of 95%. The second TPP on coal has approximately double capacity in comparison to first one. Since 2000, first TPP with no technique for the SO_2 emission reduction was in operation only when the electricity needs are higher (mainly in the summer), until 2018, when the first TPP was stopped due to the start of revitalization process.



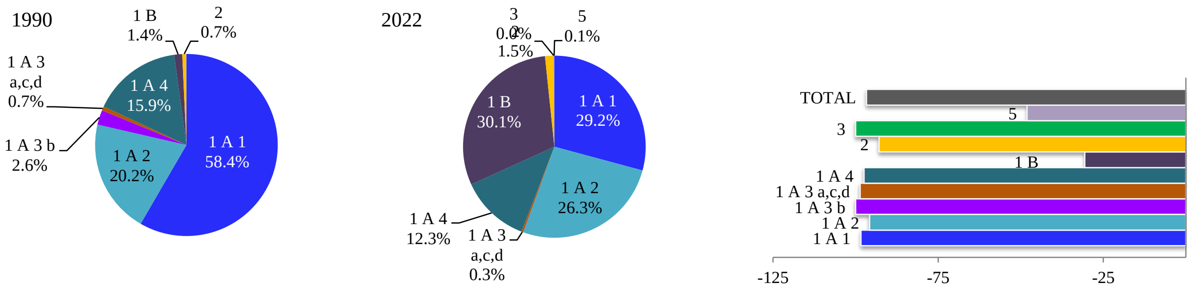


Figure 2.1-1 The SO_2 emissions (kt/yr.) and percentage share by sector and variation in SO_2 emissions

Table 2.1-2 The SO_2 emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		SO_2 emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**168.95**	**5.09**	**5.47**	**-97%**	**7%**	**99%**	**99%**
1A	FUEL COMBUSTION	166.54	3.06	3.79	-98%	24%	98%	69%
1A1	Energy Industries	99.32	1.06	1.62	-98%	53%	58%	29%
1A1a	Public electricity and heat production	76.63	0.32	0.42	-99%	33%	45%	8%
1A1b	Petroleum refining	22.49	0.74	1.20	-95%	63%	13%	22%
1A1c	Manufacture of solid fuels and other energy industries	0.20	0.00	0.00	-98%	29%	0%	0%
1A2	Manufacturing Industries and Construction	34.46	1.23	1.46	-96%	19%	20%	26%
1A2a	Iron and Steel	7.93	0.11	0.12	-98%	14%	5%	2%
1A2b	Non-ferrous Metals	0.09	0.00	0.00	-99%	36%	0%	0%
1A2c	Chemicals	6.42	0.00	0.01	-100%	122%	4%	0%
1A2d	Pulp, Paper and Print	1.77	0.01	0.01	-99%	0%	1%	0%
1A2e	Food Processing, Beverages and Tobacco	6.66	0.17	0.22	-97%	32%	4%	4%
1A2f	Non-metallic Minerals	10.64	0.93	1.09	-90%	17%	6%	20%
1A2g	Manufacturing Ind. and Constr.: Other	0.95	0.00	0.00	-100%	22%	1%	0%
1A3	Transport	5.71	0.01	0.02	-100%	45%	3%	0%
1A3a	Civil Aviation	0.02	0.01	0.02	-25%	61%	0%	0%
1A3b	Road Transportation	4.43	0.00	0.00	-100%	-3%	3%	0%
1A3c	Railways	0.74	0.00	0.00	-100%	11%	0%	0%
1A3d	Navigation	0.52	0.00	0.00	-100%	-14%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	27.05	0.76	0.69	-97%	-9%	16%	12%
1A4a	Commercial/Institutional	6.89	0.04	0.04	-99%	3%	4%	1%
1A4b	Residential	17.08	0.71	0.64	-96%	-10%	10%	11%
1A4c	Agriculture/Forestry/Fishing	3.07	0.01	0.01	-100%	4%	2%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	2.42	2.03	1.68	-31%	-18%	1%	30%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**1.20**	**0.54**	**0.05**	**-96%**	**-91%**	**1%**	**1%**
2B	CHEMICAL INDUSTRY	0.71	0.52	0.03	-95%	-94%	0%	1%
2C	METAL PRODUCTION	0.38	0.01	0.01	-97%	-9%	0%	0%

Category		SO_2 emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
2G	OTHER PRODUCT USE	0.00	0.01	0.01	209%	-18%	0%	0%
2H	OTHER INDUSTRY PRODUCTION	0.11	0.00	0.00	-100%	-	0%	0%
3	**AGRICULTURE**	**0.04**	**0.00006**	**0.00001**	**-100%**	**-84%**	**0%**	**0%**
5	**WASTE**	**0.012**	**0.007**	**0.006**	**-48%**	**-2%**	**0%**	**0%**
	NATIONAL TOTAL	**170.21**	**5.63**	**5.53**	**-97%**	**-2%**	**100%**	**100%**

2.2. Nitrogen oxides (NO_X)

The nitrogen oxides (NO_x) emission encompasses nitrogen monoxide and nitrogen dioxide emissions. The emissions are expressed as equivalents of NO_2. The NO_x is a pollutant that causes acidification and eutrophication. Together with volatile organic compounds and other reactive gases in atmosphere, and in presence of solar radiation, the NO_x takes part in ground ozone formation. Nitrogen oxides are formed in all combustion in the energy and transport sectors, and the largest emission sources are road transport, off-road vehicles and machinery, production of electricity and heating and manufacturing industry and construction.

National total emissions and trends (1990–2022) for air pollutants covered by the Gothenburg Protocol are shown in Table 2.1-1.

The NOx emission in 2021 amounted to 45.75 kt, which is a decline by 55.5 % since 1990 and compared to the year before, it remained at the same level (Figure and Table 2.2-1). Emissions from the Energy sector in 2022 were about 41.7 kt and account for about 91.2% of the total NOx emission. The main sources in the Energy sector in 2022 were the Road transport with a contribution of 45.1% to the total NOx emission (dominated by Passenger cars (1.A.3.b.i, 24.8%), Heavy duty vehicles (1.A.3.b.iii, 15.8%) and Light duty vehicles (1.A.3.b.ii, 4.2%)), Residential: stationary (1.A.4.b.i, contribution of 9.2%), Non-metallic Minerals (1.A.2.f, contribution of 6.2%), National Navigation (1.A.3.d.ii, contribution of 5.5 %), Public electricity and heat production (1.A.1.a, contribution of 7.6%) and Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery (1.A.4.c.ii, contribution of 3.9%). Agriculture sector has also great contribution to the total NOx emission of 8.1% dominated by Inorganic N-fertilizers (3.D.a.1, contribution of 5%).

Compared to 1990, the NOx emission from Road transport sector has declined by 42.6%, due to the introduction of catalytic converters in cars and the subsequent successively more strict emission standards. Energy stationary combustion sectors (including off-road mobile sources) also have recorded a great decrease since 1990, mostly due to lower fuel consumption. The Industrial processes and product use sector also record a decline of historic emissions by 93.6%, mostly due to stopping the production of aluminium, paper and pulp (Kraft process) and carbon black production and also due to overall decline in productions. The agriculture sector recorded a decrease of 33.2% since 1990, mainly due to the decrease in the use of N-fertilizers in crop production. In addition, the war for Croatian independence in the period 1991 – 1995 was the reason for the decline in fuel consumption and overall production in almost all sectors and as consequence the decline in emissions. Since 2007, the trend of NOx emission has recorded decline due to the economic crisis.

The reduction in emissions in 2020 compared to 2019 is the result of the impact of the lockdown and accompanying measures caused by the COVID-19 pandemic, registered in Croatia in late February 2020, which was registered in Croatia at the end of February 2020, and which affected on reduction of fuel consumption in road transport, increased energy demand in the household sector and reduced consumption in industry and construction, and in energy and heat production.

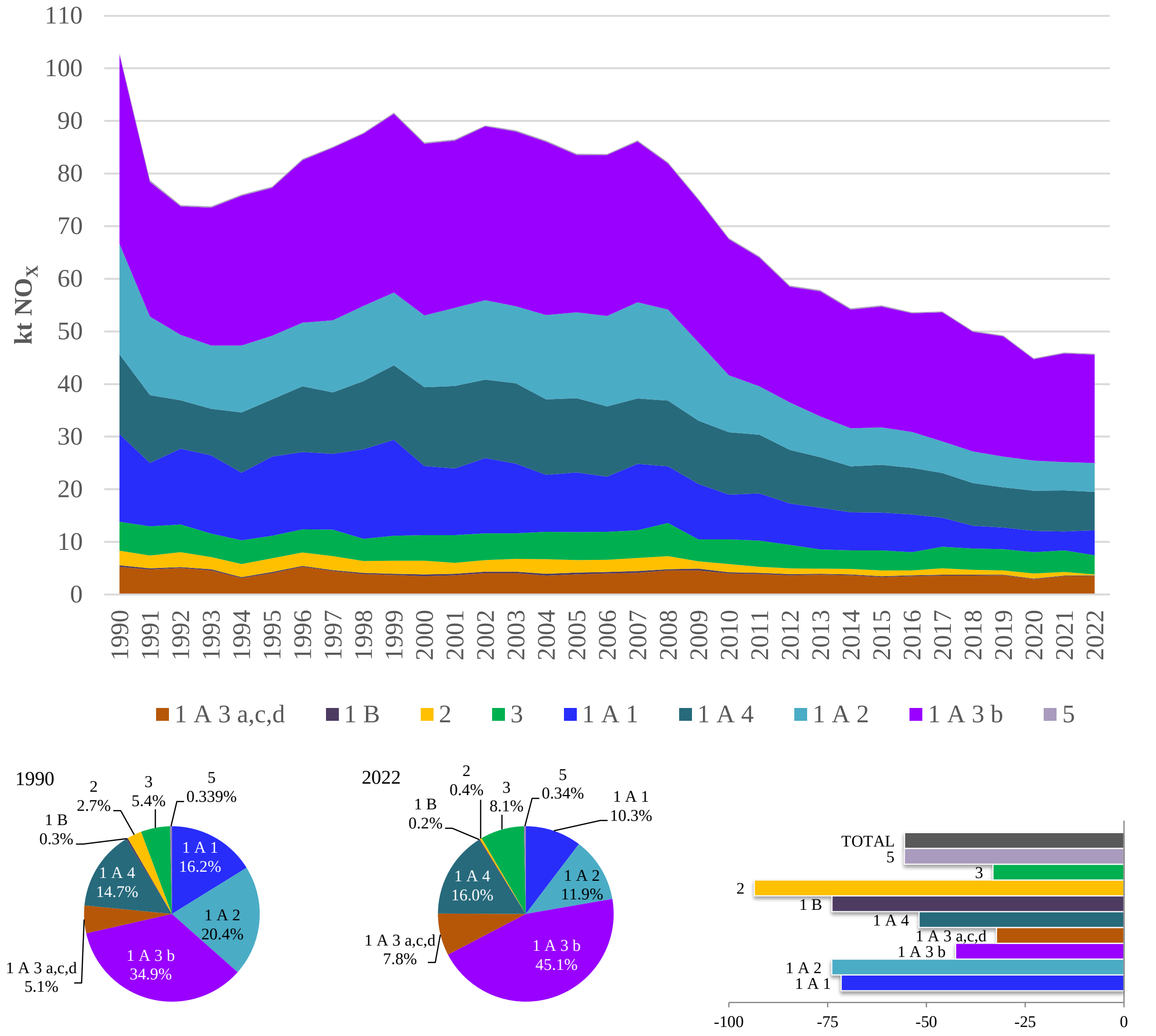


Figure 2.2-1 The NO_X emissions (kt/yr.) and percentage share by sector and variation in NO_X emissions

Table 2.2-1 The NO_x emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		NO_X emission in kt			Trend change		Share in National Total	
NFR Code	**Description**	**1990**	**2021**	**2022**	**1990-2022**	**2021-2022**	**1990**	**2022**
1	**ENERGY**	**94.28**	**41.03**	**41.73**	**-56%**	**2%**	**92%**	**91%**
1A	FUEL COMBUSTION	93.95	40.93	41.65	-56%	2%	91%	91%
1A1	Energy Industries	16.64	3.56	4.73	-72%	33%	16%	10%
1A1a	Public electricity and heat production	11.49	2.34	3.50	-70%	49%	11%	8%
1A1b	Petroleum refining	3.51	0.90	0.82	-77%	-9%	3%	2%
1A1c	Manufacture of solid fuels and other energy industries	1.63	0.32	0.41	-75%	29%	2%	1%

Category		NOx emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2	Manufacturing Industries and Construction	20.97	5.34	5.46	-74%	2%	20%	12%
1A2a	Iron and Steel	2.44	0.10	0.11	-96%	4%	2%	0%
1A2b	Non-ferrous Metals	0.09	0.04	0.05	-47%	9%	0%	0%
1A2c	Chemicals	2.56	0.22	0.12	-95%	-45%	2%	0%
1A2d	Pulp, Paper and Print	0.75	0.18	0.18	-76%	0%	1%	0%
1A2e	Food Processing, Beverages and Tobacco	2.89	0.58	0.78	-73%	35%	3%	2%
1A2f	Non-metallic Minerals	9.02	2.91	2.82	-69%	-3%	9%	6%
1A2g	Manufacturing Ind. and Constr.: Other	3.22	1.30	1.41	-56%	8%	3%	3%
1A3	Transport	41.17	24.17	24.17	-41%	0%	40%	53%
1A3a	Civil Aviation	0.28	0.28	0.28	-2%	-1%	0%	1%
1A3b	Road Transportation	35.92	20.67	20.61	-43%	0%	35%	45%
1A3c	Railways	1.99	0.75	0.77	-61%	3%	2%	2%
1A3d	Navigation	2.97	2.47	2.51	-16%	1%	3%	5%
1A4	Small combustion & other non-road mobile sources and machinery	15.17	7.86	7.30	-52%	-7%	15%	16%
1A4a	Commercial/Institutional	2.48	1.12	1.02	-59%	-9%	2%	2%
1A4b	Residential	4.33	4.60	4.25	-2%	-7%	4%	9%
1A4c	Agriculture/Forestry/Fishing	8.36	2.14	2.03	-76%	-5%	8%	4%
1B	FUGITIVE EMISSIONS FROM FUELS	0.33	0.10	0.09	-74%	-15%	0%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**2.77**	**0.69**	**0.16**	**-94%**	**-76%**	**3%**	**0%**
2B	CHEMICAL INDUSTRY	2.60	0.65	0.13	-95%	-81%	3%	0%
2C	METAL PRODUCTION	0.10	0.02	0.02	-77%	-9%	0%	0%
2G	OTHER PRODUCT USE	0.02	0.02	0.02	-28%	-4%	0%	0%
2H	OTHER INDUSTRY PRODUCTION	0.05	0.00	0.00	-100%	-	0%	0%
3	**AGRICULTURE**	**5.51**	**4.10**	**3.68**	**-33%**	**-10%**	**5%**	**8%**
3B	MANURE MANAGEMENT	0.19	0.08	0.07	-62%	-5%	0%	0%
3B1	Cattle	0.06	0.01	0.01	-78%	4%	0%	0%
3B3	Swine	0.08	0.01	0.01	-88%	-8%	0%	0%
3B4	Other livestock	0.05	0.05	0.05	1%	-7%	0%	0%
3B4g	Poultry	0.04	0.05	0.04	6%	-8%	0%	0%
3D	AGRICULTURAL SOILS	5.13	4.02	3.61	-30%	-10%	5%	8%
3Da	Direct Soil Emissions	5.13	4.02	3.61	-30%	-10%	5%	8%
3F	Field burning of agricultural residues	0.18	0.00	0.00	-100%	-84%	0%	0%
5	**WASTE**	**0.35**	**0.16**	**0.15**	**-56%**	**-2%**	**0%**	**0%**
	NATIONAL TOTAL	**102.91**	**45.97**	**45.74**	**-56%**	**-1%**	**100%**	**100%**

2.3. Ammonia (NH_3)

Ammonia contributes to acid deposition and eutrophication. It also reacts rapidly with atmospherically formed sulphuric and nitric acids to contribute to ambient levels of fine particles. Agriculture represents the largest source of ammonia emissions. Ammonia is a common by-product of animal excreta due to often-inefficient conversion of feed nitrogen into animal product (N rich meat, milk or eggs).

National total emissions and trends (1990–2022) for air pollutants covered by the Gothenburg Protocol are shown in Table 2.1-1.

The NH_3 emission in 2022 amounted to 26,9 kt. Since 1990, emission has decrease by 46,7% and since the year before by 9,6% (Table 2.3-1). The majority of ammonia emissions result from agricultural activities, which in 1990 accounted for 89%, and in 2022 for 94,2% of the total emission, and this sector recorded a decrease in emissions by 43,5% since 1990. Of the other sources, the key category from the production processes sector is 2.B.10.a production of chemicals: ammonia, nitric acid and mineral N-fertilizers whose contribution to the total emission decreased from 7.1% in 1990 to 2% in 2022. A major part of the emission from agriculture comes from manure management activities (3.B), which accounted for 40% in 1990, but decreased to 32% in 2022, and from the agricultural soils (3.D), which accounted for 49% 1990 and increased to 62% in 2022. The increase in dominance is not related to the increased intensity of activities related to agricultural soils, but mainly to the reduction of emissions related to manure management. The largest source for manure management is ammonia losses occur during manure handling in animal housing systems. For agricultural soils, NH_3 emissions mainly result from application of mineral N-fertiliser, accounted for 42% in 1990 and increased to 65% in 2022, and less from the application of animal manure to the soil (which accounted for 49%) in 1990, but decreased to 28% in 2022) and from deposition of urine and dung by grazing animals (which accounted for 10% in 1990, but decreased to 7% in 2022).

The decline in NH_3 emission from 1991 to 1995 was the result of the war for Croatian independence, while the reason for the decline in 2009 was the economic crisis. Decline in the recent years (since 2010) is related to manure management sector and occurred due to reducing number of animal (Tables 5.1-12 and 5.1-13) but also due to intensification of measures related to prevent loss of nitrogen in agricultural production. The abatement measures are related to animal housing systems (e.g. floor performance, drinking systems, ventilation, intensity of the manure removal), methods for management, storage, and application of manure (Tables 5.1-2 and 5.1-3). Regarding manure application on soils series of measures to prevent loss of nitrogen have been recommended to farmers in accordance with the principles of good agricultural practice (lit. 18) e.g. not to carry out: fertilization with slurry manure on agricultural land in winter (from 1 December to 1 March), fertilization with solid and slurry manure and slurry spreading on the agricultural surface without incorporation in the soil in summer (from 1 May to 1 September).

Unlike other sectors, the increase in NH_3 emission by approx. 8 times compared to 1990, but without a significant impact on total national emissions, occurred in Road transport, as a result of the introduction of a three-way catalytic control system in diesel vehicles (Euro 5 and 6) using selective catalytic reduction (SCR) with urea injection into the exhaust intended to control NOx emissions, which are converted to NH_3.

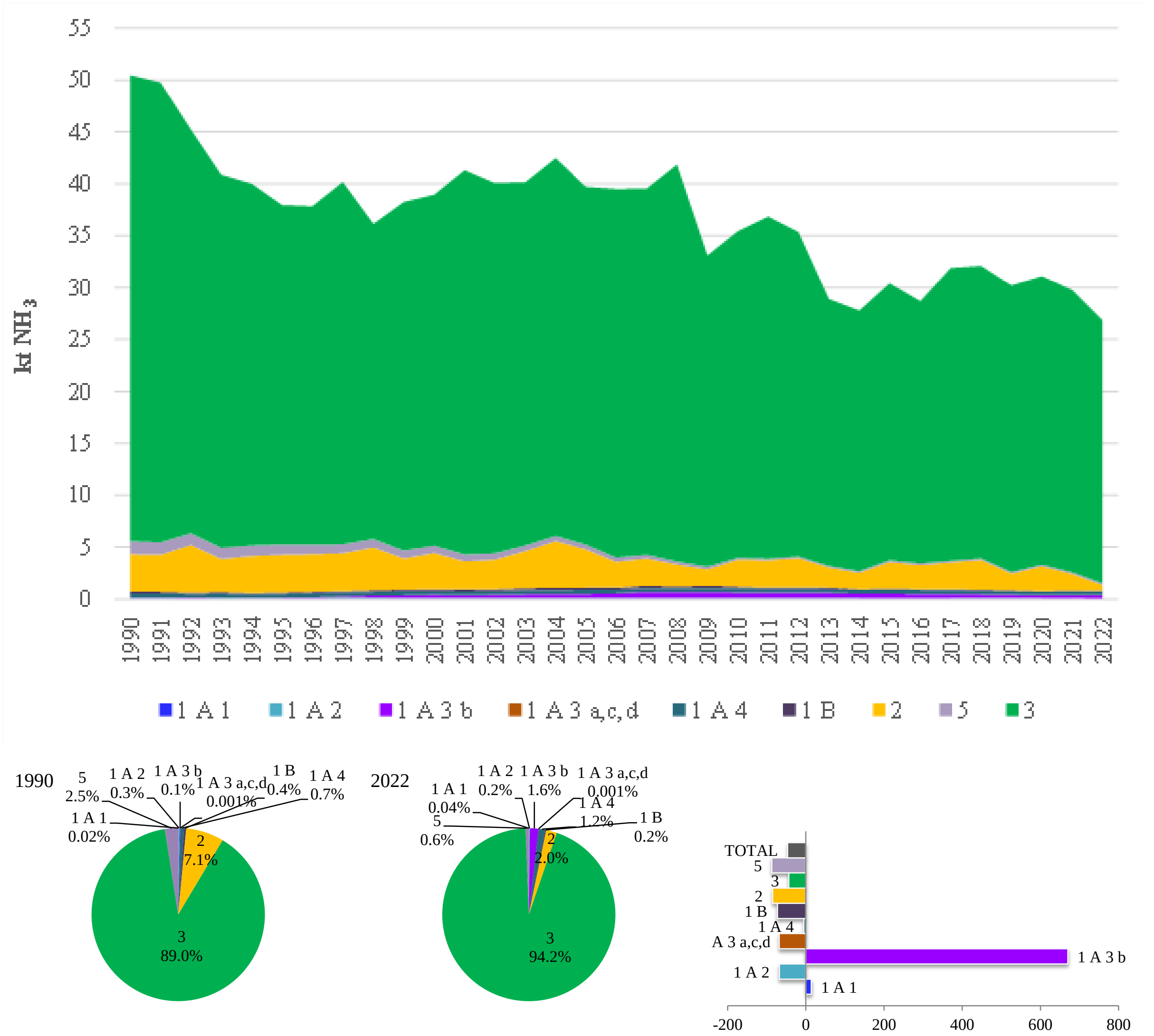


Figure 2.3-1 The NH_3 emissions (kt/yr.) and percentage share by sector and variation in NH_3 emissions

Table 2.3-1 The NH_3 emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		NH_3 emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**0.75**	**0.82**	**0.87**	**16%**	**5%**	**1%**	**3%**
1A	FUEL COMBUSTION	0.54	0.76	0.81	50%	7%	1%	3%
1A1	Energy Industries	0.01	0.01	0.01	14%	8%	0%	0%
1A1a	Public electricity and heat production	0.01	0.01	0.01	37%	6%	0%	0%
1A2	Manufacturing Industries and Construction	0.13	0.05	0.04	-68%	-13%	0%	0%
1A2d	Pulp, Paper and Print	0.003	0.003	0.004	37%	20%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	NE	0.01	0.01	100%	-12%	-	0%
1A2f	Non-metallic Minerals	0.13	0.03	0.03	-80%	-18%	0%	0%
1A3	Transport	0.06	0.34	0.44	661%	27%	0%	2%
1A3b	Road Transportation	0.06	0.34	0.44	670%	27%	0%	2%

Category		NH_3 emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A4	Small combustion & other non-road mobile sources and machinery	0.34	0.36	0.32	-5%	-9%	1%	1%
1A4a	Commercial/Institutional	0.00	0.02	0.02	2984%	1%	0%	0%
1A4b	Residential	0.34	0.33	0.30	-12%	-10%	1%	1%
1B	FUGITIVE EMISSIONS FROM FUELS	0.21	0.07	0.06	-73%	-15%	0%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**3.58**	**1.61**	**0.54**	**-85%**	**-66%**	**7%**	**2%**
2A	MINERAL PRODUCTS	0.03	0.11	0.08	202%	-30%	0%	0%
2B	CHEMICAL INDUSTRY	3.50	1.45	0.42	-88%	-71%	7%	2%
2G	OTHER PRODUCT USE	0.05	0.04	0.04	-30%	-3%	0%	0%
3	**AGRICULTURE**	**44.89**	**27.19**	**25.35**	**-44%**	**-7%**	**89%**	**94%**
3B	MANURE MANAGEMENT	20.00	9.14	8.62	-57%	-6%	40%	32%
3B1	Cattle	7.49	2.90	2.74	-63%	-5%	15%	10%
3B2	Sheep	0.27	0.23	0.23	-14%	-2%	1%	1%
3B3	Swine	7.48	4.03	3.83	-49%	-5%	15%	14%
3B4	Other livestock	4.75	1.98	1.82	-62%	-8%	9%	7%
3B4d	Goats	0.05	0.02	0.02	-53%	-5%	0%	0%
3B4e	Horses	0.15	0.11	0.12	-19%	8%	0%	0%
3B4f	Mules and asses	0.07	0.02	0.02	-64%	15%	0%	0%
3B4g	Poultry	4.49	1.83	1.65	-63%	-10%	9%	6%
3D	AGRICULTURAL SOILS	24.70	18.05	16.73	-32%	-7%	49%	62%
3Da	Direct Soil Emissions	24.70	18.05	16.73	-32%	-7%	49%	62%
3F	Field burning of agricultural residues	0.19	0.00	0.00	-100%	-84%	0%	0%
5	**WASTE**	**1.24**	**0.15**	**0.16**	**-87%**	**5%**	**2%**	**1%**
	NATIONAL TOTAL	**50.46**	**29.78**	**26.92**	**-47%**	**-10%**	**100%**	**100%**

2.4. Acid equivalent (AEQ)

Acid equivalent is a parameter for assessing the overall amount of acidifying substances emitted into the atmosphere. At different spatial and time scales, these substances contribute to the acidification of soil, air and the aquatic environment. The acid equivalent is based on the potential fixation of H^+ ion. The calculation only takes into account SO_2, NOx and NH_3, because it is quite obvious that other acidifying substances such as HCl, only have a negligible effect, regarding their low emission level compared to the other three substances. The acid equivalent is calculated using weight coefficients: 0.0313 for SO_2, 0.0217 for NOx and 0.0588 for NH_3.

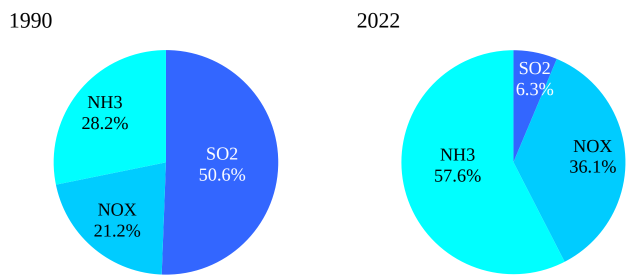
Due to the respective weight of each of three substances, the proportion of NH_3 and NO_x emissions have increased: for NOx from 21.2 % in 1990 to 36.1% in 2022 and for NH_3 from 28.2% in 1990 to 57.6% in 2021 (Table 2.4-1). In addition, their absolute emissions are slightly decreased during the observed period (Figure 2.4-1). This is mainly due to the significant decrease of SO_2 emission during the same period (from 50.6% in 1990 to 6.3% in 2022). It can be noticed that the acid equivalent has an overall decreasing trend, as a result of downward trends of all three substance emissions. This acid equivalent should follow a downward trend in coming years, as a result of the expected continuous decrease of SO_2, and with no significant change in NO_x and NH_3 emissions.

Table 2.4-1 Emission of acidifying substances that contribute to the acidification expressed in Aeq (*)

Year	SO_2 % Aeq	NO_x % Aeq	NH_3 % Aeq	Aeq(**) kt
1990	50.6	21.2	28.2	10.5
1995	38.2	26.6	35.2	6.3
2000	31.3	30.8	37.9	6.0
2005	30.7	30.3	39.0	6.0
2010	23.6	31.6	44.8	4.7
2015	14.1	34.4	51.5	3.5
2016	13.9	35.2	51.0	3.3
2017	11.4	34.0	54.6	3.4
2018	9.5	33.1	57.4	3.3
2019	7.7	34.7	57.6	3.1
2020	6.4	32.5	61.0	3.0
2021	6.1	34.1	59.8	2.9
2022	6.3	36.1	57.6	2.7

(*) Emissions concern only anthropogenic one (without nature)

(**) Acid equivalent: indicator of acid equivalent calculates on the base of potential fixation of H+ ion: 0.0313 for SO_2, 0.0217 for NOx and 0.0588 for NH_3



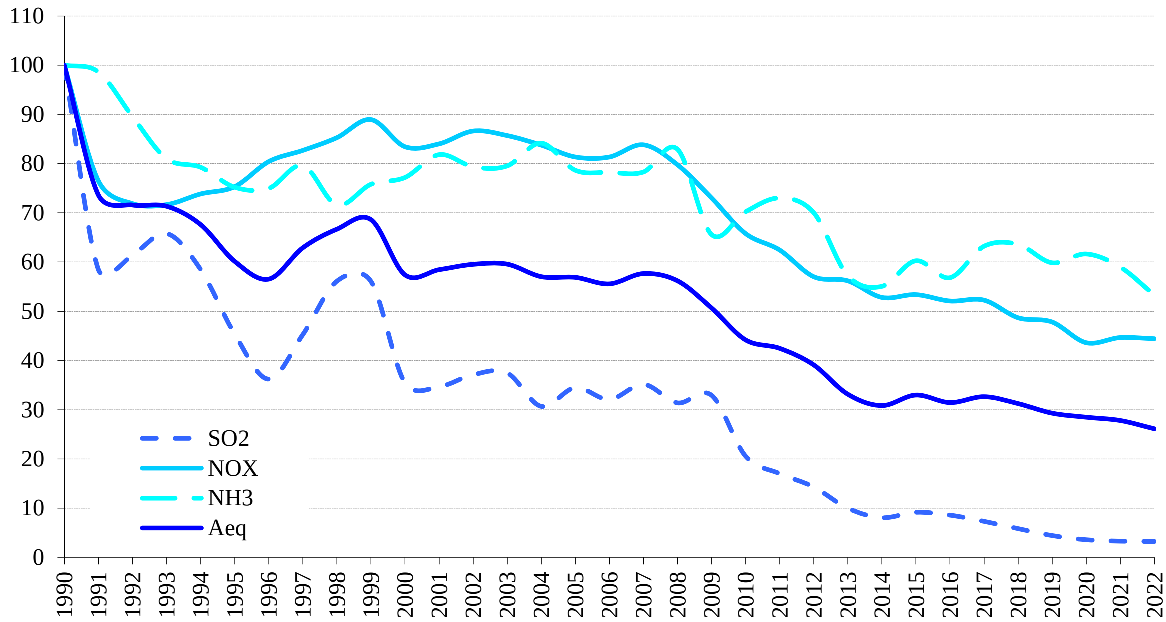


Figure 2.4-1 Relative emission of substances (without nature) that contribute to acidification and eutrophication (1990 = 100%)

2.5. Carbon monoxide (CO)

Main source in carbon monoxide emission is the incomplete fossil fuel combustion in energy sectors both, stationary and mobile.

National total emissions and trend (1990–2022) for CO are shown in Table 2.1-1.

The CO emission in 2020 amounted to 206.8 kt and compared to 1990 it decreased by 63% and compared to the year before by 9% (Figure and Table 2.5-1). The Energy sector contributes 99% to the total CO emissions in 2022, of which 76% comes from the combustion of fuel in small combustion and mobile machinery sources, 10% from road transport, 7% from fugitive emissions from fuel (key category 1.B.2.a.iv refining/storage in 2022), and 4% from fuel combustion in manufacturing industry and construction. The key category of small combustion is 1.A.4.b.i residential (dominance of biomass combustion) with a 73% contribution to total emissions in 2022 compared to 45% in 1990. The key source in road transport is the passenger car category 1.A.3.b.i, which has reduced its dominance from 38% in 1990 to 7% of the total emission contribution in 2022.

The war for Croatian independence in the period 1991 – 1995 was the reason for the decline in fuel consumption and overall production in almost all sectors and as consequence the decline in emissions. Road transport was a main reason for CO emission reduction since 1990 (by 91%) due to the introduction of catalytic converters and renewing of the vehicle fleet. Other energy sectors also note the downward trend of CO emission since 1990 mainly due to changes in the structure of fossil fuel combustion by reducing the use of low-quality coal and fuel wood and increasing use of natural gas. The Industrial processes and product use sector has recorded a great reduction of CO emissions (by 98% since 1990), due to stopping the production of aluminium, paper and pulp (Kraft process) and carbon black production and also due to the overall decline of productivity in general. The CO emissions from refining /storage sector have also decrease by 68% since 1990, mostly due to decline in catalytic cracking activity (partial burn without CO boiler). Since 2000, the trend of CO emissions has declining due to previously mentioned reasons and since 2007, the economic crisis has contributed to further reduction of CO emissions (Figure 2.2-1). The reduction since 2008 is a partly result of gradual introduction of low - emission biomass combustion techniques in residential appliances (replacement of traditional domestic stoves, fireplaces, and manual single house boilers with advanced/ecolabelled stoves and boilers and pellet stoves and boilers), which started in 2005 (see Table 3.5-1 and Figure 3.5-2). In addition to the above, the impact of climate factors on emission reductions can be seen in the years 1994, 2000, 2002, 2014 and 2022 when, due to the warmer winter, the consumption of biomass for heating was lower (Figure 3.5-3).

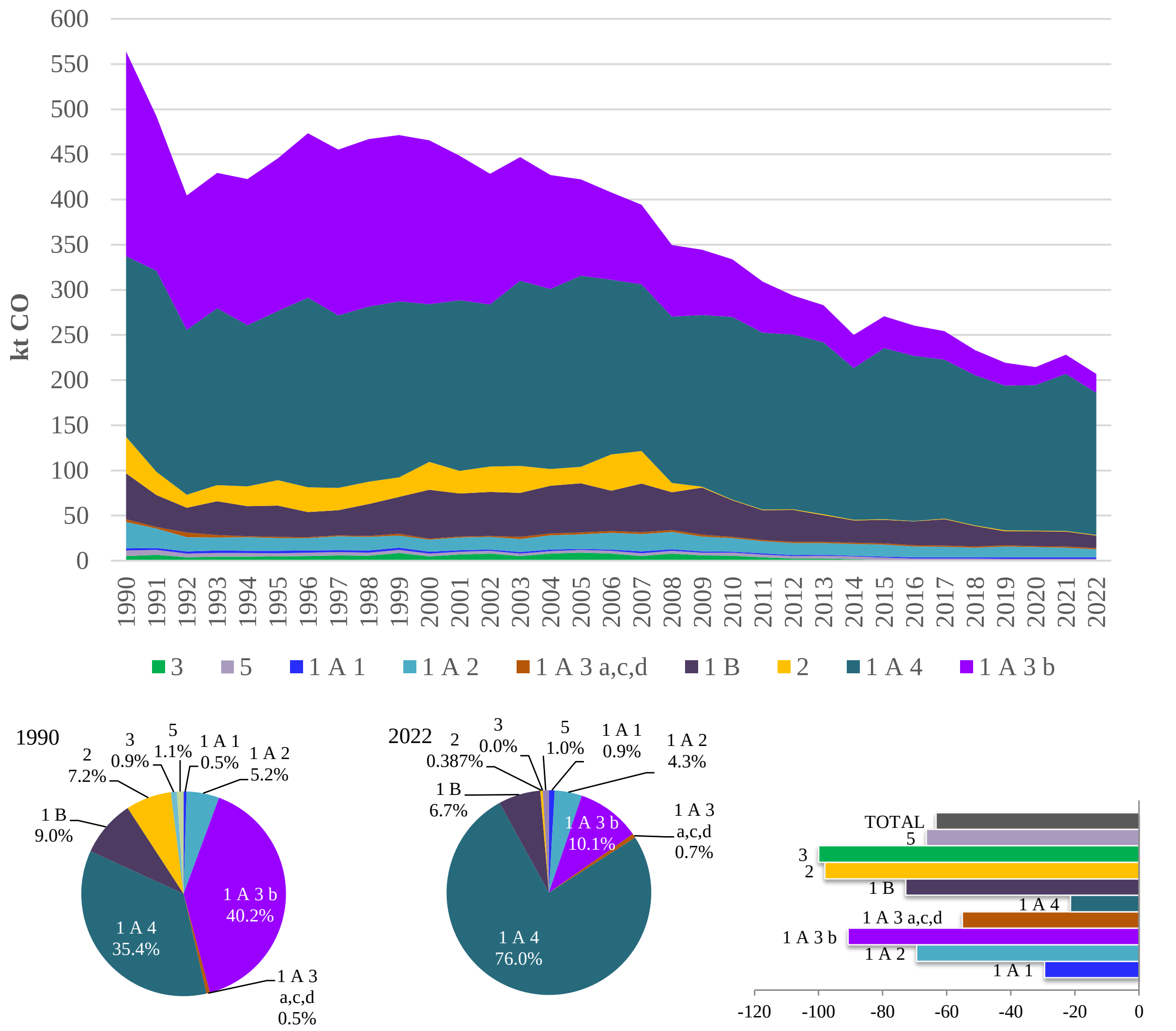


Figure 2.5-1 The CO emissions (kt/yr.) and percentage share by sector and variation in CO emissions

Table 2.5-1 The CO emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		CO emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**512.29**	**225.21**	**203.99**	**-60%**	**-9%**	**91%**	**99%**
1A	FUEL COMBUSTION	461.68	208.96	190.23	-59%	-9%	82%	92%
1A1	Energy Industries	2.67	1.66	1.88	-29%	13%	0%	1%
1A1a	Public electricity and heat production	1.59	1.29	1.56	-2%	21%	0%	1%
1A1b	Petroleum refining	0.49	0.25	0.16	-67%	-35%	0%	0%
1A1c	Manufacture of solid fuels and other energy industries	0.59	0.12	0.16	-73%	29%	0%	0%
1A2	Manufacturing Industries and Construction	29.10	10.76	8.90	-69%	-17%	5%	4%
1A2a	Iron and Steel	5.79	0.13	0.15	-97%	14%	1%	0%
1A2b	Non-ferrous Metals	0.01	0.02	0.02	25%	2%	0%	0%
1A2c	Chemicals	1.39	0.05	0.03	-98%	-36%	0%	0%
1A2d	Pulp, Paper and Print	0.85	0.12	0.13	-85%	8%	0%	0%

Category		CO emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2e	Food Processing, Beverages and Tobacco	2.35	0.40	0.44	-81%	9%	0%	0%
1A2f	Non-metallic Minerals	8.36	7.42	5.51	-34%	-26%	1%	3%
1A2g	Manufacturing Ind. and Constr.: Other	10.35	2.62	2.63	-75%	0%	2%	1%
1A3	Transport	230.01	22.70	22.24	-90%	-2%	41%	11%
1A3a	Civil Aviation	1.78	0.99	0.87	-51%	-13%	0%	0%
1A3b	Road Transportation	226.92	21.20	20.86	-91%	-2%	40%	10%
1A3c	Railways	0.60	0.15	0.16	-74%	3%	0%	0%
1A3d	Navigation	0.70	0.35	0.36	-49%	3%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	199.90	173.85	157.20	-21%	-10%	35%	76%
1A4a	Commercial/Institutional	1.56	0.71	0.68	-57%	-5%	0%	0%
1A4b	Residential	194.55	171.83	155.20	-20%	-10%	34%	75%
1A4c	Agriculture/Forestry/Fishing	3.79	1.31	1.32	-65%	1%	1%	1%
1B	FUGITIVE EMISSIONS FROM FUELS	50.62	16.24	13.77	-73%	-15%	9%	7%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**40.64**	**0.82**	**0.77**	**-98%**	**-6%**	**7%**	**0%**
2B	CHEMICAL INDUSTRY	30.63	0.00	0.00	-100%	-80%	5%	0%
2C	METAL PRODUCTION	9.20	0.31	0.29	-97%	-9%	2%	0%
2G	OTHER PRODUCT USE	0.67	0.50	0.48	-28%	-4%	0%	0%
2H	OTHER INDUSTRY PRODUCTION	0.14	0.00	0.00	-100%	-	0%	0%
3	**AGRICULTURE**	**5.33**	**0.01**	**0.00**	**-100%**	**-84%**	**1%**	**0%**
3F	Field burning of agricultural residues	5.33	0.01	0.00	-100%	-84%	1%	0%
5	**WASTE**	**5.94**	**2.04**	**2.00**	**-66%**	**-2%**	**1%**	**1%**
	NATIONAL TOTAL	**564.20**	**228.07**	**206.76**	**-63%**	**-9%**	**100%**	**100%**

2.6. Non-methane volatile organic compounds (NMVOC)

The NMVOCs play a significant role in the formation of ozone and fine particulates in the atmosphere. Under sunlight, NMVOCs react with NOx emitted mainly from vehicles, power plants and industrial activities to form ozone, which in turn helps the formation of fine particulates. The accumulation of ozone, fine particulates and other gaseous pollutants results in smog. Some of NMVOCs may have undesirable ecotoxicological properties, for example benzene and xylene.

National total emissions and trends (1990–2022) for air pollutants covered by the Gothenburg Protocol are shown in Table 2.1-1.

In 2022, the emission of NMHOS amounted to 61.1 kt, which compared to the previous year decreased by 9%, and compared to 1990 by 65% (Figure 2.6-1). The sectors, Industrial processes and product use, Small combustion and mobile machinery, Agriculture, Road transport, Refining and Waste are dominant in NMVOC emission and in 2022, and these sectors contribute to the total NMVOC emissions with the following: 39.4%, 30.4%, 13.7%, 7.1%, 3.7% and 2.4%. The key sources for Industrial processes and product use sector are: Other solvent use (2.D) which accounted for 71% in 1990, and increased to 83% in 2022 (dominated by 3 categories: Coating applications (2.D.3.d, 17.6%), Domestic solvent use (2.D.3.a, 7%), and Other solvent use (2.D.3.i, 4.5%)), and Other industry production (2.H) which made up 25% in 1990, and decreased to 14 % in 2022 (dominated by Food and beverages industry 2.H.2, 5.7%). In sector Small combustion and mobile machinery the main source is Residential: stationary (1.A.4.b.i) with the contribution of 29,1%. In Agriculture sector, evaporative emissions mainly originates from from manure management (3.B) (81% in 2022, and dominated by 3.B.1.b Non-dairy cattle, 5.6 % and 3.B.1.a Dairy cattle, 2.7%) while the remaining emissions come from crop production and agricultural soils (3.D) (dominated by 3.D.e cultivating crops, 2.7%). In the road transport sector, the key category in 2022 was 1.A.3.b.v of gasoline evaporation with a contribution of 2.3% to the total emission. In the waste sector, the key category in 2022 was 5.A disposal of solid waste on lend with a contribution of 2.3%.

The NMVOC emission reduction in the historical trend since 1990 has been recorded in all sectors. In the Industrial processes and product use, 73% decrease was recorded as a result of the introduction of environmental protection requirements for the reduction of NMVOC emissions from organic solvent containing products i.e. the implementation of best available techniques (BAT) and partly as a result of reduced production of solvent and solvent based products and stopping the production of certain chemicals. The decrease in the solvent sector (2.D) was achieved due to the Croatian regulation on the limit values of air pollutant emissions from stationary sources and the regulation on the limit values of the content of volatile organic compounds in certain paints and varnishes used in construction and vehicle finishing products. In the road transport sector, the NMVOC emission has decreased by 87% since 1990, due to the increased use of energy-efficient vehicles and the introduction of new exhaust emission requirements (e.g. three-way catalytic converters in automobiles). Fugitive emissions of NMVOC from petroleum products (gasoline) and natural gas have also decreased by 62% since 1990. In addition, the war for Croatian independence in the period 1991 – 1995 was the reason for the NMVOC emission decline, due to lower fuel consumption and overall reduction of production activities in almost all sectors. The economic crisis has contributed to further reduction of NMVOC emissions since 2007 (Figure 2.6-1). Also, the reduction since 2008 is a partly result of gradual introduction of low - emission biomass combustion techniques in residential appliances (replacement of traditional domestic stoves, fireplaces and manual single house boilers with advanced/ecolabelled stoves and boilers and pellet stoves and boilers), which started in 2005 (see Table 3.5-1 and Figure 3.5-2). The only sector that records an increase in NMHOS emissions since 1990 (up to 2 times) is the waste sector due to greater disposal of solid waste on the ground, despite the decline in the number of inhabitants in Croatia, it is growing with the rise in living standards. The category 5.A solid waste disposal on land became a key source of emissions in 2022, which is the result of using new activity data collected by the project to improve the GHG emission inventory in the Waste sector. A new country-specific emission factors for degradable organic carbon (DOC) were estimated, which affects the calculation of CH_4 emissions from which NMVOC emissions are calculated. An increase in generated and deposited solid waste exists during the reporting period. In recent years, the increasing trend of generated waste is slower and deposited waste starts to decrease influenced by the implementation of the measures undertaken to avoid/reduce and recycle waste. Accordingly, there is an increase in NMVOC emissions during the reporting period. In recent years, the increasing trend in NMVOC emissions is slower compared to the previous period and started to decline in 2018.

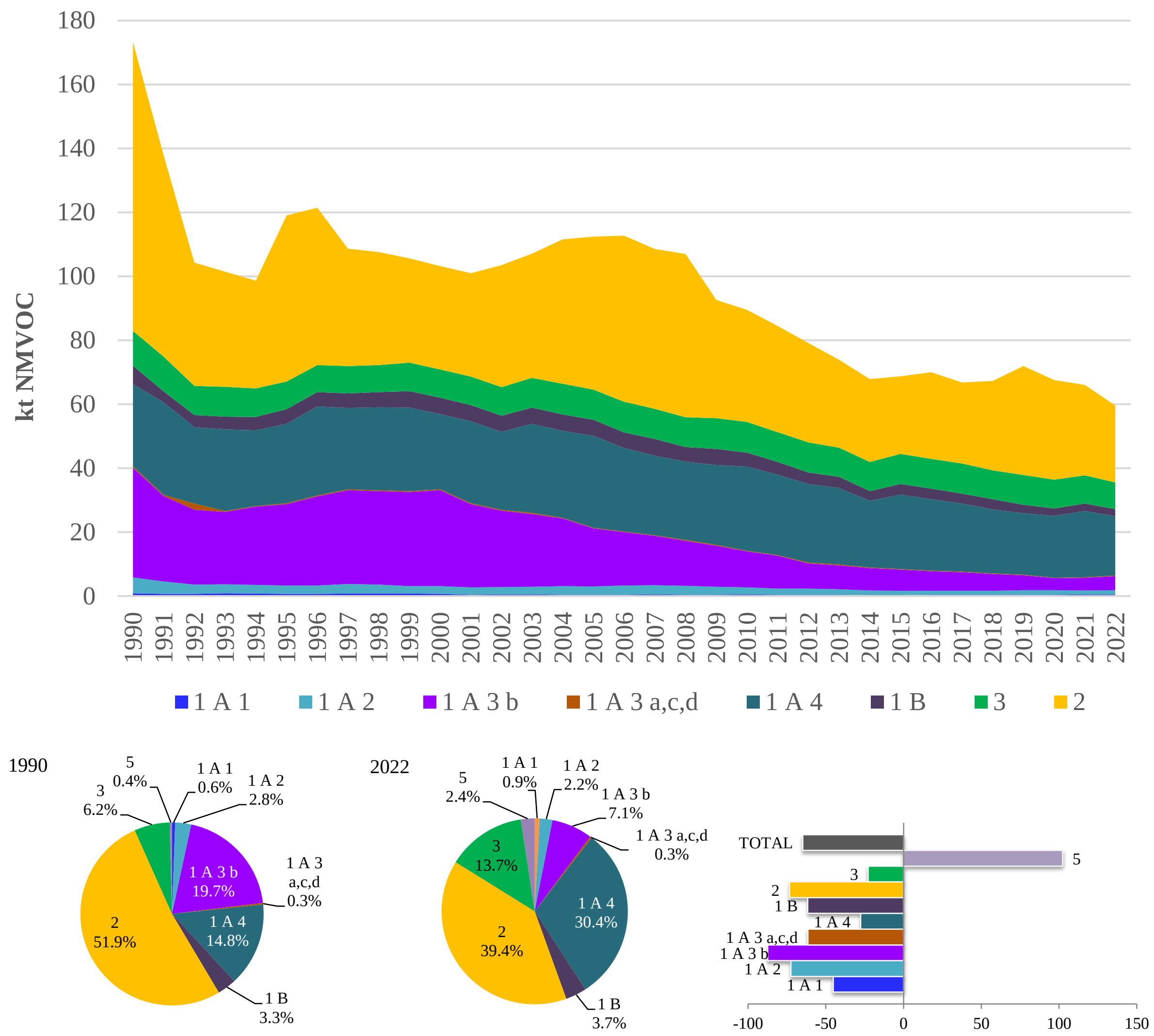


Figure 2.6-1 The NMVOCs emissions (kt/yr.) and percentage share by sector and variation in NMVOC

Table 2.6-1 The NMVOC emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		NMVOC emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**72,09**	**28,94**	**27,19**	**-62%**	**-6%**	**41%**	**44%**
1A	FUEL COMBUSTION	66,27	26,59	24,96	-62%	-6%	38%	41%
1A1	Energy Industries	0,96	0,49	0,53	-45%	8%	1%	1%
1A1a	Public electricity and heat production	0,51	0,36	0,38	-26%	4%	0%	1%
1A1b	Petroleum refining	0,09	0,03	0,02	-76%	-19%	0%	0%
1A1c	Manufacture of solid fuels and other energy industries	0,36	0,10	0,13	-65%	29%	0%	0%
1A2	Manufacturing Industries and Construction	4,91	1,32	1,35	-72%	2%	3%	2%
1A2a	Iron and Steel	0,70	0,03	0,03	-95%	12%	0%	0%
1A2b	Non-ferrous Metals	0,01	0,01	0,01	115%	1%	0%	0%
1A2c	Chemicals	0,33	0,05	0,02	-95%	-64%	0%	0%
1A2d	Pulp, Paper and Print	0,18	0,08	0,08	-54%	5%	0%	0%

Category		NMVOC emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2e	Food Processing, Beverages and Tobacco	0,37	0,21	0,23	-39%	7%	0%	0%
1A2f	Non-metallic Minerals	1,78	0,75	0,78	-56%	4%	1%	1%
1A2g	Manufacturing Ind. and Constr.: Other	1,55	0,20	0,20	-87%	4%	1%	0%
1A3	Transport	34,74	4,13	4,52	-87%	10%	20%	7%
1A3a	Civil Aviation	0,04	0,03	0,02	-37%	-8%	0%	0%
1A3b	Road Transportation	34,25	3,94	4,33	-87%	10%	20%	7%
1A3c	Railways	0,19	0,07	0,07	-64%	3%	0%	0%
1A3d	Navigation	0,27	0,10	0,10	-63%	2%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	25,65	20,65	18,55	-28%	-10%	15%	30%
1A4a	Commercial/Institutional	0,29	0,43	0,39	37%	-8%	0%	1%
1A4b	Residential	23,98	19,99	17,94	-25%	-10%	14%	29%
1A4c	Agriculture/Forestry/Fishing	1,39	0,23	0,22	-84%	-4%	1%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	5,82	2,35	2,23	-62%	-5%	3%	4%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**90,22**	**28,23**	**24,06**	**-73%**	**-15%**	**52%**	**39%**
2A	MINERAL PRODUCTS	0,01	0,05	0,05	407%	0%	0%	0%
2B	CHEMICAL INDUSTRY	1,01	0,03	0,00	-100%	-81%	1%	0%
2C	METAL PRODUCTION	0,01	0,01	0,01	-19%	-9%	0%	0%
2D	NON ENERGY PRODUCTS/SOLVENTS	63,61	24,27	19,88	-69%	-18%	37%	33%
2D3	Solvent use	63,61	24,27	19,88	-69%	-18%	37%	33%
2D3a	Domestic solvent use including fungicides	11,08	10,49	4,29	-61%	-59%	6%	7%
2D3b	Road paving with asphalt	0,01	0,04	0,04	333%	-5%	0%	0%
2D3d	Coating applications	21,61	8,69	10,73	-50%	24%	12%	18%
2D3e	Degreasing	10,50	0,10	0,06	-99%	-43%	6%	0%
2D3f	Dry cleaning	0,17	0,01	0,02	-86%	98%	0%	0%
2D3g	Chemical products	3,01	0,72	0,63	-79%	-12%	2%	1%
2D3h	Printing	5,69	1,53	1,33	-77%	-13%	3%	2%
2D3i	Other solvent use	11,53	2,68	2,77	-76%	3%	7%	5%
2G	OTHER PRODUCT USE	3,19	0,75	0,63	-80%	-17%	2%	1%
2H	OTHER INDUSTRY PRODUCTION	22,39	3,12	3,48	-84%	12%	13%	6%
3	**AGRICULTURE**	**10,87**	**8,86**	**8,40**	**-23%**	**-5%**	**6%**	**14%**
3B	MANURE MANAGEMENT	9,14	7,18	6,72	-26%	-6%	5%	11%
3B1	Cattle	6,04	5,25	4,95	-18%	-6%	3%	8%
3B2	Sheep	0,06	0,05	0,05	-13%	-2%	0%	0%
3B3	Swine	1,47	0,74	0,67	-54%	-9%	1%	1%
3B4	Other livestock	1,58	1,14	1,05	-33%	-8%	1%	2%
3B4d	Goats	0,01	0,00	0,00	-52%	-5%	0%	0%
3B4e	Horses	0,09	0,07	0,07	-19%	8%	0%	0%
3B4g	Poultry	1,47	1,07	0,97	-34%	-9%	1%	2%
3D	AGRICULTURAL SOILS	1,69	1,68	1,68	0%	0%	1%	3%
3De	Cultivated crops	1,69	1,68	1,68	0%	0%	1%	3%

Category		NMVOC emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
3F	Field burning of agricultural residues	0,04	0,00	0,00	-100%	-84%	0%	0%
5	**WASTE**	**0,73**	**1,49**	**1,47**	**102%**	**-1%**	**0%**	**2%**
	NATIONAL TOTAL	**173,90**	**67,51**	**61,11**	**-65%**	**-9%**	**100%**	**100%**

2.7. Particles (TSP, PM_{10} and $PM_{2.5}$) and black carbon (BC)

Particulate matter (PM) is an air pollutant consisting of a mixture of particles suspended in the air. These particles differ in their physical properties (such as size and shape) and chemical composition[25]. Calculation of particulate matter emissions and its fractions (PM_{10} and $PM_{2.5}$) is the obligation of the Parties to CLRTAP since 2002.

The TSP and BC is the substances for which emission reporting is encouraged in CLRTAP by Executive Body. The BC emission calculation is introduced in the reporting Guidelines as a component of $PM_{2.5}$. The Republic of Croatia voluntarily reports the emissions of these two pollutants. Calculation of BC emission has been introduced in the Reporting Guidelines as a $PM_{2.5}$ component. BC emissions are calculated for all NFR emission sources with available FE in accordance with GB2023.

The TSP emission trend for the source category 2.A.1 Cement production is lower than PM_{10}, and $PM_{2.5}$ trends. The reason for that is abatement technologies installed in all four cement production facilities in Croatia. Abatement technologies are ESP on main stacks and smaller fabric filters for moderate control of fugitive sources with default efficiency of 93% for TSP emission reduction, 40% for PM_{10} emission reduction and 34% for $PM_{2.5}$ emission reduction.

National total emissions and trends (1990–2022) for particles and black carbon are shown in Table 2.7-1.

Table 2.7-1 National total emissions and trends (1990–2022) for particles and black carbon

Year	Emission [kt]			
	$PM_{2.5}$	PM_{10}	TSP	BC
Trend 1990-2022	**-34.4%**	**-38.4%**	**-43.2%**	**-33.9%**
1990	39.94	59.21	93.33	5.50
1991	42.32	59.27	88.11	5.57
1992	36.40	49.59	72.16	4.72
1993	37.95	52.37	77.87	4.94
1994	35.55	52.83	86.99	4.76
1995	37.67	55.37	91.07	5.07
1996	41.50	60.02	96.73	5.50
1997	40.14	58.93	97.11	5.34
1998	40.26	58.08	92.59	5.41
1999	39.19	53.90	79.98	5.40
2000	35.60	47.75	73.08	5.29
2001	38.39	49.58	70.68	5.56
2002	38.14	53.04	84.21	5.49

[25] ece.eb.125, Advance version of Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution, TFEIP, March 2014

Year	Emission [kt]			
	$PM_{2.5}$	PM_{10}	TSP	BC
2003	43.35	60.16	97.22	6.24
2004	41.98	58.13	93.23	6.08
2005	43.38	57.52	86.66	6.23
2006	39.88	53.71	82.22	5.84
2007	38.09	53.15	84.03	5.62
2008	37.39	53.76	87.76	5.51
2009	37.25	51.89	81.76	5.38
2010	38.26	52.24	80.53	5.39
2011	36.33	51.35	83.04	5.06
2012	35.33	51.03	84.64	4.89
2013	34.29	50.47	84.20	4.70
2014	29.62	42.21	66.48	4.17
2015	32.23	42.64	60.82	4.51
2016	30.96	43.27	66.02	4.31
2017	29.46	38.69	53.38	4.20
2018	28.46	41.40	65.44	4.00
2019	27.49	38.87	58.36	3.86
2020	27.77	44.39	77.63	3.75
2021	29.13	43.87	72.22	3.94
2022	26.22	36.46	53.01	3.64

The trends of TSP, PM_{10}, $PM_{2.5}$ and BC emissions (Figures 2.7.1-1 to 2.7.4-1) are quite fluctuating, which was influenced by several factors: the war for Croatian independence, economic trends, fuel consumption in residential appliances (Figure 3.5-2), techniques for reducing particulate emissions in residential appliances and in the road transport, and climatic conditions.

The large reduction in emissions since 1991 was caused by the war for Croatian independence (1991-1995) and consequently lower fuel consumption and an overall decline in productivity in almost all sectors.

Reconstruction of war-ravaged areas has been started since 1994, so emissions from construction and mineral production have risen sharply, followed by stagnation and a slight decline until 2001.

The second trend of emission increase began in 2002 mainly due to increased activity of road paving with asphalt, quarrying and mining, construction and demolition, cement production, and inorganic chemicals production (such as carbon black, ammonium phosphate, urea and NPK fertilizers). Road paving with asphalt has recorded great increase in 2002, mainly due to the start of construction of the longest highway in Croatia "A1" (Dalmatina) from Zagreb to Dubrovnik (total length is 456 km).

The mentioned growth trend in construction remained until 2008 (with oscillations), when the economic crisis occurred, which hit the construction sector the hardest in Croatia, so the activities of the construction sector were marked by negative trends. The decline continued with certain oscillations until 2015, and in that year the largest decline in construction was achieved. In 2016, the beginning of gradual growth can be noticed, with the recovery of the economy and the return of investment in the construction sector, as well as the construction of roads (the latter, responsible for the peaks in 2016, 2018 and 2020).

The trend of reducing emissions since 2005 is greatly influenced by the inclusion of biomass combustion techniques in residential, with lower particulate emissions (gradual replacement of traditional domestic stoves and manual single house boilers with advanced/ecolabelled stoves, high efficiency stoves and boilers and boilers and pellet stoves and boilers), and to a lesser extent due to the introduction of stricter standards for particulate emissions in road transport (Euro 4, Euro 5, Euro 6 vehicles equipped with catalytic converters, diesel particulate filters (DPF) and additives)) (see Table 3.5-1 and Figure 3.5-2). In addition to the above, reductions in emissions due to climate factors can be seen in 1994, 2000, 2002, 2014 and 2022, when due to warmer winters, the consumption of biomass for heating in households was lower (Figure 3.5-3).

2.7.1. Total suspended particles (TSP)

Emission of TSP is voluntary reported as an additional air pollutant.

In 2022, the total TSP emission was 53 kt, which is a decrease of 27% compared to the previous year and 43% compared to 1990 (figure and table 2.7.1-1). In 2022, the key sectors of TSP emissions were: Industrial processes and product use with 38%, Energy with 53% and Agriculture with 9%. In the Energy sector, the key categories in 2022 were: 1.A.4.b.i residential (41.8% contribution to the total emission) and 1A1a public electricity and heat production (4.5%). In the sector Industrial processes and product use, the key categories in 2022 were 2.A.5.b construction and demolition (28.9% contribution to total emissions) and 2.A.5.a quarrying and mining of minerals other than coal (5.9%).

Since 1990, the TSP emission has a downward trend, to which the Energy sector contributed the most, with a 36% reduction in emissions due to a reduction in solid fuel consumption and a simultaneous increase in gaseous and liquid fuel consumption, the IPPU sector with a 50% reduction due to a decrease in construction activities and the Agriculture sector, with a decrease of 56% due to decrease in number of animals and in crop production. The sector with an increasing trend of TSP emissions since 1990 is road transport (increase by 33%) due to the increase in the number of vehicles.

In addition to the influencing factors on the TSP emission trend described in section 2.7, it should be mentioned that the emission reduction from 2000 is influenced by the reduction of the total cultivated agricultural area (ha/year) and the consequent reduction of activities related to agricultural soils in the Agricultural sector.

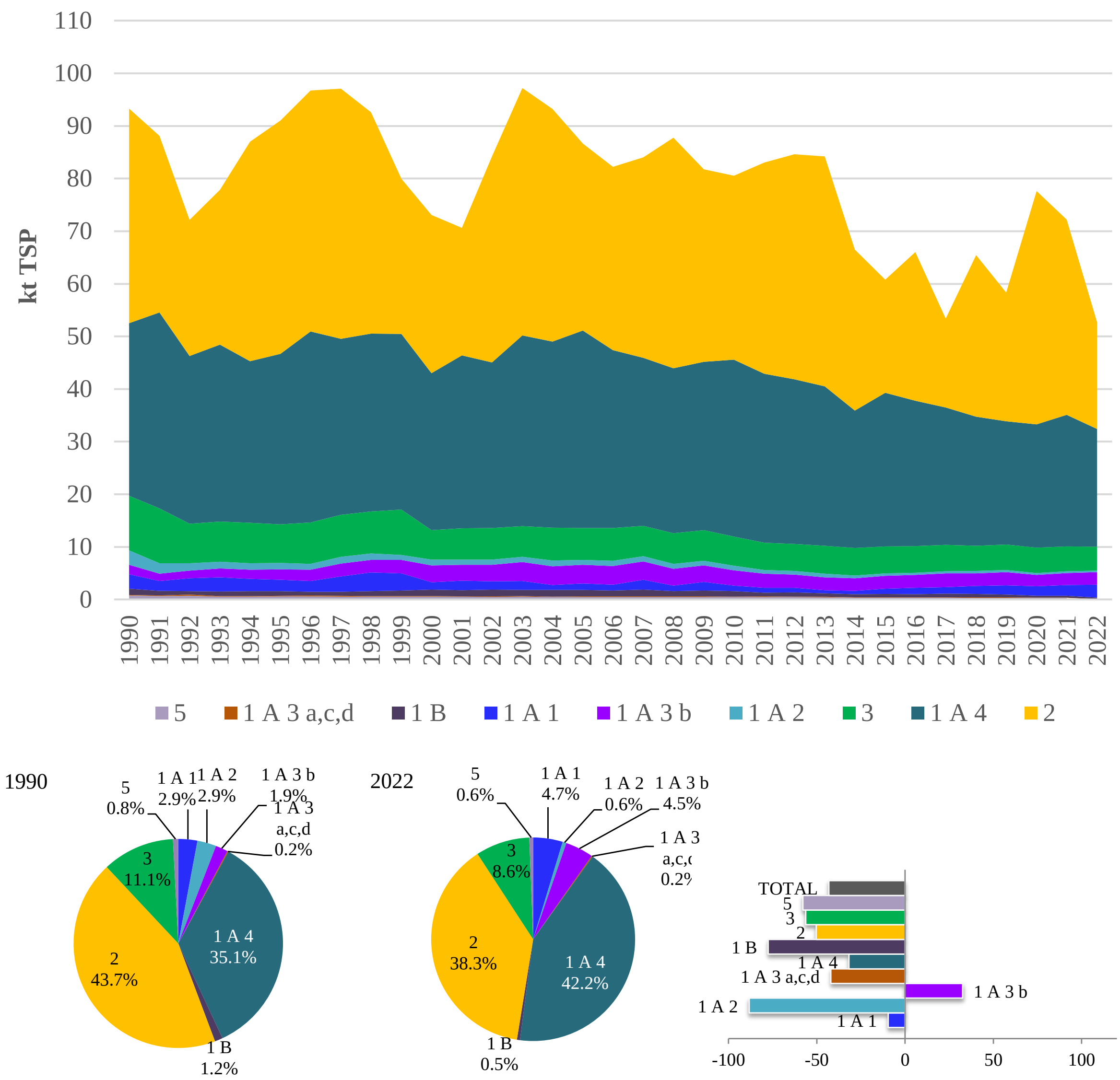


Figure 2.7.1-1: The TSP emissions (kt/yr.) and percentage share by sector and variation in TSP emissions

Table 2.7.1-1 The TSP emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		TSP emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**41.34**	**30.06**	**27.86**	**-33%**	**-7%**	**44%**	**53%**
1A	FUEL COMBUSTION	40.19	29.75	27.60	-31%	-7%	43%	52%
1A1	Energy Industries	2.75	2.08	2.48	-10%	19%	3%	5%
1A1a	Public electricity and heat production	2.14	2.02	2.38	11%	18%	2%	4%
1A1b	Petroleum refining	0.55	0.06	0.10	-82%	75%	1%	0%
1A2	Manufacturing Industries and Construction	2.74	0.32	0.32	-88%	1%	3%	1%
1A2a	Iron and Steel	0.78	0.02	0.02	-98%	12%	1%	0%
1A2c	Chemicals	0.21	0.00	0.00	-98%	4%	0%	0%
1A2d	Pulp, Paper and Print	0.12	0.02	0.02	-84%	17%	0%	0%

Category		TSP emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2e	Food Processing, Beverages and Tobacco	0.35	0.08	0.08	-78%	2%	0%	0%
1A2f	Non-metallic Minerals	0.86	0.14	0.14	-84%	-6%	1%	0%
1A2g	Manufacturing Ind. and Constr.: Other	0.42	0.06	0.06	-85%	8%	0%	0%
1A3	Transport	1.93	2.34	2.45	27%	5%	2%	5%
1A3b	Road Transportation	1.78	2.25	2.36	33%	5%	2%	4%
1A3c	Railways	0.08	0.02	0.02	-73%	3%	0%	0%
1A3d	Navigation	0.07	0.06	0.06	-5%	2%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	32.77	25.01	22.35	-32%	-11%	35%	42%
1A4a	Commercial/Institutional	0.26	0.11	0.11	-55%	2%	0%	0%
1A4b	Residential	31.62	24.82	22.16	-30%	-11%	34%	42%
1A4c	Agriculture/Forestry/Fishing	0.90	0.08	0.07	-92%	-5%	1%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	1.15	0.31	0.26	-78%	-16%	1%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**40.82**	**37.10**	**20.28**	**-50%**	**-45%**	**44%**	**38%**
2A	MINERAL PRODUCTS	33.39	34.90	18.71	-44%	-46%	36%	35%
2B	CHEMICAL INDUSTRY	0.73	0.57	0.08	-89%	-86%	1%	0%
2C	METAL PRODUCTION	0.48	0.01	0.01	-99%	-8%	1%	0%
2D	NON ENERGY PRODUCTS/SOLVENTS	5.69	0.92	0.87	-85%	-5%	6%	2%
2G	OTHER PRODUCT USE	0.40	0.53	0.47	16%	-11%	0%	1%
2H	OTHER INDUSTRY PRODUCTION	0.03	0.00	0.00	-100%	-	0%	0%
2I	WOOD PROCESSING	0.09	0.18	0.14	54%	-23%	0%	0%
3	**AGRICULTURE**	**10.40**	**4.74**	**4.54**	**-56%**	**-4%**	**11%**	**9%**
3B	MANURE MANAGEMENT	5.16	2.44	2.28	-56%	-6%	6%	4%
3D	AGRICULTURAL SOILS	4.77	2.30	2.26	-53%	-2%	5%	4%
3F	Field burning of agricultural residues	0.46	0.00	0.00	-100%	-84%	0%	0%
5	**WASTE**	**0.77**	**0.31**	**0.32**	**-58%**	**5%**	**1%**	**1%**
	NATIONAL TOTAL	**93.33**	**72.21**	**53.00**	**-43%**	**-27%**	**100%**	**100%**

2.7.2. Particulate matter (PM_{10})

The total PM_{10} emission in 2022 amounted to 36.5 kt. Emissions decreased by 38% compared to 1990, and by 17% compared to the previous year (Figure 2.7.2-1). The Energy sector is the largest source of PM_{10} emissions and contributes 71% to the total emissions in 2022, and the second largest source is Industrial processes and product use sector which contributes 20% (Table 2.7.2-1). In the Energy sector, there are two key categories: 1.A.4.b.i residential (dominated of biomass combustion) with a contribution of 57.9% to the total national emissions in 2022 and 1.A.1.a public electricity and heat production with a contribution of 5.8%. In the industrial processes and product use, activity 2.A.5.b construction and demolition dominate (contribution of 12.6% to total emissions in 2022). The third key sector in PM_{10} emissions is agriculture, which contributes 8% to the total emissions in 2022, and the key category is 3.D.c agricultural activities on farms (contribution of 6.2% to the total emissions in 2022).

Since 1990, PM_{10} emission has had a downward trend, to which the stationary Energy sector contributed the most, with a decrease in PM_{10} emissions by an average of 34%, due to a reduction in consumption of solid fuels and a simultaneous increase in the consumption of gaseous and liquid fuels and the agriculture sector, with a decrease of 59% due to a decrease in the number of animals and reduced crop production. The sector that also records a trend of decreasing PM_{10} emissions since 1990 is the IPPU sector by 45% due to the trend of decreasing road construction activities.

Factors influencing the trend of PM_{10} emissions are described in section 2.7.

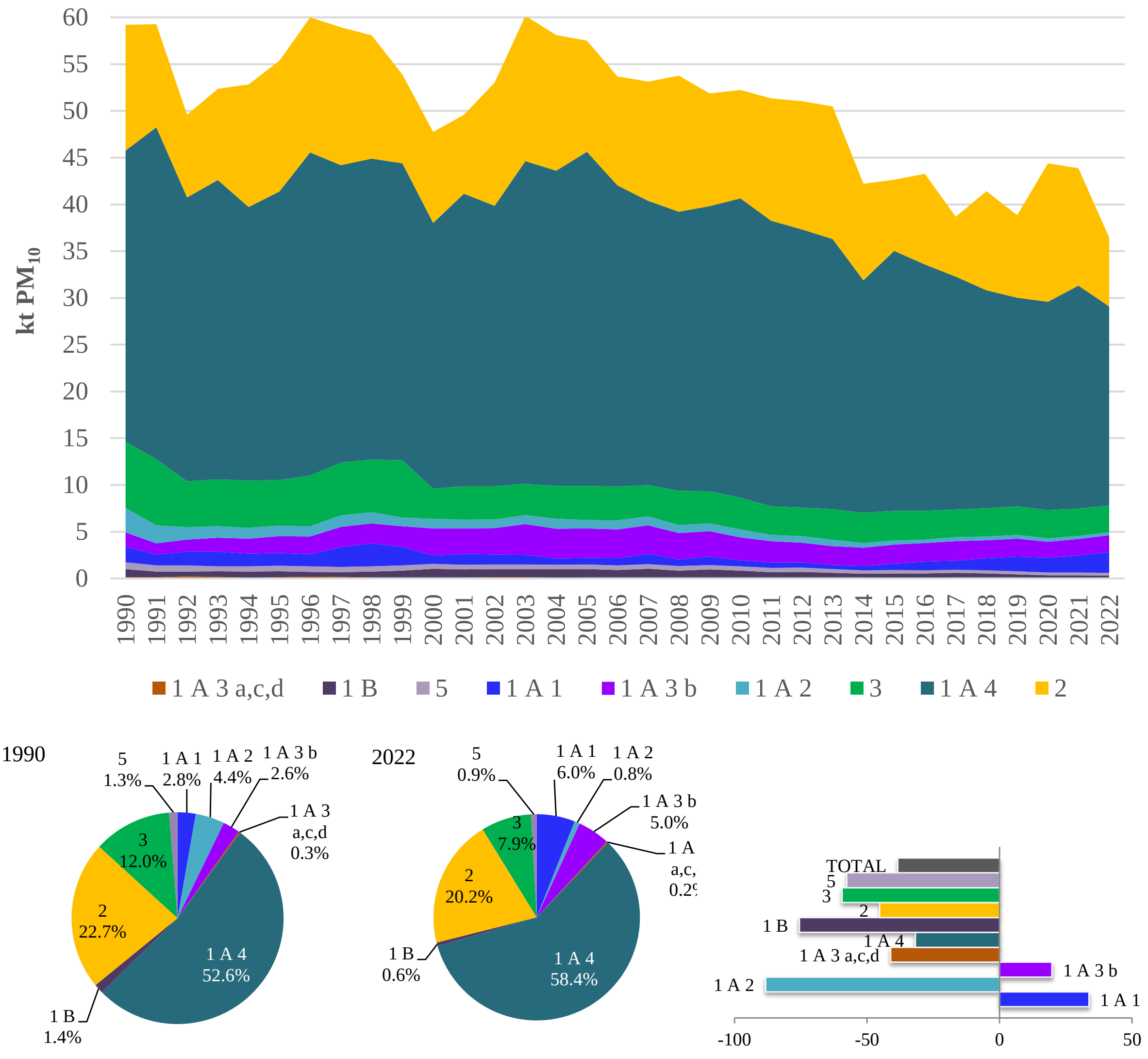


Figure 2.7.2-1 The PM_{10} emissions (kt/yr.) and percentage share by sector and variation in PM_{10} emissions

Table 2.7.2-1 The PM_{10} emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		PM_{10} emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**37.95**	**28.06**	**25.91**	**-32%**	**-8%**	**64%**	**71%**
1A	FUEL COMBUSTION	37.12	27.82	25.70	-31%	-8%	63%	70%

Category		PM_{10} emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A1	Energy Industries	1.64	1.83	2.19	34%	19%	3%	6%
1A1a	Public electricity and heat production	1.18	1.79	2.11	78%	18%	2%	6%
1A1b	Petroleum refining	0.40	0.04	0.07	-82%	68%	1%	0%
1A1c	Manufacture of solid fuels and other energy industries	0.05	0.00	0.00	-92%	29%	0%	0%
1A2	Manufacturing Industries and Construction	2.63	0.31	0.31	-88%	1%	4%	1%
1A2a	Iron and Steel	0.73	0.02	0.02	-98%	12%	1%	0%
1A2c	Chemicals	0.20	0.00	0.00	-98%	2%	0%	0%
1A2d	Pulp, Paper and Print	0.11	0.02	0.02	-84%	17%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	0.34	0.07	0.08	-78%	3%	1%	0%
1A2f	Non-metallic Minerals	0.83	0.14	0.13	-84%	-6%	1%	0%
1A2g	Manufacturing Ind. and Constr.: Other	0.42	0.06	0.06	-85%	8%	1%	0%
1A3	Transport	1.68	1.85	1.92	14%	4%	3%	5%
1A3b	Road Transportation	1.53	1.77	1.83	20%	4%	3%	5%
1A3c	Railways	0.08	0.02	0.02	-73%	3%	0%	0%
1A3d	Navigation	0.07	0.06	0.06	-5%	2%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	31.17	23.82	21.28	-32%	-11%	53%	58%
1A4a	Commercial/Institutional	0.25	0.11	0.11	-56%	2%	0%	0%
1A4b	Residential	30.02	23.64	21.10	-30%	-11%	51%	58%
1A4c	Agriculture/Forestry/Fishin g	0.90	0.08	0.07	-92%	-5%	2%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	0.84	0.25	0.21	-75%	-17%	1%	1%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**13.43**	**12.57**	**7.36**	**-45%**	**-41%**	**23%**	**20%**
2A	MINERAL PRODUCTS	10.89	11.47	6.63	-39%	-42%	18%	18%
2B	CHEMICAL INDUSTRY	0.38	0.34	0.04	-89%	-88%	1%	0%
2C	METAL PRODUCTION	0.36	0.00	0.00	-99%	-9%	1%	0%
2D	NON ENERGY PRODUCTS/SOLVENTS	1.39	0.25	0.24	-83%	-4%	2%	1%
2D3	Solvent use	1.39	0.25	0.24	-83%	-4%	2%	1%
2D3b	Road paving with asphalt	1.27	0.19	0.18	-86%	-5%	2%	0%
2D3c	Asphalt roofing	0.01	0.01	0.01	-12%	-2%	0%	0%
2D3i	Other solvent use	0.11	0.05	0.05	-54%	-2%	0%	0%
2G	OTHER PRODUCT USE	0.40	0.50	0.45	13%	-11%	1%	1%
2H	OTHER INDUSTRY PRODUCTION	0.01	0.00	0.00	-100%	#DIV/0 !	0%	0%
3	**AGRICULTURE**	**7.08**	**2.94**	**2.87**	**-59%**	**-2%**	**12%**	**8%**
3B	MANURE MANAGEMENT	1.85	0.64	0.62	-67%	-3%	3%	2%
3B1	Cattle	0.17	0.06	0.06	-68%	-8%	0%	0%
3B3	Swine	0.23	0.14	0.13	-41%	-3%	0%	0%
3B4	Other livestock	1.44	0.43	0.42	-71%	-3%	2%	1%
3B4g	Poultry	1.44	0.43	0.42	-71%	-3%	2%	1%

Category		PM_{10} emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
3D	AGRICULTURAL SOILS	4.77	2.30	2.26	-53%	-2%	8%	6%
3Dc	On-farm storage, handling and transport of agricultural products	4.77	2.30	2.26	-53%	-2%	8%	6%
3F	Field burning of agricultural residues	0.46	0.00	0.00	-100%	-84%	1%	0%
5	**WASTE**	**0.75**	**0.30**	**0.32**	**-58%**	**5%**	**1%**	**1%**
	NATIONAL TOTAL	**59.21**	**43.87**	**36.46**	**-38%**	**-17%**	**100%**	**100%**

2.7.3. Particulate matter ($PM_{2.5}$)

The $PM_{2.5}$ emission in 2022 amounted to 26.2 kt. Emissions decreased by 34% compared to 1990 and increased by 10% compared to the previous year (Figure and Table 2.7.3-1). The Energy sector is the largest source of $PM_{2.5}$ emissions and contributes 93% to the total emissions in 2022. The second in order is the IPPU sector, which contributes 5% in 2022. In the Energy sector, the only two key sources of emissions in 2022 are: 1.A.4.b.i residential, which contributes to the national total emission in 2022 with 78.5% and 1.A.1.a public electricity and heat production with contribution of 6.9%

Since 1990, $PM_{2.5}$ emission has had a downward trend, driven most by the stationary Energy sector, with a 33% reduction in $PM_{2.5}$ emission, due to a reduction in the consumption of solid fossil fuels while increasing the consumption of gaseous and liquid fuels. Nevertheless, category 1.A.1.a records an increase in emissions since 1990 by 77.8% because of the increasing use of biomass in power plants. The sector Production processes and use also recorded a decreasing trend of $PM_{2.5}$ emissions since 1990 by 47%, mainly due to the reduction of road construction activities. The sector that has seen a slight increase in $PM_{2.5}$ emissions since 1990 is road transport (+1.1% compared to 2022), because of a reduction in exhaust emissions due to the application of measures in vehicles (filters) and a simultaneous increase in emissions from tire and brake wear, and road abrasion due to the increase in the number of vehicles and the number of kilometers travelled.

Factors influencing the trend of $PM_{2.5}$ emissions are described in section 2.7. Economic conditions have mostly affected the construction and manufacturing sectors, but this influence is not so notable in the $PM_{2.5}$ trend due to the dominance of emissions from the biomass combustion in residential appliances. In road transport sector it was noticed that in 2002, compared to 2001, was a significant drop in $PM_{2.5}$ emissions in the passenger cars category (1.A.3.b.i), due to the drop in conventional SUVs and medium-sized vehicles that use diesel fuel (Figures 2.7.3-1 and 3.4-2).

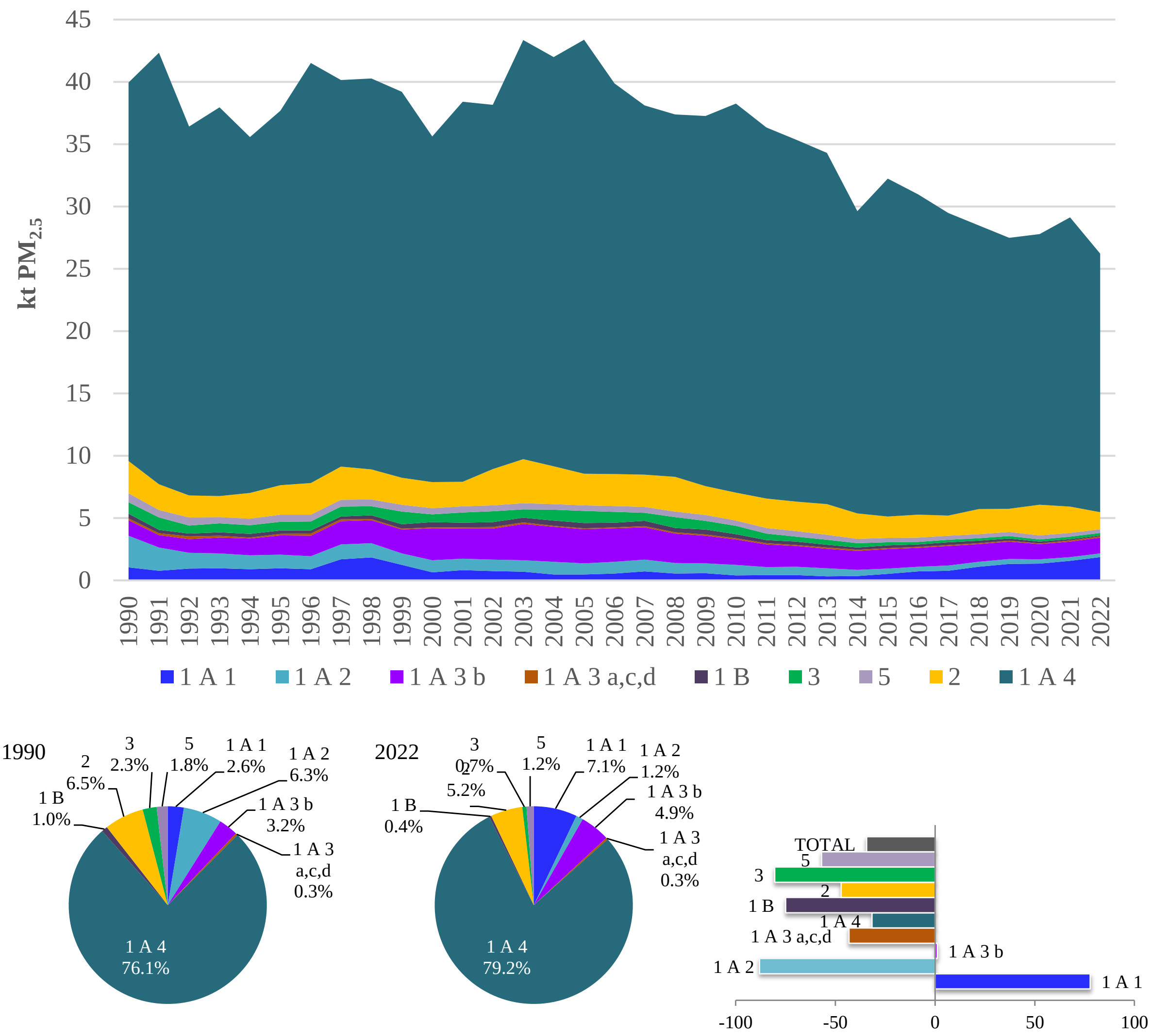


Figure 2.7.3-1 The $PM_{2.5}$ emissions (kt/yr.) and percentage share by sector and variation in $PM_{2.5}$ emissions

Table 2.7.3-1 The $PM_{2.5}$ emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		PM2.5 emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**35.73**	**26.54**	**24.36**	**-32%**	**-8%**	**89%**	**93%**
1A	FUEL COMBUSTION	35.34	26.42	24.27	-31%	-8%	88%	93%
1A1	Energy Industries	1.04	1.55	1.86	78%	19%	3%	7%
1A1a	Public electricity and heat production	0.69	1.52	1.80	160%	18%	2%	7%
1A1b	Petroleum refining	0.31	0.03	0.06	-82%	67%	1%	0%
1A1c	Manufacture of solid fuels and other energy industries	0.05	0.00	0.00	-91%	29%	0%	0%
1A2	Manufacturing Industries and Construction	2.52	0.30	0.30	-88%	1%	6%	1%
1A2a	Iron and Steel	0.68	0.01	0.02	-98%	11%	2%	0%
1A2c	Chemicals	0.19	0.00	0.00	-98%	-1%	0%	0%
1A2d	Pulp, Paper and Print	0.11	0.02	0.02	-83%	17%	0%	0%

Category		PM2.5 emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2e	Food Processing, Beverages and Tobacco	0.32	0.07	0.07	-77%	3%	1%	0%
1A2f	Non-metallic Minerals	0.80	0.13	0.13	-84%	-6%	2%	0%
1A2g	Manufacturing Ind. and Constr.: Other	0.42	0.06	0.06	-85%	8%	1%	0%
1A3	Transport	1.40	1.33	1.35	-3%	1%	4%	5%
1A3b	Road Transportation	1.26	1.26	1.27	1%	1%	3%	5%
1A3c	Railways	0.07	0.02	0.02	-73%	3%	0%	0%
1A3d	Navigation	0.06	0.06	0.06	-9%	2%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	30.38	23.23	20.76	-32%	-11%	76%	79%
1A4a	Commercial/Institutional	0.22	0.10	0.11	-52%	2%	1%	0%
1A4b	Residential	29.26	23.05	20.58	-30%	-11%	73%	78%
1A4c	Agriculture/Forestry/Fishing	0.89	0.08	0.07	-92%	-5%	2%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	0.39	0.12	0.10	-75%	-18%	1%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**2.58**	**2.11**	**1.36**	**-47%**	**-35%**	**6%**	**5%**
2A	MINERAL PRODUCTS	1.29	1.40	0.91	-30%	-35%	3%	3%
2B	CHEMICAL INDUSTRY	0.28	0.25	0.03	-89%	-88%	1%	0%
2C	METAL PRODUCTION	0.27	0.00	0.00	-99%	-9%	1%	0%
2D	NON ENERGY PRODUCTS/SOLVENTS	0.37	0.08	0.08	-79%	-4%	1%	0%
2D3	Solvent use	0.37	0.08	0.08	-79%	-4%	1%	0%
2D3b	Road paving with asphalt	0.30	0.04	0.04	-86%	-5%	1%	0%
2D3i	Other solvent use	0.07	0.03	0.03	-54%	-2%	0%	0%
2G	OTHER PRODUCT USE	0.36	0.38	0.34	-6%	-9%	1%	1%
2H	OTHER INDUSTRY PRODUCTION	0.01	0.00	0.00	-100%	#DIV/0!	0%	0%
3	**AGRICULTURE**	**0.91**	**0.18**	**0.18**	**-80%**	**-3%**	**2%**	**1%**
3B	MANURE MANAGEMENT	0.30	0.09	0.09	-69%	-3%	1%	0%
3B1	Cattle	0.11	0.04	0.04	-68%	-8%	0%	0%
3B3	Swine	0.01	0.01	0.01	-42%	-4%	0%	0%
3B4	Other livestock	0.17	0.05	0.05	-72%	0%	0%	0%
3B4g	Poultry	0.17	0.05	0.05	-73%	0%	0%	0%
3D	AGRICULTURAL SOILS	0.18	0.09	0.09	-53%	-2%	0%	0%
3Dc	On-farm storage, handling and transport of agricultural products	0.18	0.09	0.09	-53%	-2%	0%	0%
3F	Field burning of agricultural residues	0.43	0.00	0.00	-100%	-84%	1%	0%
5	**WASTE**	**0.72**	**0.29**	**0.31**	**-57%**	**5%**	**2%**	**1%**
	NATIONAL TOTAL	**39.94**	**29.13**	**26.22**	**-34%**	**-10%**	**100%**	**100%**

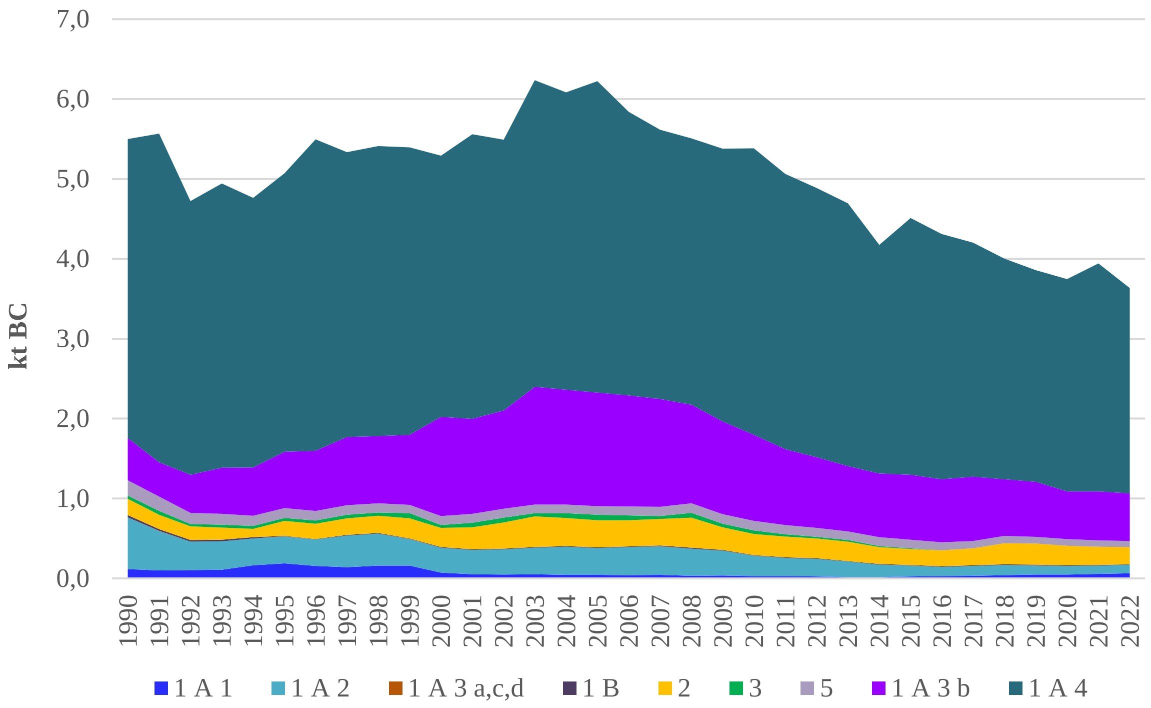
2.7.4. Black carbon (BC)

The Republic of Croatia voluntarily reports on the emissions of BC as an additional pollutant in the air.

In 2022, BC emission was 3.6 kt (Figure 2.7.4-1) and was down by 34% compared to 1990 and by 8% compared to the previous year. The Energy sector is the sector with the highest contribution to the total BC emission in 2022 (92%). The remaining emissions in 2022 (8%) originate from two sectors, namely, the IPPU (6%) and Waste (2%). The key categories in the Energy sector in 2022 are: 1.A.4.b.i residential that contributes to the total BC emission with 68.5% and 1.A.3.b.i road transport – passenger cars with a contribution of 9.5%. In the IPPU sector in 2022, the key source was 2.G production and use of other products - tobacco combustion activity (2.8% contribution to the total national BC emission).

Since 1990, the BC emission has a downward trend, and the largest contributing sector was the stationary Energy with the reduction of the BC emission by 39% due to the reduction of the consumption of solid fossil fuels and at the same time increasing the consumption of gaseous and liquid fuels. Since 1990, the BC emission trend has increased in the following sectors: the IPPU by 6%, due to an increase in road asphalting activities (2.D.3.b) and road transport by 12%, due to an increase in the number of vehicles and the number of kilometers travelled. In road transport, exhaust emissions make up the majority (83% in 2022 and 91% in 1990) of emissions, while the remaining emissions come from tire and brake wear and road abrasion, the contribution of which is increasing in the historical trend (9% in 1990 and 17% 2022).

Factors influencing the trend of BC emissions are described in section 2.7. Economic conditions have mostly affected the construction and manufacturing sectors, but this impact is not so notable in the BC trend due to the dominance of emissions from biomass combustion in domestic fireplaces and emissions from road transport.



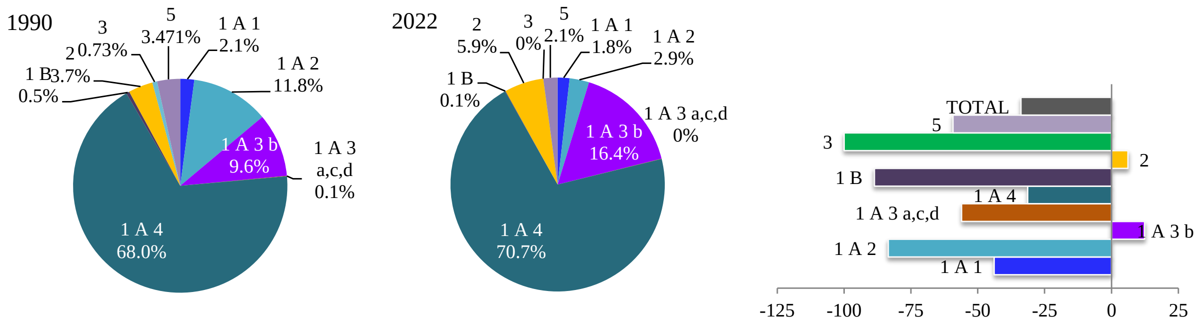


Figure 2.7.4-1 The BC emissions (kt/yr.) and percentage share by sector and variation in BC emissions

Table 2.7.4-1 The BC emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		BC emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**5,07**	**3,63**	**3,34**	**-34%**	**-8%**	**92%**	**92%**
1A	FUEL COMBUSTION	5,04	3,63	3,34	-34%	-8%	92%	92%
1A1	Energy Industries	0,12	0,05	0,07	-44%	19%	2%	2%
1A1a	Public electricity and heat production	0,07	0,05	0,06	-17%	17%	1%	2%
1A1b	Petroleum refining	0,02	0,00	0,00	-81%	46%	0%	0%
1A1c	Manufacture of solid fuels and other energy industries	0,02	0,00	0,00	-99%	29%	0%	0%
1A2	Manufacturing Industries and Construction	0,65	0,11	0,11	-83%	0%	12%	3%
1A2a	Iron and Steel	0,06	0,00	0,00	-97%	-2%	1%	0%
1A2c	Chemicals	0,05	0,00	0,00	-98%	-14%	1%	0%
1A2d	Pulp, Paper and Print	0,02	0,00	0,00	-71%	19%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	0,06	0,02	0,02	-65%	6%	1%	1%
1A2f	Non-metallic Minerals	0,23	0,04	0,03	-87%	-14%	4%	1%
1A2g	Manufacturing Ind. and Constr.: Other	0,22	0,04	0,05	-79%	8%	4%	1%
1A3	Transport	0,53	0,61	0,60	12%	-3%	10%	16%
1A3b	Road Transportation	0,53	0,61	0,60	12%	-3%	10%	16%
1A4	Small combustion & other non-road mobile sources and machinery	3,74	2,85	2,57	-31%	-10%	68%	71%
1A4a	Commercial/Institutional	0,08	0,03	0,03	-56%	4%	1%	1%
1A4b	Residential	3,18	2,77	2,49	-22%	-10%	58%	69%
1A4c	Agriculture/Forestry/Fishing	0,49	0,05	0,05	-91%	-6%	9%	1%
1B	FUGITIVE EMISSIONS FROM FUELS	0,03	0,00	0,00	-89%	-35%	0%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0,20**	**0,23**	**0,22**	**6%**	**-6%**	**4%**	**6%**
2A	MINERAL PRODUCTS	0,01	0,01	0,01	17%	-6%	0%	0%
2B	CHEMICAL INDUSTRY	0,01	0,00	0,00	-91%	-88%	0%	0%
2C	METAL PRODUCTION	0,02	0,00	0,00	-100%	-9%	0%	0%
2D	NON ENERGY PRODUCTS/SOLVENTS	0,02	0,11	0,10	333%	-5%	0%	3%
2D3	Solvent use	0,02	0,11	0,10	333%	-5%	0%	3%

Category		BC emission in kt			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
2D3b	Road paving with asphalt	0,02	0,11	0,10	333%	-5%	0%	3%
2G	OTHER PRODUCT USE	0,15	0,11	0,10	-30%	-3%	3%	3%
2H	OTHER INDUSTRY PRODUCTION	0,00	0,00	0,00	-100%	-	0%	0%
3	**AGRICULTURE**	**0,04**	**0,00**	**0,00**	**-100%**	**-84%**	**1%**	**0%**
3F	Field burning of agricultural residues	0,04	0,00	0,00	-100%	-84%	1%	0%
5	**WASTE**	**0,19**	**0,08**	**0,08**	**-59%**	**-2%**	**3%**	**2%**
	NATIONAL TOTAL	**5,50**	**3,94**	**3,64**	**-34%**	**-8%**	**100%**	**100%**

2.8. Priority heavy metal emissions (Pb, Cd and Hg)

Heavy metals (HM) emissions from anthropogenic sources became of importance to UNECE/CLRTAP, after various studies showed that HM attached to air-borne particles can be widely dispersed on very large scales. They are stable and cannot be degraded or destroyed, and therefore they tend to accumulate in soils and sediments. Because of their toxicity and other mentioned properties, HM are also hazardous for living organisms. Recognized danger from heavy metals accelerated UN decision to include the Protocol on heavy metals in the framework of the CLRTAP. The Republic of Croatia has signed this Protocol in June 1999 at the meeting of the ministers of environmental protection in Aarhus and ratified it by Low on ratification of the Protocol to the 1979 Convention on long-range transboundary air pollution on Heavy Metals (OG-IT 05/07) in 2007.

Emissions of priority metals are mainly a result of fuel combustion. The emission depends on the type and quantity of combusted fuel, so Cadmium (Cd) emission will be greater if in the observed year more fuel oil was used, while the Mercury (Hg) emission increases with higher consumption of natural gas.

National total emissions and trends (1990–2022) for priority heavy metal are shown in Table 2.8-1.

Table 2.8-1 National total emissions and trends (1990–2022) for priority heavy metal

Year	Emission [t]		
	Pb	Cd	Hg
Trend 1990-2022	**-98.4%**	**-34.3%**	**-68.8%**
1990	528.73	1.20	1.08
1991	356.65	1.11	1.05
1992	262.17	0.88	1.06
1993	259.17	0.92	0.27
1994	282.63	0.82	0.24
1995	263.47	0.89	0.24
1996	212.13	0.95	0.23
1997	192.49	0.92	0.27
1998	183.82	0.96	0.30
1999	178.70	0.99	0.33
2000	146.28	0.93	0.43
2001	111.93	1.01	0.44

Year	Emission [t]		
	Pb	Cd	Hg
2002	69.19	1.01	0.49
2003	34.33	1.09	0.51
2004	23.03	1.10	0.52
2005	15.42	1.16	0.54
2006	12.13	1.11	0.51
2007	11.92	0.99	0.54
2008	11.32	1.01	0.52
2009	10.70	0.99	0.45
2010	10.04	1.02	0.47
2011	9.76	0.95	0.45
2012	9.05	0.91	0.42
2013	10.47	0.91	0.44
2014	9.80	0.82	0.43
2015	9.98	0.87	0.41
2016	10.03	0.82	0.42
2017	10.31	0.82	0.36
2018	10.64	0.83	0.36
2019	7.48	0.79	0.31
2020	7.47	0.78	0.32
2021	8.52	0.85	0.34
2022	8.36	0.79	0.34

2.8.1. Lead (Pb)

Lead emission occurs due to the content of lead in the product, fuel, or raw material.

Lead emissions (figure and table 2.8.1-1) in 2022 amounted to 6.3 t. Pb emissions decreased by 98% compared to 1990 and by 2% compared to the previous year. The two key sectors in the emission of Pb in 2022 were: production processes and use of products (41.2%), where the key categories are 2.G other product manufacture and use - use of fireworks, signal rockets and pyrotechnics activity (20.6 % share in the total national emission) and 2.A.3 glass production (6.4% share) and Energy (67.5%) with key categories 1.A.3.b.vi road transport - tire and brake wear (41.1% share in the total national emission) and 1.A.4.b.i residential (13.4%).

The declining trend of Pb emissions is dominated by the impact of road transport. The reduction in emissions in the period 1991 – 1994 was caused by the war for Croatian independence (1991-1995), and consequently lower fuel consumption and the overall decline in productivity in almost all sectors. As a result of the war, the steel production process in Siemens-Martin furnaces was stopped in 1992. Road transport has seen a reduction in lead emissions by almost 100 % since 1990 because of the gradual ban on the use of leaded gasoline fuels. Efforts began in 1996 when the Pb content in leaded petrol was reduced from 0.6 g/l to 0.74 g/l, and in unleaded from 0.02 g/l to 0.013 g/l, then in 2003 The Pb content in leaded petrol was reduced to 0.15 g/l and in unleaded petrol to 0.005 g/l, and in 2006 leaded petrol was reduced to a minimum.

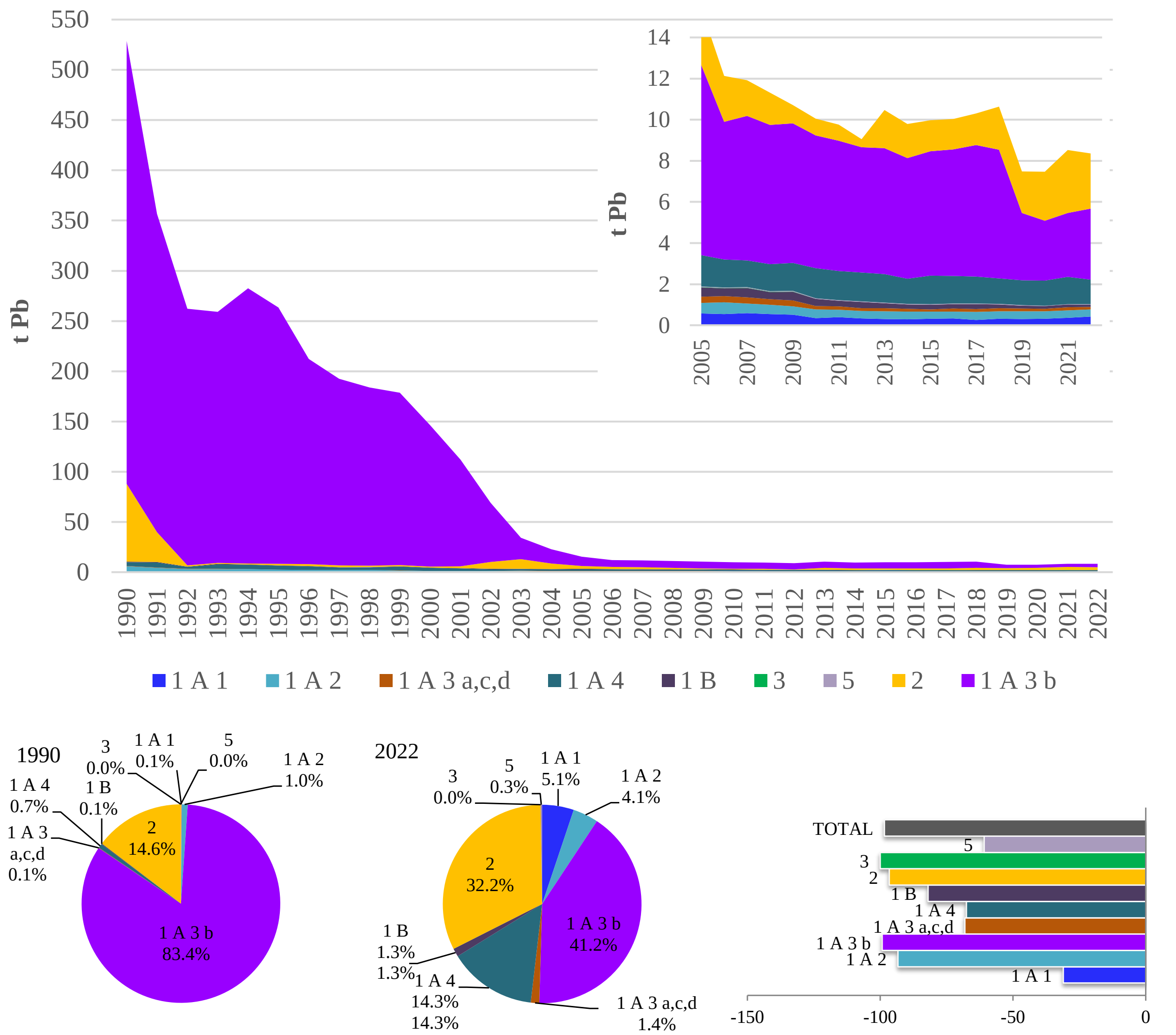


Figure 2.8.1-1 The Pb emissions (t/yr.) and percentage share by sector and variation in Pb emissions

Table 2.8.1-1 The Pb emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Pb emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**451.25**	**5.43**	**5.65**	**-99%**	**4%**	**85%**	**68%**
1A	FUEL COMBUSTION	450.62	5.30	5.53	-99%	4%	85%	66%
1A1	Energy Industries	0.62	0.37	0.43	-31%	17%	0%	5%
1A1a	Public electricity and heat production	0.50	0.35	0.41	-18%	16%	0%	5%
1A1b	Petroleum refining	0.11	0.02	0.02	-81%	32%	0%	0%
1A1c	Manufacture of solid fuels and other energy industries	0.02	0.00	0.00	-100%	29%	0%	0%
1A2	Manufacturing Industries and Construction	5.18	0.36	0.35	-93%	-5%	1%	4%
1A2a	Iron and Steel	0.16	0.00	0.00	-98%	14%	0%	0%
1A2c	Chemicals	0.03	0.00	0.00	-99%	806%	0%	0%
1A2d	Pulp, Paper and Print	0.02	0.00	0.00	-86%	20%	0%	0%

Category		Pb emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2e	Food Processing, Beverages and Tobacco	0.06	0.01	0.01	-81%	-5%	0%	0%
1A2f	Non-metallic Minerals	0.32	0.33	0.31	-2%	-6%	0%	4%
1A2g	Manufacturing Ind. and Constr.: Other	4.59	0.01	0.01	-100%	-3%	1%	0%
1A3	Transport	441.14	3.25	3.56	-99%	10%	83%	43%
1A3a	Civil Aviation	0.33	0.14	0.11	-67%	-20%	0%	1%
1A3b	Road Transportation	440.77	3.10	3.44	-99%	11%	83%	41%
1A3c	Railways	0.03	0.00	0.00	-100%	3%	0%	0%
1A3d	Navigation	0.01	0.01	0.01	16%	3%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	3.69	1.32	1.20	-67%	-9%	1%	14%
1A4a	Commercial/Institutional	0.17	0.02	0.02	-86%	5%	0%	0%
1A4b	Residential	3.50	1.29	1.17	-67%	-9%	1%	14%
1A4c	Agriculture/Forestry/Fishing	0.01	0.00	0.00	-70%	4%	0%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	0.62	0.13	0.11	-82%	-15%	0%	1%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**77.42**	**3.06**	**2.69**	**-97%**	**-12%**	**15%**	**32%**
2A	MINERAL PRODUCTS	0.47	0.50	0.53	14%	8%	0%	6%
2C	METAL PRODUCTION	76.39	0.48	0.44	-99%	-9%	14%	5%
2G	OTHER PRODUCT USE	0.56	2.09	1.72	209%	-18%	0%	21%
3	**AGRICULTURE**	**0.01**	**0.00**	**0.00**	**-100%**	**-84%**	**0%**	**0%**
3F	Field burning of agricultural residues	0.01	0.00	0.00	-100%	-84%	0%	0%
5	**WASTE**	**0.05**	**0.02**	**0.02**	**-61%**	**-2%**	**0%**	**0%**
	NATIONAL TOTAL	**528.73**	**8.52**	**8.36**	**-98%**	**-2%**	**100%**	**100%**

2.8.2. Cadmium (Cd)

Cadmium emissions occur due to its content in energy sources (biomass, fuel oil, coal) and raw materials at the entrance to industrial processes.

Cadmium emissions in 2022 amounted to 0.79 t. Cd emission decreased by 34% compared to 1990, and by 7% compared to the previous year (figure and table 2.8.2-1). The majority of Cd emissions come from fuel combustion in the Energy sector (85% in 2022), with the key category 1.A.4.b.i households (69.1% of the total national emission). The second most dominant sector in Cd emissions in 2022 is the sector Production processes and use of products with a contribution of 15% and with two key categories 2.G production and use of other products - activities of using fireworks, signal rockets and pyrotechnics (6.2% share into the total national emission) and 2.A.3 glass production (5.2% in 2022).

Since 1990, total Cd emissions have been declining, as a result of reduced fuel oil consumption and a simultaneous increase in natural gas consumption. Also, lower fossil fuel consumption in the energy sectors has contributed to reducing Cd emissions. Cadmium emissions decreased significantly between 1991 and 1992 (by about 27%), due to the cessation of the steel production process at the Siemens-Martin furnaces in Sisak in 1992, as a consequence of the war for Croatian independence (1991-1995), which also caused a reduction in fuel consumption in the general consumption sectors and manufacturing sectors. In addition to the above, reductions in emissions due to climate factors can be seen in 1994, 2000, 2002, 2014 and 2022 when due to warmer winters, the consumption of biomass for firewood in residential was lower (Figure 3.5-3).

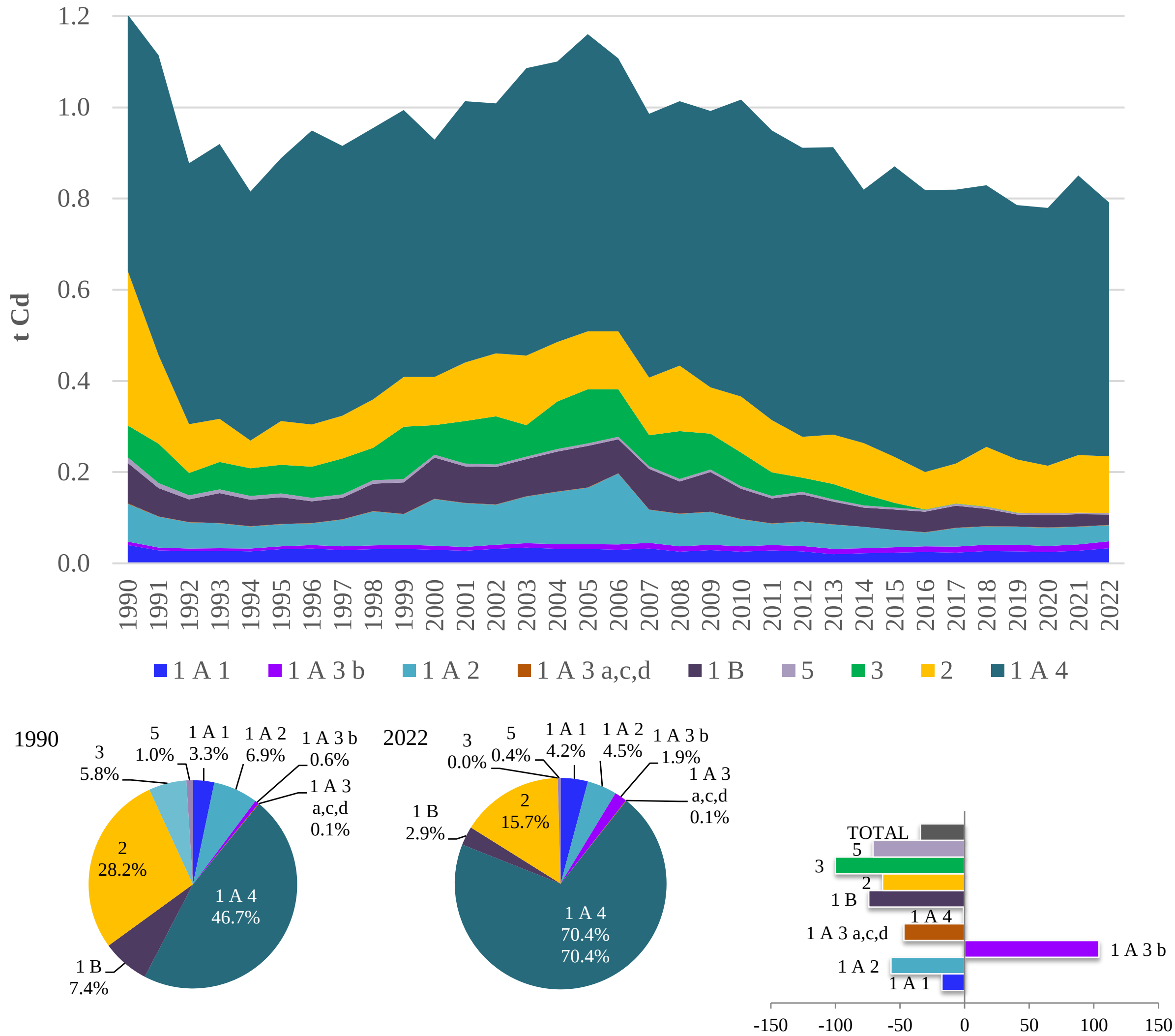


Figure 2.8.2-1 The Cd emissions (t/yr.) and percentage share by sector and variation in Cd emissions

Table 2.8.2-1 The Cd emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Cd emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**0.78**	**0.72**	**0.66**	**-15%**	**-8%**	**65%**	**84%**
1A	FUEL COMBUSTION	0.69	0.69	0.64	-8%	-8%	58%	81%
1A1	Energy Industries	0.04	0.03	0.03	-18%	18%	3%	4%
1A1a	Public electricity and heat production	0.01	0.02	0.03	309%	17%	1%	3%
1A1b	Petroleum refining	0.03	0.01	0.01	-81%	23%	3%	1%
1A2	Manufacturing Industries and Construction	0.08	0.04	0.04	-57%	-8%	7%	5%
1A2a	Iron and Steel	0.01	0.00	0.00	-97%	9%	1%	0%

Category		Cd emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2f	Non-metallic Minerals	0.06	0.03	0.03	-55%	-10%	5%	4%
1A4a	Commercial/Institutional	0.00	0.01	0.01	189%	3%	0%	1%
1A4b	Residential	0.56	0.60	0.55	-2%	-9%	46%	69%
1A4c	Agriculture/Forestry/Fishing	0.00	0.00	0.00	-16%	3%	0%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	0.09	0.03	0.02	-74%	-15%	7%	3%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.34**	**0.13**	**0.12**	**-63%**	**-2%**	**28%**	**16%**
2A	MINERAL PRODUCTS	0.04	0.04	0.04	14%	8%	3%	5%
2C	METAL PRODUCTION	0.24	0.04	0.03	-86%	-9%	20%	4%
2G	OTHER PRODUCT USE	0.07	0.05	0.05	-26%	-4%	6%	6%
3	**AGRICULTURE**	**0.07**	**1E-04**	**2E-05**	**-100%**	**-84%**	**6%**	**0%**
3F	Field burning of agricultural residues	0.07	1E-04	2E-05	-100%	-84%	6%	0%
5	**WASTE**	**0.01**	**0.003**	**0.003**	**-71%**	**1%**	**1%**	**0%**
	NATIONAL TOTAL	**1.20**	**0.85**	**0.79**	**-34%**	**-7%**	**100%**	**100%**

2.8.3. Mercury (Hg)

Mercury emission comes from its content in energy sources (e.g. coal, natural gas, biomass), raw materials at the entrance to industrial processes (e.g. oil refining, steel and glass production) and in waste gas flows that are combusted on flares in refineries and during the hydrocarbon exploitation.

In 2022, mercury emissions amounted to 0.34 t (figure and table 2.8.3-1). The emission decreased by 69% compared to 1990 and compared to the previous year by 2%. The majority of Hg emission in 2022 comes from the Energy sector (94% of the total Hg emission), where category 1.A.2 industry and construction participates with 37% and the key source 1.A.2.f non-metallic minerals (35.1% in the total national emission), 1A1 energy industries with 37% and the key source 1.A.1.a public electricity and heat production (36.2% in 2022), 1.A.4 small combustion plants and mobile machinery with 8.3% and key source 1.A.4.b.i residential (7.8%) and 1.B fugitive emissions from fuel with 7.3% and key source 1.B.2.a.iv refining/storage (7.3%).

In 1990, fugitive emissions from fuels, especially fugitive emissions from natural gas extraction and processing (1.B.2.b.i), were the dominant source of Hg emissions (65% in 1990). In 1993, technological units for mercury removal were built. With this technical measure to reduce mercury emissions, the average input concentration of mercury in natural gas of 516 $\mu g/m^3$ was reduced to an average output concentration of 0.12 $\mu g/m^3$ (lit 7). The above is the reason for the reduction of Hg emissions in the observed period. Since 2000, Hg emission has started to rise, due to the commissioning of the second of Croatia's two coal-fired power plants. In 2017 and 2019, there was a decline in mercury emissions due to reduced operation of coal-fired power plants.

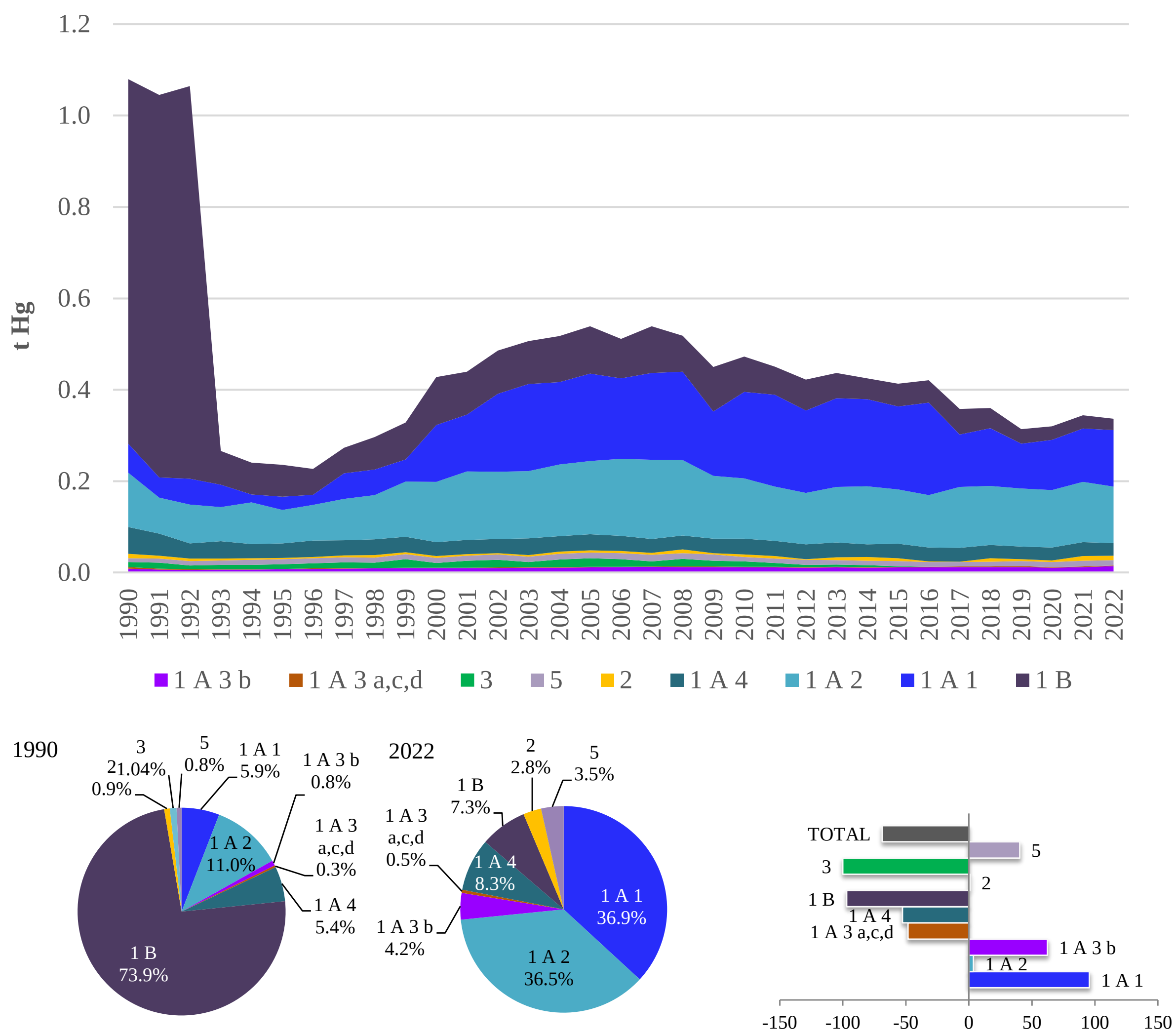


Figure 2.8.3-1 The Hg emissions (t/yr.) and percentage share by sector and variation in Hg emissions

Table 2.8.3-1 The Hg emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Hg emission in +t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**1.05**	**0.32**	**0.32**	**-70%**	**-2%**	**97%**	**94%**
1A	FUEL COMBUSTION	0.25	0.29	0.29	15%	-1%	23%	86%
1A1	Energy Industries	0.06	0.12	0.12	96%	7%	6%	37%
1A1a	Public electricity and heat production	0.05	0.11	0.12	123%	7%	5%	36%
1A1b	Petroleum refining	0.01	0.00	0.00	-79%	10%	1%	0%
1A2	Manufacturing Industries and Construction	0.12	0.13	0.12	4%	-7%	11%	37%
1A2a	Iron and Steel	0.01	0.00	0.00	-92%	14%	1%	0%
1A2f	Non-metallic Minerals	0.10	0.13	0.12	16%	-6%	9%	35%
1A3	Transport	0.01	0.01	0.02	32%	16%	1%	5%
1A3b	Road Transportation	0.01	0.01	0.01	62%	18%	1%	4%

Category		Hg emission in +t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A4	Small combustion & other non-road mobile sources and machinery	0.06	0.03	0.03	-53%	-9%	5%	8%
1A4a	Commercial/Institutional	0.01	0.00	0.00	-84%	-11%	1%	0%
1A4b	Residential	0.05	0.03	0.03	-48%	-9%	5%	8%
1B	FUGITIVE EMISSIONS FROM FUELS	0.80	0.03	0.02	-97%	-15%	74%	7%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.01**	**0.01**	**0.01**	**1%**	**-7%**	**1%**	**3%**
2C	METAL PRODUCTION	0.01	0.01	0.01	-1%	-9%	1%	3%
3	**AGRICULTURE**	**0.01**	**2E-05**	**3E-06**	**-100%**	**-84%**	**1%**	**0%**
3F	Field burning of agricultural residues	0.01	2E-05	3E-06	-100%	-84%	1%	0%
5	**WASTE**	**0.01**	**0.01**	**0.01**	**40%**	**-5%**	**1%**	**4%**
	NATIONAL TOTAL	**1.08**	**0.34**	**0.34**	**-69%**	**-2%**	**100%**	**100%**

2.9. Other heavy metals (As, Cr, Cu, Ni, Se, Zn)

Emissions of other heavy metals (As, Cr, Cu, Ni, Se and Zn) Croatia voluntary reports as an additional air pollutants.

A group of other heavy metals included Arsenic (As), Chrome (Cr), Copper (Cu), Nickel (Ni), Selenium (Se) and Zinc (Zn). Sources of their emissions are different, e.g. the emission of arsenic, chromium and nickel occur because of their presence (trace) in the solid fuel and heavy fuel oil, and partly in the composition of the individual input materials in manufacturing processes such as glass, iron and steel. Copper is mostly emitted because of tire and brake wear, Zinc is mostly emitted because of biomass combustion in residential sector, while Selenium is emitted due to their presence, in trace, in raw materials for e.g. glass and mineral wool production.

National total emissions and trends (1990–2022) for other heavy metal are shown in Table 2.9-1.

Table 2.9-1 National total emissions and trends (1990–2022) for other heavy metal

Year	Emission [t]					
	As	Cr	Cu	Ni	Se	Zn
Trend 1990-2022	**-95.8%**	**-49.9%**	**81.7%**	**-82.9%**	**-13.7%**	**-8.2%**
1990	8.65	5.72	16.94	17.05	0.46	40.99
1991	3.62	4.14	12.90	12.71	0.38	39.51
1992	0.91	3.95	12.34	13.37	0.29	33.51
1993	0.85	4.00	13.05	12.13	0.28	34.59
1994	1.80	5.41	14.57	11.14	0.33	32.80
1995	1.26	4.13	14.89	13.88	0.31	33.79
1996	1.06	3.89	16.16	13.37	0.30	36.95
1997	1.22	4.19	17.97	12.23	0.28	35.67
1998	1.47	4.83	18.76	14.36	0.31	36.06
1999	1.61	5.07	20.00	16.12	0.32	35.52
2000	1.13	3.80	19.73	12.67	0.31	32.53

Year	Emission [t]					
	As	Cr	Cu	Ni	Se	Zn
Trend 1990-2022	**-95.8%**	**-49.9%**	**81.7%**	**-82.9%**	**-13.7%**	**-8.2%**
2001	1.24	4.01	18.42	12.55	0.33	34.24
2002	1.30	4.11	22.79	13.29	0.34	35.52
2003	1.50	5.00	26.18	15.65	0.38	40.52
2004	1.11	4.08	24.12	12.81	0.38	38.76
2005	1.15	4.36	23.58	13.76	0.40	39.42
2006	1.29	4.36	24.89	14.14	0.41	37.88
2007	1.22	4.32	26.41	12.08	0.41	37.59
2008	1.03	4.09	25.47	10.45	0.40	36.87
2009	1.05	4.26	25.37	11.64	0.39	37.57
2010	0.82	3.27	23.86	7.81	0.37	38.78
2011	0.64	3.21	23.36	6.85	0.36	37.52
2012	0.62	3.09	22.96	6.10	0.34	36.98
2013	0.50	2.92	24.23	4.77	0.35	37.31
2014	0.39	2.67	23.61	3.94	0.37	34.00
2015	0.52	2.91	24.88	4.60	0.34	37.43
2016	0.43	2.78	25.53	4.27	0.37	36.39
2017	0.55	2.96	27.75	4.37	0.38	36.67
2018	0.59	2.79	27.32	3.59	0.38	36.39
2019	0.62	2.78	29.18	2.90	0.38	36.11
2020	0.30	2.65	26.38	2.38	0.34	35.40
2021	0.34	2.85	28.22	2.62	0.38	38.63
2022	0.36	2.87	30.78	2.91	0.40	37.61

2.9.1. Arsenic (As)

The emission of arsenic results from its content in raw materials and fuels.

Arsenic emissions in 2022 amounted to 0.36 t (Figure and Table 2.9.1-1). Emissions decreased by 96% compared to 1990 and increased by 9% compared to the previous year. The Energy sector is the key sector for arsenic emissions in 2022 (81%) with key categories: 1.A.1.a public electricity and heat production (43.1% of the total national emission), 1.A.2.f non-metallic minerals (17.4%) and 1A3bvi road transport – automobile tire and brake wear (10.8%). Of the non-energy sectors, the dominant sector is Production processes and product use, which in 2022 contributed with 20% of As emissions and key category 2.A.3 glass production (16.4% in 2022).

Within the IPPU sector, the steelmaking activity in open hearth furnace steel plant (NFR 2.C.1) was the key source of As emissions in 1990. The shutdown of the steel production process in Siemens-Martin furnaces in 1992 in Sisak, resulted in a significant reduction in As emissions. The cessation of the process was a consequence of the war for Croatian independence (1991 – 1995). Also, the war for Croatian independence caused a decrease in fuel consumption and productivity in the Industrial processes and product use sector.

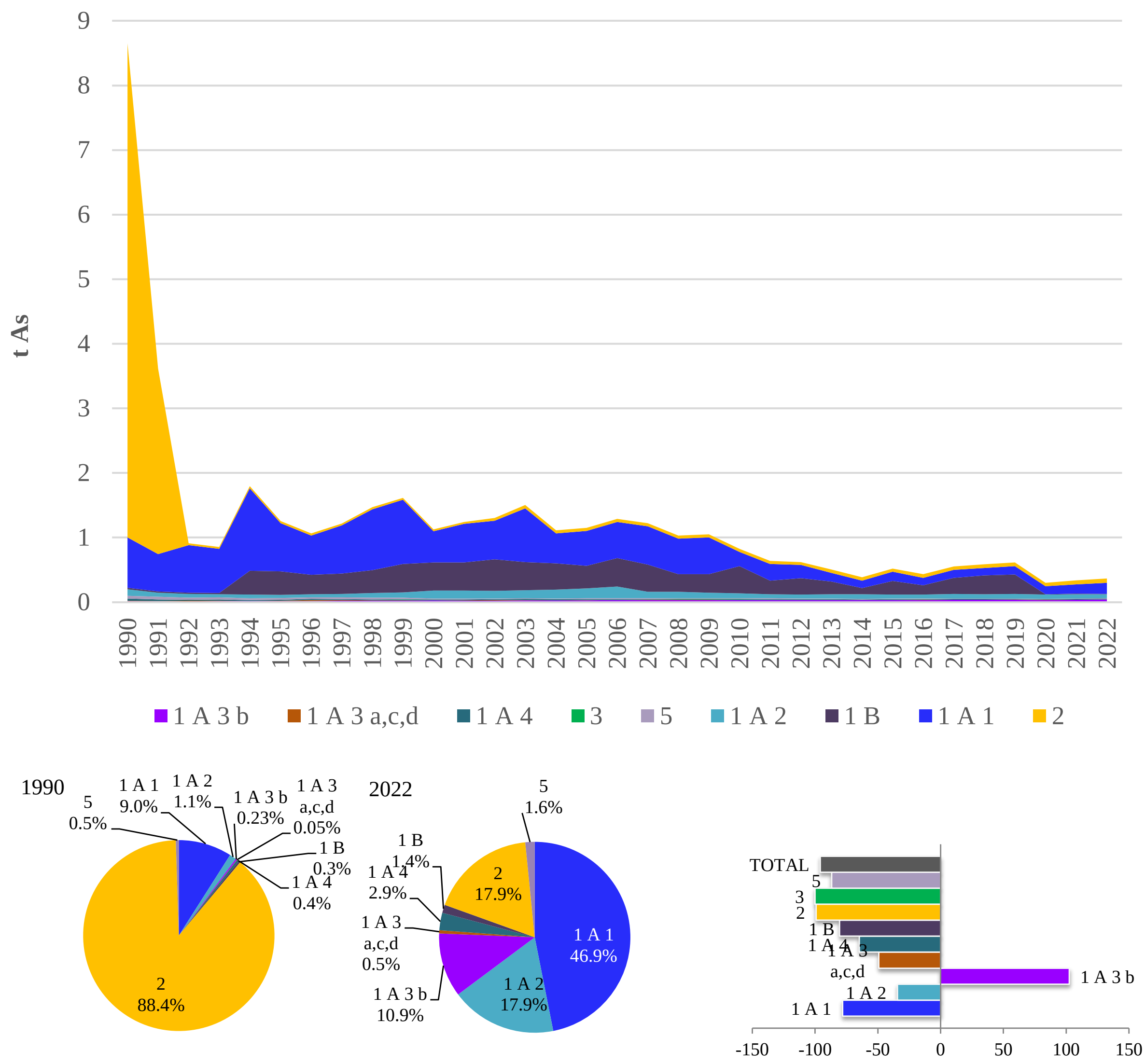


Figure 2.9.1-1 The As emissions (t/yr.) and percentage share by sector and variation in As emissions

Table 2.9.1-1 The As emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		As emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2021	2021-2022	1990	2022
1	**ENERGY**	**0.96**	**0.27**	**0.29**	**-69%**	**10%**	**11%**	**81%**
1A	FUEL COMBUSTION	0.93	0.26	0.29	-69%	10%	11%	79%
1A1	Energy Industries	0.78	0.14	0.17	-78%	19%	9%	47%
1A1a	Public electricity and heat production	0.71	0.13	0.16	-78%	17%	8%	43%
1A1b	Petroleum refining	0.07	0.01	0.01	-81%	52%	1%	4%
1A2	Manufacturing Industries and Construction	0.10	0.07	0.07	-34%	-5%	1%	18%
1A2a	Iron and Steel	0.02	0.00	0.00	-97%	15%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	0.01	0.00	0.00	-91%	27%	0%	0%
1A2f	Non-metallic Minerals	0.06	0.07	0.06	9%	-6%	1%	17%
1A3	Transport	0.02	0.04	0.04	77%	11%	0%	11%

Category		As emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2021	2021-2022	1990	2022
1A3b	Road Transportation	0.02	0.04	0.04	103%	11%	0%	11%
1A4	Small combustion	0.03	0.01	0.01	-65%	-9%	0%	3%
1A4a	Commercial/Institutional	0.01	0.00	0.00	-79%	-8%	0%	0%
1A4b	Residential	0.02	0.01	0.01	-60%	-10%	0%	2%
1B	FUGITIVE EMISSIONS FROM FUELS	0.03	0.01	0.01	-80%	-15%	0%	1%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**7.65**	**0.06**	**0.07**	**-99%**	**5%**	**88%**	**18%**
2A	MINERAL PRODUCTS	0.05	0.06	0.06	14%	8%	1%	16%
2C	METAL PRODUCTION	7.60	0.00	0.00	-100%	-9%	88%	1%
3	**AGRICULTURE**	**5E-04**	**8E-07**	**1E-07**	**-100%**	**-84%**	**0%**	**0%**
5	**WASTE**	**0.04**	**0.01**	**0.01**	**-87%**	**0%**	**1%**	**2%**
	NATIONAL TOTAL	**8.65**	**0.34**	**0.36**	**-96%**	**9%**	**100%**	**100%**

2.9.2. Chromium (Cr)

Higher consumption of solid fossil fuels, biomass and heavy fuel oil results in higher chromium emissions.

Chromium emissions in 2022 amounted to 2.87 t (Figure and Table 2.9.2-1). Cr emissions decreased by 50% compared to 1990, as a result of a decrease in heavy fuel oil and coal consumption in the stationary energy sectors and a simultaneous increase in natural gas consumption. Compared to the previous year, the emission of Cr increased by 1%. The key sector in Cr emissions in 2022 was the Energy sector with key categories: 1.A.3.b.vi road transport - automobile tyre and break wear (with a contribution of 44.9% to the total emission), 1.A.4.b.i Residential (33.8% contribution to the total emission) and 1.A.1.a public electricity and heat production (5% contribution to the total emission).

The great reduction in Cr emissions (by 89 %) compared to 1990 also occurred in the Industrial processes and product use sector, due to the cessation of the process of pig iron production (blast furnace charging) in Sisak and Split in 1992 and steel production in the open hearth furnace steel plant (Siemens Martin' furnaces) in Sisak, 1992. The cessation of these processes was the result of the war for Croatian independence (1991 – 1995). About 6% of Cr emissions in 2022 come from Energy industries, while this impact was significantly higher in the 1990s (33.5% in 1990). Annual Cr emissions from this source show fluctuations in historic trend, which is directly dependent on the type of fuel.

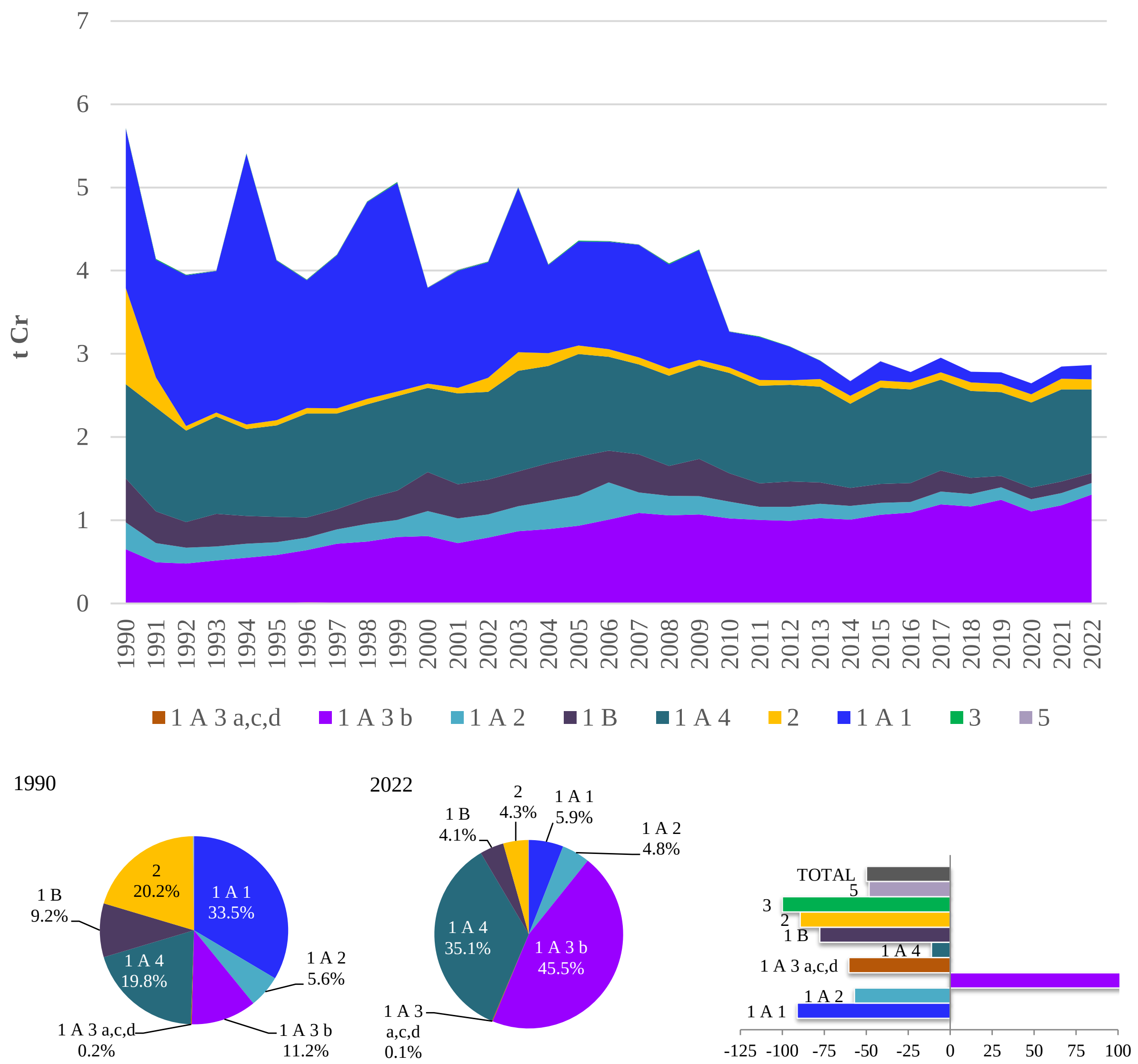


Figure 2.9.2-1 The Cr emissions (t/yr.) and percentage share by sector and variation in Cr emissions

Table 2.9.2-1 The Cr emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Cr emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**4.55**	**2.72**	**2.74**	**-40%**	**1%**	**80%**	**96%**
1A	FUEL COMBUSTION	4.02	2.58	2.62	-35%	2%	70%	92%
1A1	Energy Industries	1.92	0.15	0.17	-91%	15%	34%	6%
1A1a	Public electricity and heat production	1.78	0.12	0.14	-92%	17%	31%	5%
1A1b	Petroleum refining	0.11	0.02	0.03	-78%	4%	2%	1%
1A1c	Manufacture of solid fuels and other energy industries	0.02	0.00	0.00	-100%	29%	0%	0%
1A2	Manufacturing Industries and Construction	0.32	0.15	0.14	-57%	-6%	6%	5%
1A2a	Iron and Steel	0.08	0.00	0.00	-98%	13%	1%	0%
1A2c	Chemicals	0.01	0.00	0.00	-99%	254%	0%	0%

Category		Cr emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2d	Pulp, Paper and Print	0.01	0.00	0.00	-78%	20%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	0.03	0.01	0.01	-70%	-7%	1%	0%
1A2f	Non-metallic Minerals	0.18	0.13	0.12	-34%	-7%	3%	4%
1A2g	Manufacturing Ind. and Constr.: Other	0.01	0.01	0.01	21%	8%	0%	0%
1A3	Transport	0.65	1.18	1.31	101%	11%	11%	46%
1A3b	Road Transportation	0.64	1.18	1.30	103%	11%	11%	46%
1A4	Small combustion & other non-road mobile sources and machinery	1.13	1.11	1.01	-11%	-9%	20%	35%
1A4a	Commercial/Institutional	0.08	0.02	0.02	-70%	5%	1%	1%
1A4b	Residential	1.03	1.07	0.97	-6%	-9%	18%	34%
1A4c	Agriculture/Forestry/Fishing	0.03	0.01	0.01	-47%	3%	0%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	0.53	0.14	0.12	-78%	-15%	9%	4%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**1.16**	**0.13**	**0.12**	**-89%**	**-3%**	**20%**	**4%**
2A	MINERAL PRODUCTS	0.06	0.07	0.07	14%	8%	1%	3%
2C	METAL PRODUCTION	1.08	0.02	0.02	-98%	-9%	19%	1%
2G	OTHER PRODUCT USE	0.01	0.04	0.03	209%	-18%	0%	1%
3	**AGRICULTURE**	**0.01**	**1E-05**	**2E-06**	**-100%**	**-84%**	**0%**	**0%**
3F	Field burning of agricultural residues	0.01	1E-05	2E-06	-100%	-84%	0%	0%
5	**WASTE**	**0.00**	**2E-03**	**2E-03**	**-48%**	**9%**	**0%**	**0%**
	NATIONAL TOTAL	**5.72**	**2.85**	**2.87**	**-50%**	**1%**	**100%**	**100%**

2.9.3. Copper (Cu)

Cu emission in 2022 amounted to 30.8 t (Figure and Table 2.9.3-1). The emission of Cu increased by 82% compared to 1990 and compared to the previous year by 9%. The key source in 2022 was road transport (1.A.3.b) with key category 1.A.3.b.vi automobile tire and brake wear and contribution of 91.9% to total emissions in 2022.

The reduction in emissions in 1991 was a consequence of the war for Croatian independence (1991 – 1995). After a period of reduction, Cu emissions have a long period of increase, mainly due to the increase in the number of road vehicles and increasing the number of kilometers travelled, resulting in an increase in tire and brake wear. The period of high emissions in 2002 – 2005, with a peak in 2003, is the result of a growing trend in the use of fireworks and signal rockets (NFR 2.G, SNAP 060601).

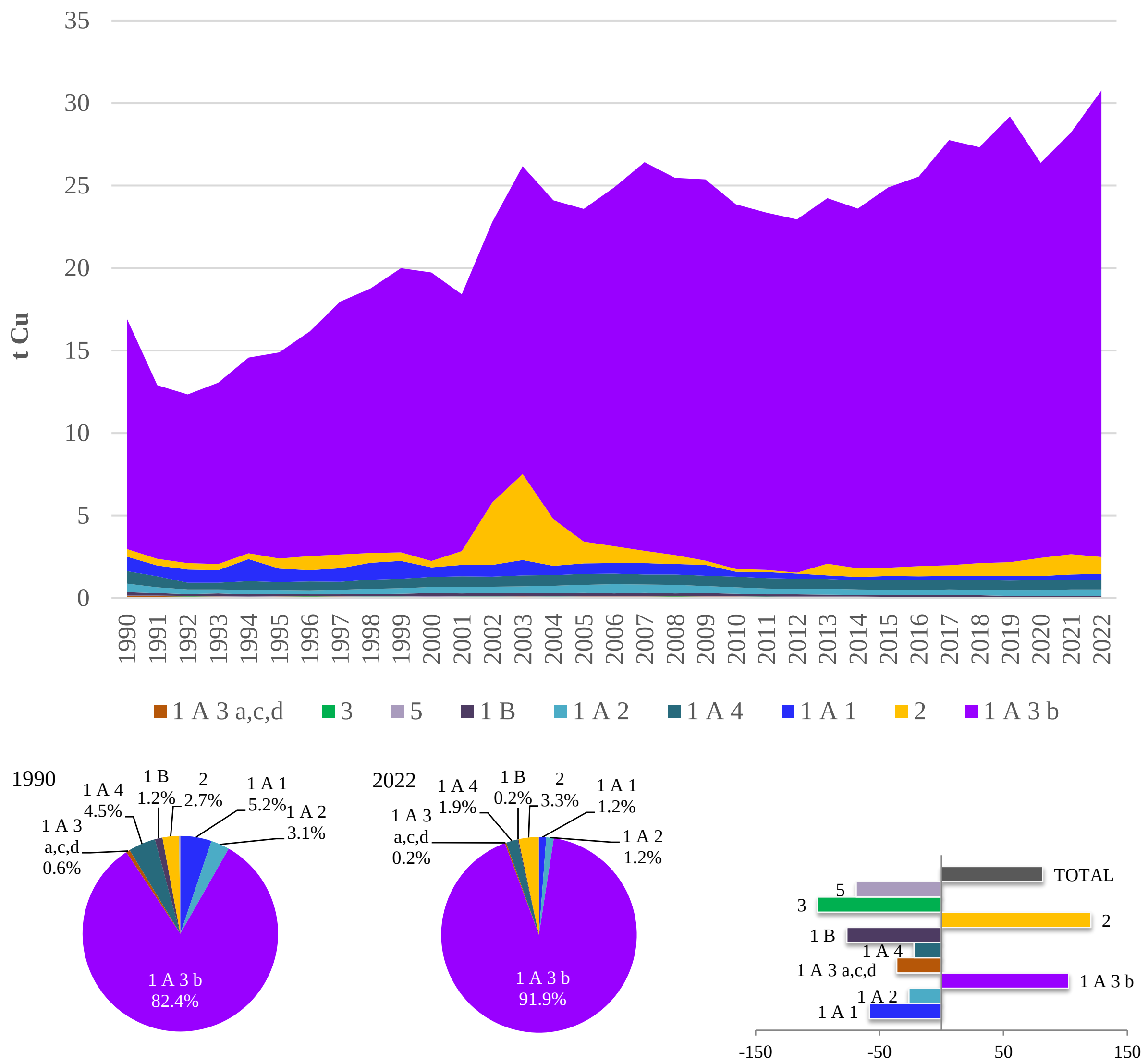


Figure 2.9.3-1 The Cu emissions (t/yr.) and percentage share by sector and variation in Cu emissions

Table 2.9.3-1 The Cu emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Cu emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**16.44**	**26.98**	**29.75**	**81%**	**10%**	**97%**	**97%**
1A	FUEL COMBUSTION	16.23	26.92	29.70	83%	10%	96%	96%
1A1	Energy Industries	0.87	0.31	0.37	-58%	17%	5%	1%
1A1a	Public electricity and heat production	0.73	0.29	0.34	-54%	17%	4%	1%
1A1b	Petroleum refining	0.14	0.02	0.03	-80%	22%	1%	0%
1A1c	Manufacture of solid fuels and other energy industries	0.01	0.00	0.00	-100%	29%	0%	0%
1A2	Manufacturing Industries and Construction	0.52	0.38	0.38	-26%	2%	3%	1%
1A2a	Iron and Steel	0.10	0.00	0.00	-98%	15%	1%	0%
1A2c	Chemicals	0.02	0.00	0.00	-99%	575%	0%	0%
1A2d	Pulp, Paper and Print	0.01	0.00	0.00	-95%	20%	0%	0%

Category		Cu emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2e	Food Processing, Beverages and Tobacco	0.04	0.00	0.00	-91%	5%	0%	0%
1A2f	Non-metallic Minerals	0.17	0.17	0.16	-5%	-5%	1%	1%
1A2g	Manufacturing Ind. and Constr.: Other	0.18	0.20	0.21	21%	8%	1%	1%
1A3	Transport	14.07	25.62	28.36	102%	11%	83%	92%
1A3b	Road Transportation	13.96	25.55	28.29	103%	11%	82%	92%
1A3c	Railways	0.07	0.02	0.02	-63%	3%	0%	0%
1A3d	Navigation	0.04	0.04	0.04	14%	3%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	0.76	0.61	0.59	-22%	-3%	4%	2%
1A4a	Commercial/Institutional	0.04	0.01	0.01	-82%	5%	0%	0%
1A4b	Residential	0.37	0.29	0.27	-28%	-9%	2%	1%
1A4c	Agriculture/Forestry/Fishing	0.35	0.31	0.32	-10%	3%	2%	1%
1B	FUGITIVE EMISSIONS FROM FUELS	0.21	0.06	0.05	-76%	-15%	1%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.46**	**1.23**	**1.02**	**121%**	**-17%**	**3%**	**3%**
2C	METAL PRODUCTION	0.08	0.00	0.00	-96%	-9%	0%	0%
2G	OTHER PRODUCT USE	0.38	1.23	1.02	168%	-17%	2%	3%
3	**AGRICULTURE**	**0.01**	**9E-06**	**2E-06**	**-100%**	**-84%**	**0%**	**0%**
3F	Field burning of agricultural residues	0.01	9E-06	2E-06	-100%	-84%	0%	0%
5	**WASTE**	**0.03**	**0.008**	**0.008**	**-69%**	**3%**	**0%**	**0%**
	NATIONAL TOTAL	**16.94**	**28.22**	**30.78**	**82%**	**9%**	**100%**	**100%**

2.9.4. Nickel (Ni)

Higher consumption of solid fossil fuels and heavy fuel oil results in higher Ni emissions.

Nickel emission in 2021 amounted to 2.5 t (Figure and Table 2.9.4-1). The emission of Ni decreased by 83% compared to 1990 and compared to the previous year it increased by 11%. The majority of Ni emissions come from the Energy sector (83.3% in 1990 and 87.6% in 2022), with key categories in 2022: 1A1b petroleum refining (42.9% contribution to total emissions), 1A1a public electricity and heat production (14.1%), 1.B.2.a.iv refining/storage (7.4%), 1.A.3.b.vi automobile tire and brake wear (6.7%) and 1.A.4.a.i commercial/institutional (4.6%). In addition to the energy sector, the key sector is the industrial processes sector with the key category 2.A.3 glass production with a contribution of 5.3% to the total emission in 2022.

The historical trend of Ni emission from this source shows fluctuations that are directly dependent on the type of energy used. Higher consumption of solid fuel (coal) and biomass to a lesser extent are the result of higher Ni emission and vice versa. The reduction in Ni emission in 1991 was a consequence of the war for Croatian independence (1991 – 1995). During this period, there was a reduction in fossil fuel consumption and a cessation in the steel production process in Siemens - Martin furnaces in Sisak in 1992. In recent years (since 2010) the trend of Ni emission has been declining, as a result of the decreasing use of coal in the Energy. The increase in emissions in the period from 1998 to 2006 in sector 1.A.2 industry and construction is the result of greater use of heavy fuel oil in category 1.A.2.c chemicals. The increase in recent years occurred due to greater use of fuel oil in category 1.A.1.b of the refinery.

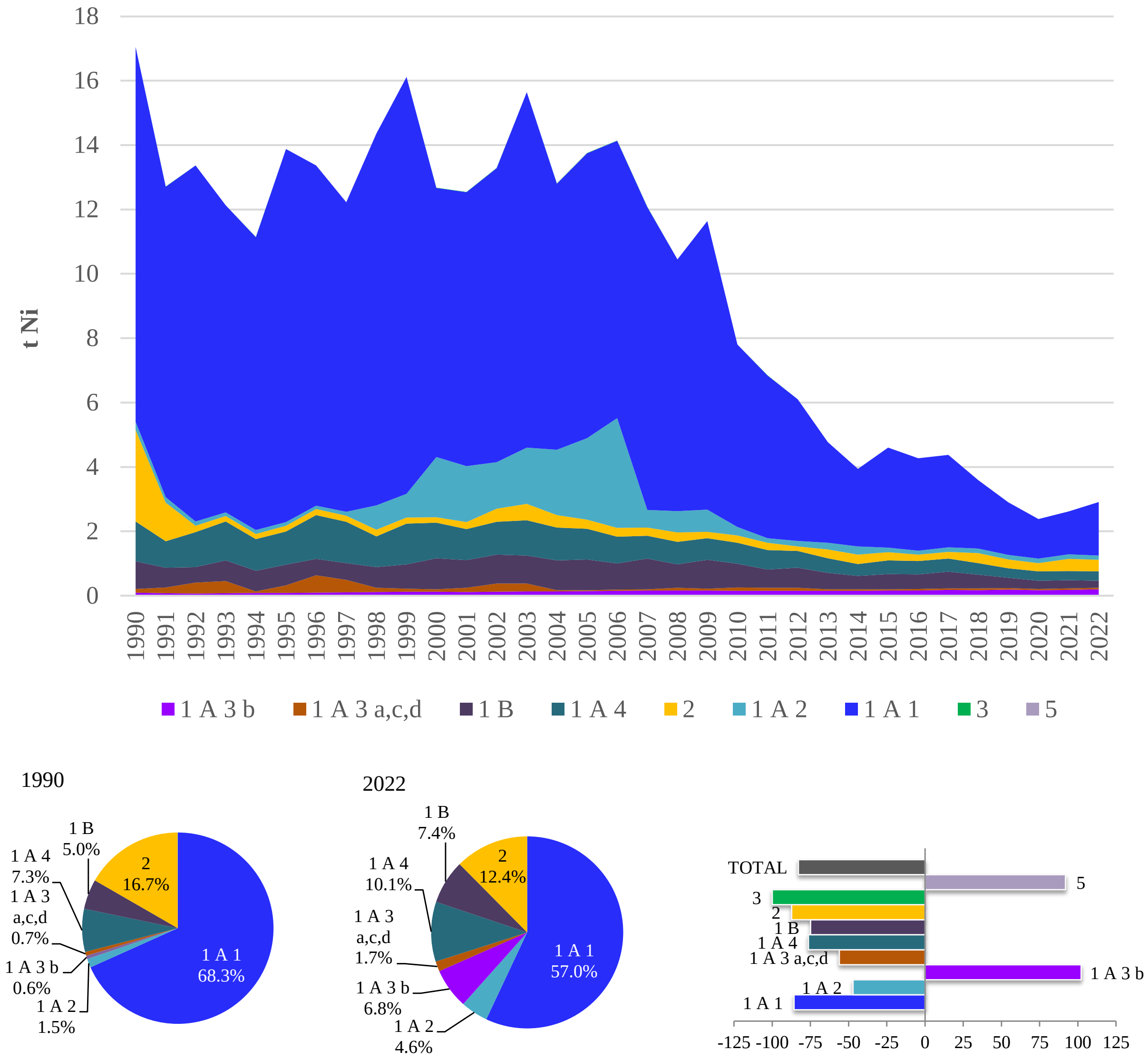


Figure 2.9.4-1The Ni emissions (t/yr.) and percentage share by sector and variation in Ni emissions

Table 2.9.4-1 The Ni emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Ni emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**14.21**	**2.24**	**2.55**	**-82%**	**14%**	**83%**	**88%**
1A	FUEL COMBUSTION	13.35	1.98	2.33	-83%	18%	78%	80%
1A1	Energy Industries	11.64	1.33	1.66	-86%	25%	68%	57%
1A1a	Public electricity and heat production	6.07	0.34	0.41	-93%	22%	36%	14%
1A1b	Petroleum refining	5.33	0.99	1.25	-77%	25%	31%	43%
1A1c	Manufacture of solid fuels and other energy industries	0.25	0.00	0.00	-100%	29%	1%	0%

Category		Ni emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2	Manufacturing Industries and Construction	0.25	0.14	0.13	-47%	-4%	1%	5%
1A2a	Iron and Steel	0.08	0.00	0.00	-98%	15%	0%	0%
1A2c	Chemicals	0.01	0.00	0.00	-99%	525%	0%	0%
1A2d	Pulp, Paper and Print	0.01	0.00	0.00	-97%	17%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	0.03	0.00	0.00	-94%	13%	0%	0%
1A2f	Non-metallic Minerals	0.12	0.13	0.12	2%	-5%	1%	4%
1A2g	Manufacturing Ind. and Constr.: Other	0.01	0.01	0.01	21%	8%	0%	0%
1A3	Transport	0.21	0.23	0.25	18%	10%	1%	8%
1A3b	Road Transportation	0.10	0.18	0.20	102%	11%	1%	7%
1A3c	Railways	0.01	0.00	0.00	-84%	3%	0%	0%
1A3d	Navigation	0.11	0.05	0.05	-54%	3%	1%	2%
1A4	Small combustion & other non-road mobile sources and machinery	1.24	0.29	0.29	-76%	1%	7%	10%
1A4a	Commercial/Institutional	0.87	0.12	0.13	-85%	9%	5%	5%
1A4b	Residential	0.15	0.09	0.09	-43%	-10%	1%	3%
1A4c	Agriculture/Forestry/Fishing	0.22	0.07	0.07	-66%	3%	1%	3%
1B	FUGITIVE EMISSIONS FROM FUELS	0.86	0.25	0.22	-75%	-15%	5%	7%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**2.84**	**0.38**	**0.36**	**-87%**	**-4%**	**17%**	**12%**
2A	MINERAL PRODUCTS	0.13	0.14	0.15	14%	8%	1%	5%
2C	METAL PRODUCTION	2.65	0.13	0.12	-96%	-9%	16%	4%
2G	OTHER PRODUCT USE	0.05	0.10	0.09	64%	-14%	0%	3%
3	**AGRICULTURE**	**0.004**	**7E-06**	**1E-06**	**-100%**	**-84%**	**0%**	**0%**
3F	Field burning of agricultural residues	0.004	7E-06	1E-06	-100%	-84%	0%	0%
5	**WASTE**	**7E-05**	**1E-04**	**1E-04**	**92%**	**-6%**	**0%**	**0%**
	NATIONAL TOTAL	**17.05**	**2.62**	**2.91**	**-83%**	**11%**	**100%**	**100%**

2.9.5. Selenium (Se)

Selenium emissions in 2022 amounted to 0.4 t (Figure and Table 2.9.5-1) and decreased by 14% compared to 1990 and increased by 5% compared to the previous year. The dominant sector in the emission of Se is the sector Production processes and product use with a 63% contribution to the total emission in 2022 and 48% in 1990. It contributes to the total emission of Se with the dominance of the glass production activity (2.A.3) due to the content of Se in the raw material. The key sector in 2022 was also the energy sector with key categories 1.A.2.f non-metallic minerals (contribution 14.8% to the total emission) and 1.A.4.b.i residential (5.4% contribution to the total emission).

The dominant sector in the emission sector is the Industrial processes and product use sector. This sector contributes 64% in 2021, while in 1990 it contributes 48 % to total Se emission, with the dominance of the glass production activity (2.A.3) due to the content of Se in the raw material. In 2022, 18% of Se emissions come from fuel combustion in Manufacturing industry and construction (1.A.2.f) and 6.2% from Energy industries (1.A.1).

The reduction in Se emission in 1991 was a consequence of the war for Croatian independence (1991 – 1995). During the war, fossil fuel consumption declined as a result. After a period of stagnation, since 2001 there has been an upward trend in the emission of Se from production, which, with certain oscillations, has continued.

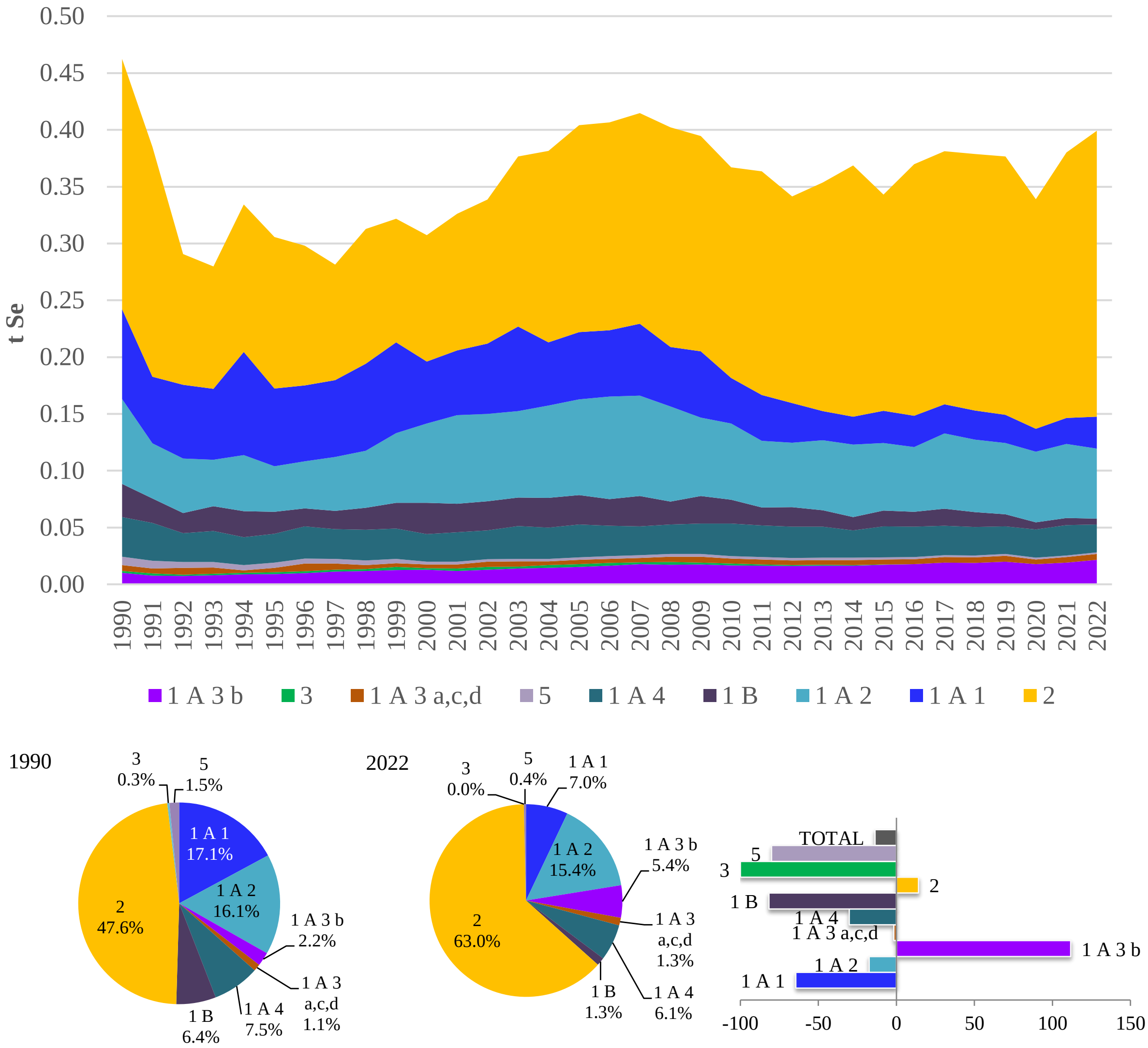


Figure 2.9.5-1 The Se emissions (t/yr.) and percentage share by sector and variation in Se emissions

Table 2.9.5-1 The Se emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Se emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**0.23**	**0.14**	**0.15**	**-37%**	**1%**	**50%**	**37%**
1A	FUEL COMBUSTION	0.20	0.14	0.14	-31%	1%	44%	35%
1A1	Energy Industries	0.08	0.02	0.03	-64%	23%	17%	7%
1A1a	Public electricity and heat production	0.04	0.02	0.02	-46%	16%	8%	5%
1A1b	Petroleum refining	0.04	0.01	0.01	-81%	44%	9%	2%

Category		Se emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2	Manufacturing Industries and Construction	0.07	0.07	0.06	-18%	-6%	16%	15%
1A2a	Iron and Steel	0.01	0.00	0.00	-97%	14%	2%	0%
1A2f	Non-metallic Minerals	0.05	0.06	0.06	10%	-6%	12%	15%
1A3	Transport	0.02	0.02	0.03	74%	11%	3%	7%
1A3b	Road Transportation	0.01	0.02	0.02	112%	14%	2%	5%
1A4	Small combustion & other non-road mobile sources and machinery	0.03	0.03	0.02	-30%	-9%	8%	6%
1A4b	Residential	0.03	0.02	0.02	-29%	-9%	7%	5%
1B	FUGITIVE EMISSIONS FROM FUELS	0.03	0.01	0.01	-82%	-13%	6%	1%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.22**	**0.23**	**0.25**	**14%**	**8%**	**48%**	**63%**
2A	MINERAL PRODUCTS	0.22	0.23	0.25	14%	8%	48%	63%
3	**AGRICULTURE**	**0.002**	**3E-06**	**4E-07**	**-100%**	**-84%**	**0%**	**0%**
3F	Field burning of agricultural residues	0.002	3E-06	4E-07	-100%	-84%	0%	0%
5	**WASTE**	**0.01**	**0.001**	**0.001**	**-80%**	**-3%**	**2%**	**0%**
	NATIONAL TOTAL	**0.46**	**0.38**	**0.40**	**-14%**	**5%**	**100%**	**100%**

2.9.6. Zinc (Zn)

Zinc is mostly emitted as a result of biomass combustion in residential sector, due to its content in wood.

The emission of zinc in 2022 amounted to 37.6 t (figure and table 2.9.6-1) and decreased by 8% compared to 1990 and 3% compared to the previous year. A significant source of Zn emissions in Croatia is fuel combustion in the Energy sector (95% contribution to the total national emissions in 2022 and 88% in 1990). The key categories in 2022 were 1.A.4.b.i households (57.3% contribution to total emissions) and 1.A.3.b.vi road transport - tire and brake wear (23% contribution to total emissions).

The historical trend of Zn emissions is slightly declining, partly as a result of the cessation of steel production at the Siemens Martin furnace plant in 1992. This emission of Zinc comes from its content in the raw material for the Siemens Martin furnace. The cessation of this process in Sisak in 1992 was a consequence of the war for Croatian independence (1991 – 1995). The trend of Zn emission predominantly follows the trend of biomass combustion in the small residential appliances (Figure 3.5-2), and as a result of its content in that fuel. In addition to the above, reductions in emission as a result of climatic factors can be seen in the years 1994, 2000, 2002 and 2014, when due to warmer winters, the consumption of firewood in households was lower (Figure 3.5-3). In recent years, road transport has contributed the most to the increase in emissions - the tires and brakes wear, due to the increase in the number of vehicles and kilometers travelled.

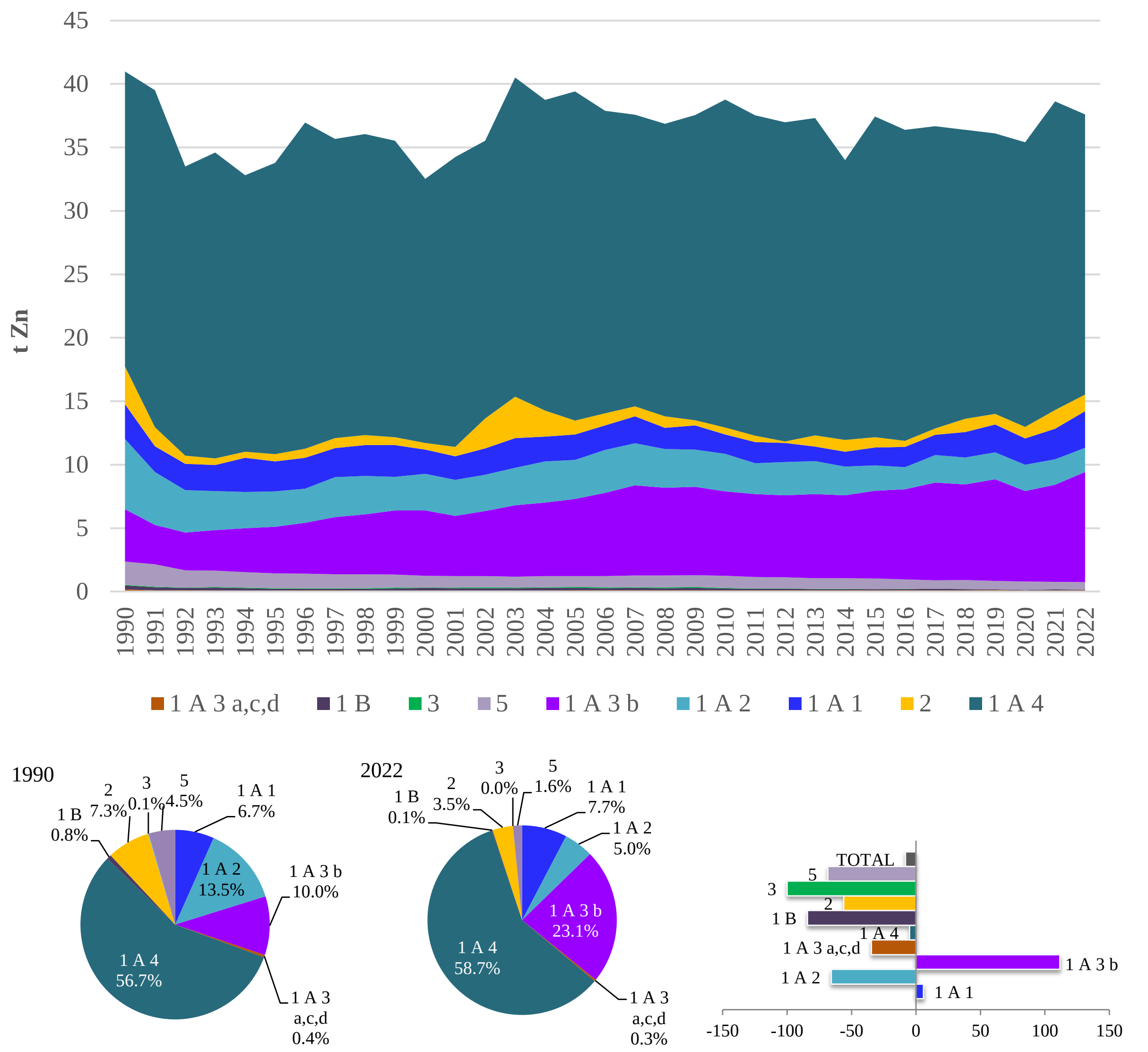


Figure 2.9.6-1 The Zn emissions (t/yr.) and percentage share by sector and variation in Zn emissions

Table 2.9.6-1 The Zn emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		Zn emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**36.09**	**36.54**	**35.70**	**-1%**	**-2%**	**88%**	**95%**
1A	FUEL COMBUSTION	35.77	36.49	35.65	0%	-2%	87%	95%
1A1	Energy Industries	2.73	2.40	2.89	6%	21%	7%	8%
1A1a	Public electricity and heat production	0.85	2.16	2.55	199%	18%	2%	7%
1A1b	Petroleum refining	1.83	0.23	0.33	-82%	44%	4%	1%
1A1c	Manufacture of solid fuels and other energy industries	0.05	0.00	0.00	-91%	29%	0%	0%
1A2	Manufacturing Industries and Construction	5.54	2.01	1.90	-66%	-6%	14%	5%
1A2a	Iron and Steel	1.24	0.03	0.03	-98%	11%	3%	0%
1A2c	Chemicals	0.32	0.00	0.00	-98%	18%	1%	0%

Category		Zn emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2d	Pulp, Paper and Print	0.21	0.05	0.06	-71%	19%	1%	0%
1A2e	Food Processing, Beverages and Tobacco	0.55	0.22	0.21	-62%	-5%	1%	1%
1A2f	Non-metallic Minerals	3.11	1.59	1.46	-53%	-8%	8%	4%
1A2g	Manufacturing Ind. and Constr.: Other	0.10	0.12	0.13	21%	8%	0%	0%
1A3	Transport	4.27	7.77	8.79	106%	13%	10%	23%
1A3a	Civil Aviation	0.04	0.04	0.04	-2%	-2%	0%	0%
1A3b	Road Transportation	4.10	7.66	8.68	112%	13%	10%	23%
1A3c	Railways	0.08	0.01	0.01	-82%	3%	0%	0%
1A3d	Navigation	0.05	0.06	0.06	18%	3%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	23.23	24.31	22.08	-5%	-9%	57%	59%
1A4a	Commercial/Institutional	0.30	0.31	0.32	5%	2%	1%	1%
1A4b	Residential	22.69	23.81	21.56	-5%	-9%	55%	57%
1A4c	Agriculture/Forestry/Fishing	0.24	0.19	0.20	-17%	3%	1%	1%
1B	FUGITIVE EMISSIONS FROM FUELS	0.31	0.06	0.05	-84%	-14%	1%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**3.00**	**1.49**	**1.32**	**-56%**	**-12%**	**7%**	**4%**
2A	MINERAL PRODUCTS	0.10	0.11	0.12	14%	8%	0%	0%
2C	METAL PRODUCTION	2.68	0.67	0.61	-77%	-9%	7%	2%
2G	OTHER PRODUCT USE	0.22	0.72	0.59	173%	-17%	1%	2%
3	**AGRICULTURE**	**0.04**	**7E-05**	**1E-05**	**-100%**	**-84%**	**0%**	**0%**
3F	Field burning of agricultural residues	0.04	7E-05	1E-05	-100%	-84%	0%	0%
5	**WASTE**	**1.85**	**0.60**	**0.59**	**-68%**	**-2%**	**5%**	**2%**
	NATIONAL TOTAL	**40.99**	**38.63**	**37.61**	**-8%**	**-3%**	**100%**	**100%**

2.10. Persistent organic pollutants (POPs)

Persistent organic pollutants (POPs) are organic substances with toxic properties, resistant to chemical, photochemical, and biochemical degradation. They can accumulate in the fatty tissues of living organisms and are toxic to humans and wildlife. They also remain stable in the environment for a long period of time and can distribute easily through air, water and across the national border and can be deposited far from their place of their release.

With the aim for POPs emissions reductions, the Executive Body adopted the Protocol on Persistent Organic Pollutants on June 1998 in Aarhus (Denmark) in the framework of LRTAP Convention for urgent global actions to control, reduce and eliminate emissions of these chemicals. Annual reduction of POPs (polycyclic aromatic hydrocarbons (PAHs), Dioxins/furans, and hexachlorocyclohexane) emissions from a specified reference year achieved by taking appropriate effective measures is one of the Protocols basic obligation for countries that are Parties to the Protocol. Each Party should develop and maintain emission inventories for these substances.

In 1996, the Republic of Croatia has started to calculate estimate the POPs emissions in accordance with EMEP/CORINAIR methodology, officially adopted by the Executive Body of the LARTAP Convention. Persistent organic pollutants are divided into three groups: industrial chemicals, polycyclic aromatic hydrocarbons and dioxins and furans (Table 2.10-1). Reporting for HCH – Hexachlorocyclohexane (Lindan) emissions is excluded from the obligation to report since 2015.

Table 2.10-1 Persistent organic pollutants (POPs)

Group	POPs
Dioxins and furans (PCDD/PCDF)	PCDD – polychlorinated dibenzo-dioxins
	PCDF – polychlorinated dibenzo-furans
Polycyclic aromatic hydrocarbons (PAHs)	Benzo(a) pyrene
	Benzo(b) fluoranthene
	Benzo(k) fluoranthene
	Indeno(1,2,3-cd) pyrene
Industrial chemicals or by-product of the chemical synthesis	HCB – Hexachlorobenzene
	PCBs – Polychlorinated biphenyls

National total emissions and trends (1990–2022) for POPs is presented in Table 2.10-2.

Table 2.10-2 National total emissions and trends (1990–2022) for persistent organic pollutants

Year	Emission			
	PCDD/PCDF	PAHs	HCB	PCBs
	g I-TEQ	kt	kg	kg
Trend 1990-2022	**-70.1%**	**-42.9%**	**-95.5%**	**-35.1%**
1990	83.77	23.35	7.09	4.98
1991	94.25	22.86	6.52	3.00
1992	67.86	18.29	8.05	2.43
1993	74.25	18.92	8.26	1.93
1994	71.22	17.09	8.91	1.20
1995	73.51	17.62	6.43	1.32
1996	80.32	19.38	5.81	1.05
1997	83.57	18.01	5.16	1.87
1998	79.86	18.06	5.42	1.87
1999	104.08	17.69	4.81	1.58
2000	71.44	15.73	1.99	3.31
2001	90.70	16.99	2.06	3.50
2002	96.10	16.41	1.36	4.22
2003	80.64	18.55	0.99	4.41
2004	99.49	18.43	0.84	4.22
2005	110.22	19.45	0.45	4.50
2006	98.21	17.88	0.43	4.33
2007	75.82	17.05	0.43	4.56
2008	95.91	17.02	0.42	4.76
2009	80.93	17.33	0.43	3.27
2010	80.01	18.38	0.85	4.69
2011	65.60	17.46	0.85	4.88
2012	52.62	17.05	0.85	4.14
2013	53.04	16.85	0.85	4.80
2014	42.90	14.67	0.62	4.76
2015	37.74	16.34	0.43	4.51
2016	30.41	15.62	0.47	4.60
2017	28.62	15.02	0.46	2.81

Year	Emission			
	PCDD/PCDF	PAHs	HCB	PCBs
	g I-TEQ	kt	kg	kg
2018	27.21	14.25	0.55	2.97
2019	26.09	13.74	0.60	3.19
2020	25.49	13.67	0.36	2.37
2021	27.37	14.67	0.33	3.13
2022	25.01	13.33	0.32	3.24

2.10.1. Dioxin and furans (PCDD/PCDF)

Dioxins and furans are persistent organic compounds that occur as a product of combustion of organic matter that contains chlorine (Cl) at temperatures between 250°C and 400°C and can occur in all sectors.

In 2022, the emission of dioxins and furans amounted to 25 g of I-TEQ (figure and table 2.10.1-1). The emission decreased by 70.1% compared to 1990 and 9% compared to the previous year. The dominant sector in the emission of dioxins and furans in 2022 was the energy sector, in 1990, in addition to the energy sector, the agriculture sector was also a key sector. The key source of dioxin and furan emissions in 2022 is category 1.A.4.b.i residential with a contribution of 82.7% to the total national emission.

In the historical trend in the agricultural sector, the key category was 3.F field burning of agricultural residues (with a contribution of 47.7% to the total national emission). For fluctuations in the historic trend, responsible activity is burning of agricultural residues. The peaks in the years 1991, 1999, 2002, 2005, and 2008 and the emission declines after, were caused by changes in the areas under maize whose harvest residues are burned, and changes in the maize yield. In the years in which emissions peaks are expressed, peaks in production and average yield of maize (t/ha) are also expressed, and for all years except 1991 and 2008, peaks are also expressed in areas under maize that are burned. In the period 2008 – 2011, the reason for reducing emission is the decline in production and average yield of maize, and after 2011, the reason is reducing the burning of agricultural residues due to education of farmers and their punishment (i.e. reduction of State aid per unit of agricultural area). Category 1A.4.b.i residential also contributes to the appearance of the emission trend path. The decrease in emissions until 1995 was caused by the reduced consumption of energy sources (biomass and coal), which in turn was caused by the war for Croatian independence (1991-1995). Furthermore, the emission reductions of this category in the years 1994, 2000, 2002, 2014 and 2022 were caused by climatic conditions, when due to warmer winters the consumption of firewood in residential was lower (Figure 3.5-3). Also, the declining trend in this sector since 2005 is the result of the gradual inclusion of low-emission biomass combustion techniques (gradual replacement of traditional domestic stoves and manual single house boilers with advanced/ecolabelled stoves and boilers, high efficiency stoves and boilers and pellet stoves and boilers) (see Table 3.5-1 and Figure 3.5-2).

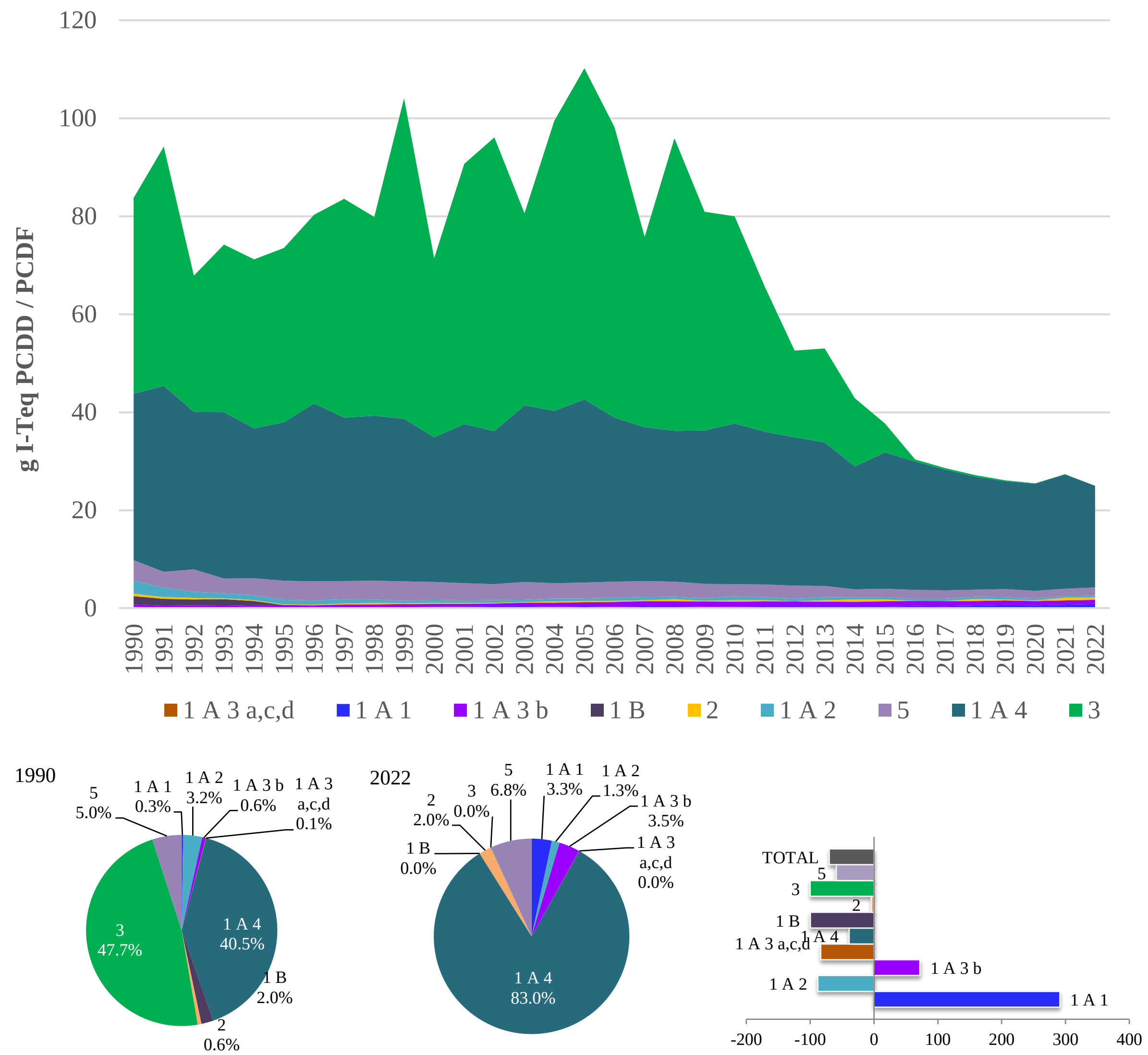


Figure 2.10.1-1 The PCDD/PCDF emissions (g I-TEQ/yr.) and percentage share by sector and variation in PCDD/PCDF emission

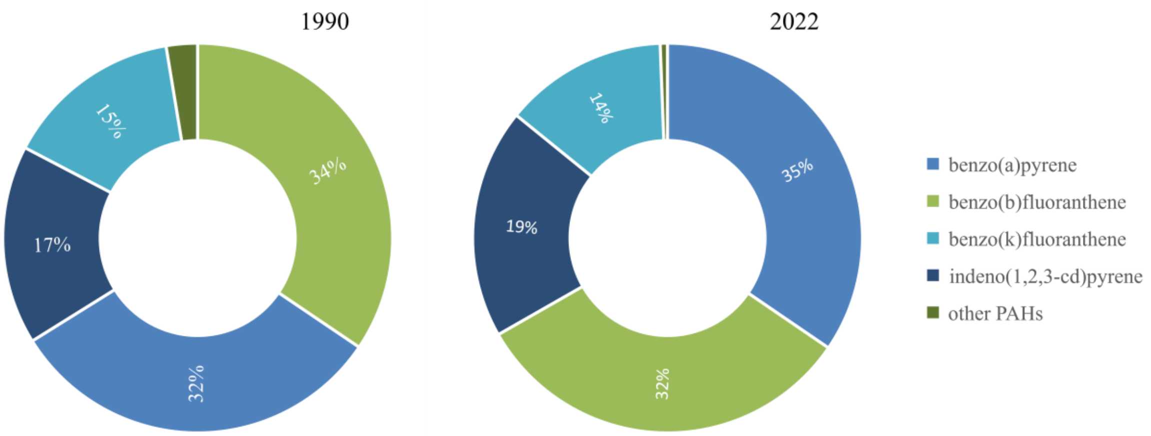
Table 2.10.1-1 The PCDD/PCDF emissions per NFR Category 19902021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		PCDD/PCDF emission in g I-TEQ			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**39.10**	**25.23**	**22.78**	**-42%**	**-10%**	**47%**	**91%**
1A	FUEL COMBUSTION	37.41	25.22	22.78	-39%	-10%	45%	91%
1A1	Energy Industries	0.21	0.72	0.83	291%	16%	0%	3%
1A1a	Public electricity and heat production	0.15	0.71	0.82	433%	16%	0%	3%
1A1b	Petroleum refining	0.04	0.01	0.01	-79%	29%	0%	0%
1A1c	Manufacture of solid fuels and other energy industries	0.02	0.00	0.00	-85%	29%	0%	0%
1A2	Manufacturing Industries and Construction	2.69	0.31	0.32	-88%	3%	3%	1%
1A2a	Iron and Steel	1.20	0.02	0.03	-98%	15%	1%	0%
1A2c	Chemicals	0.22	0.00	0.00	-99%	137%	0%	0%

Category		PCDD/PCDF emission in g I-TEQ			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2d	Pulp, Paper and Print	0.16	0.01	0.01	-92%	17%	0%	0%
1A2e	Food Processing, Beverages and Tobacco	0.44	0.05	0.05	-88%	1%	1%	0%
1A2f	Non-metallic Minerals	0.68	0.23	0.23	-66%	1%	1%	1%
1A3	Transport	0.56	0.87	0.88	57%	1%	1%	4%
1A3b	Road Transportation	0.50	0.86	0.87	72%	1%	1%	3%
1A3c	Railways	0.05	0.00	0.00	-98%	3%	0%	0%
1A3d	Navigation	0.01	0.01	0.01	4%	3%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	33.95	23.32	20.74	-39%	-11%	41%	83%
1A4a	Commercial/Institutional	0.21	0.06	0.06	-70%	1%	0%	0%
1A4b	Residential	33.73	23.26	20.68	-39%	-11%	40%	83%
1A4c	Agriculture/Forestry/Fishing	0.01	0.00	0.00	-84%	-6%	0%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	1.69	0.01	0.01	-100%	-15%	2%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.53**	**0.56**	**0.51**	**-4%**	**-9%**	**1%**	**2%**
2C	METAL PRODUCTION	0.53	0.56	0.51	-4%	-9%	1%	2%
3	**AGRICULTURE**	**39.97**	**0.06**	**0.01**	**-100%**	**-84%**	**48%**	**0%**
3F	Field burning of agricultural residues	39.97	0.06	0.01	-100%	-84%	48%	0%
5	**WASTE**	**4.16**	**1.52**	**1.71**	**-59%**	**12%**	**5%**	**7%**
	NATIONAL TOTAL	**83.77**	**27.37**	**25.01**	**-70%**	**-9%**	**100%**	**100%**

2.10.2. Polycyclic aromatic hydrocarbons (PAHs)

There are more than 100 of different polycyclic aromatic hydrocarbons, and annual emissions are estimated and reported (NFR19 tables) for four of them, as follows: benzo (a) pyrene, benzo (b) fluoranthene, benzo (k) fluoranthene, indeno (1,2,3-cd) pyrene along with total PAHs emission. The four PAHs are those defined by the Aarhus protocol. Benzo (a) pyrene (32% in 1990 and 35% in 2022) and benzo (b) fluoranthene (34% in 1990 and 32% in 2022) contribute the most to the total PAHs emission in the entire historical period, and indeno (1,2,3-cd) pyrene (17% in 1990 and 19% in 2022) at least. Emission of PAHs by sectors is presented in Figure 2.10.2-1. Emission of total PAHs by sources is shown in Figure 2.10.2-2 and Table 2.10.2-1.



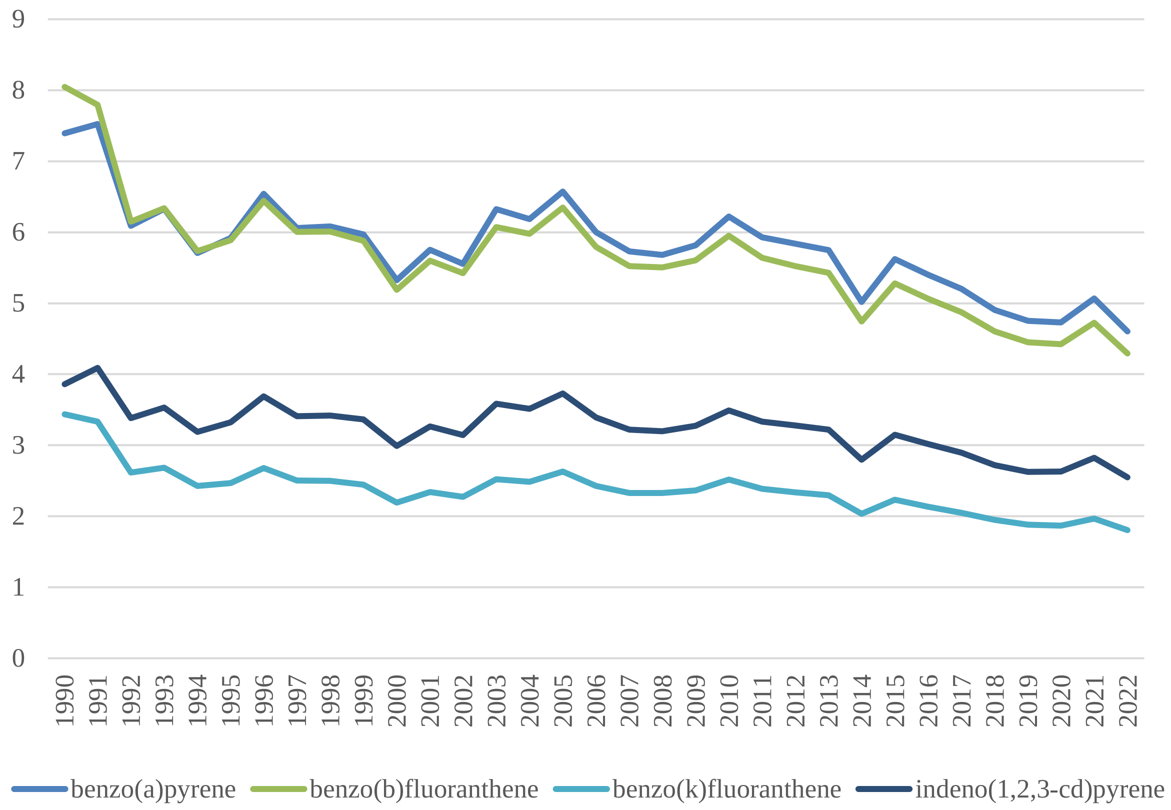


Figure 2.10.2-1 The 4 PAHs emissions (t/yr.) and percentage share in total PAHs emissions

PAH emissions amounted to 13.3 t in 2022 and decreased by 43% compared to 1990 and by 9% compared to the previous year. The key source of PAH emission in 2022 is the energy sector and the key category is 1.A.4.b.i residential with a contribution of 90.8% to the total national emission, and as a result of their content in firewood, biomass. This category is the key source of emissions in the historical trend for all four PAHs. The key sector of PAH emission in 1990 was also the waste sector with key category 5.C.2 open burning of waste with a contribution of 5.7% to the total emission in 1990.

The reduction in emissions in 1991 and 1992 was due to a reduction in coal consumption in the Residential sector and due to the cessation of aluminium production process (with Söderberg anodes) in Šibenik in 1992, iron production (blast furnace filling) in Sisak and Split in 1992 and coke production in Bakar in 1994. All the above happened as a result of the war for Croatian independence (1991 – 1995). There is also a slight downward trend since 2005 as a result of the inclusion of biomass combustion techniques with low emissions in residential appliances. In addition to the above, reductions in emissions as a result of climatic factors can be seen in the years 1994, 2000, 2002, 2014 and 2022, when due to warmer winters, the consumption of firewood in residential was lower (Figure 3.5-3).

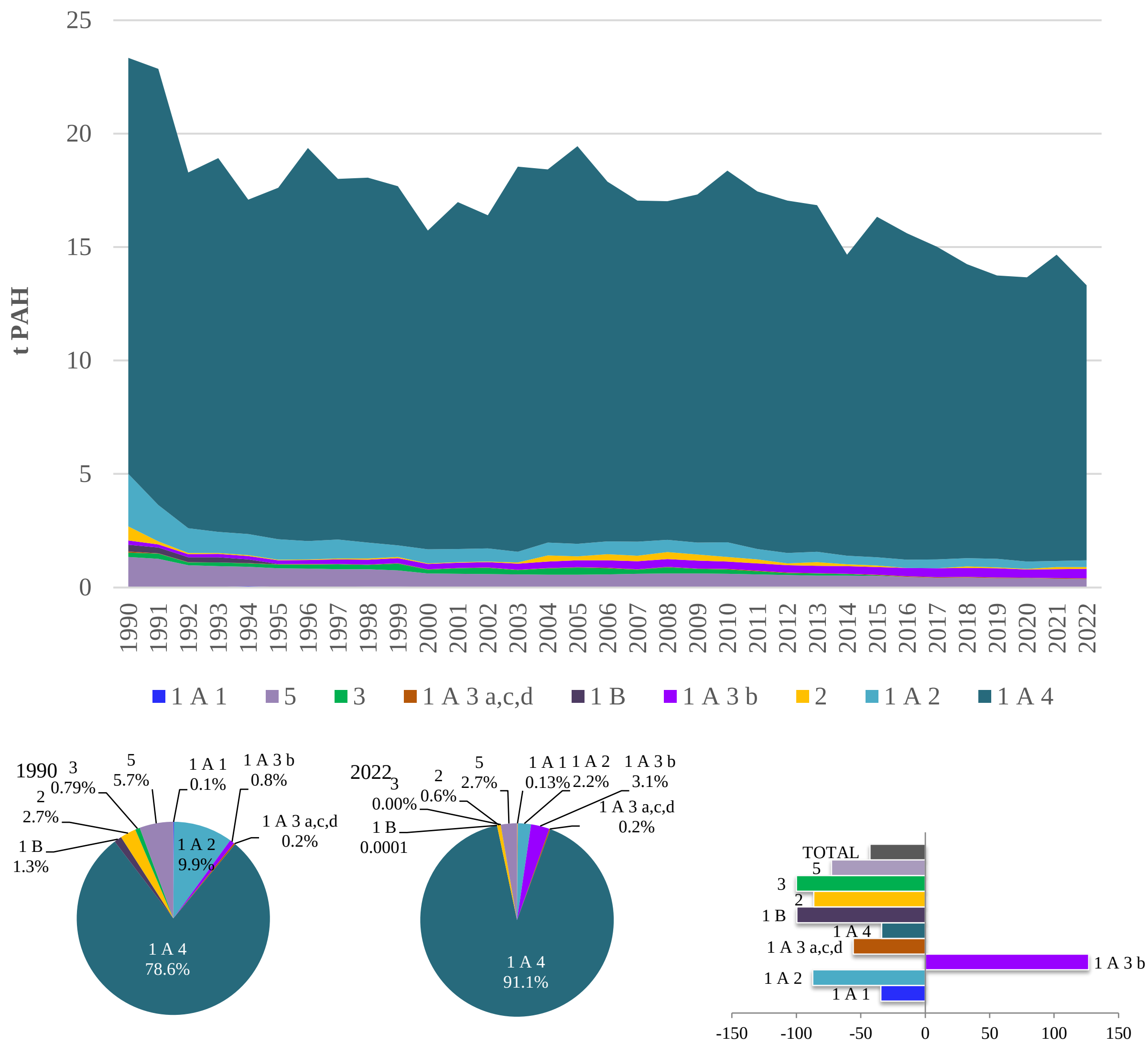


Figure 2.10.2-1 The PAHs emissions (t/yr.), percentage share by sector and variation in PAHs emissions

Table 2.10.2-1 The PAHs emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		PAHs emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**21.22**	**14.21**	**12.88**	**-39%**	**-9%**	**91%**	**97%**
1A	FUEL COMBUSTION	20.92	14.21	12.88	-38%	-9%	90%	97%
1A1	Energy Industries	0.03	0.01	0.02	-34%	23%	0%	0%
1A1a	Public electricity and heat production	0.03	0.01	0.02	-34%	23%	0%	0%
1A2	Manufacturing Industries and Construction	2.32	0.27	0.29	-87%	8%	10%	2%
1A2a	Iron and Steel	0.94	0.02	0.03	-97%	13%	4%	0%
1A2b	Non-ferrous Metals	0.00	0.00	0.00	-10%	4%	0%	0%
1A2c	Chemicals	0.26	0.01	0.01	-97%	-39%	1%	0%
1A2d	Pulp, Paper and Print	0.14	0.02	0.02	-88%	2%	1%	0%
1A2e	Food Processing, Beverages and Tobacco	0.42	0.05	0.06	-85%	23%	2%	0%

Category		PAHs emission in t			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2f	Non-metallic Minerals	0.55	0.16	0.17	-69%	5%	2%	1%
1A2g	Manufacturing Ind. and Constr.: Other	0.01	0.01	0.01	21%	8%	0%	0%
1A3	Transport	0.24	0.42	0.44	83%	4%	1%	3%
1A3a	Civil Aviation	0.02	0.02	0.02	6%	-1%	0%	0%
1A3b	Road Transportation	0.18	0.39	0.41	127%	5%	1%	3%
1A3c	Railways	0.03	0.00	0.00	-97%	3%	0%	0%
1A4	Small combustion & other non-road mobile sources and machinery	18.34	13.51	12.14	-34%	-10%	79%	91%
1A4a	Commercial/Institutional	0.13	0.02	0.02	-85%	3%	1%	0%
1A4b	Residential	18.19	13.47	12.10	-33%	-10%	78%	91%
1A4c	Agriculture/Forestry/Fishing	0.02	0.01	0.01	-9%	3%	0%	0%
1B	FUGITIVE EMISSIONS FROM FUELS	0.30	0.001	0.001	-100%	-15%	1%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.62**	**0.09**	**0.08**	**-87%**	**-9%**	**3%**	**1%**
2C	METAL PRODUCTION	0.62	0.09	0.08	-87%	-9%	3%	1%
3	**AGRICULTURE**	**0.18**	**3E-04**	**5E-05**	**-100%**	**-84%**	**1%**	**0%**
3F	Field burning of agricultural residues	0.18	3E-04	5E-05	-100%	-84%	1%	0%
5	**WASTE**	**1.32**	**0.367**	**0.359**	**-73%**	**-2%**	**6%**	**3%**
	NATIONAL TOTAL	**23.35**	**14.67**	**13.33**	**-43%**	**-9%**	**100%**	**100%**

2.10.3. Hexachlorobenzene (HCB)

Hexachlorobenzene (HCB) is an industrial chemical but is also an integral part of solid fossil fuels and biomass. HCB emission from the use of pesticides in agriculture and forestry originates from the presence of HCB as a contaminant. According to the Pesticide Leaching Model (PELMO 3.31; Ferrari et al., 2005), all the HCB present as a contaminant will be volatilised. In addition to the use of pesticides, HCB emission occurs from biomass and solid fuel combustion and in minor extent from waste incineration, if it exists in the county.

HCB emissions in 2022 amounted to 0.32 kg (figure and table 2.10.3-1). Compared to 1990, HCB emissions have decreased by 95% due to a reduction in pesticide use in the agricultural sector, which is the key source of HCB emissions in the historical trend (96% contribution to national emissions in 1990). Compared to the previous year, emissions decreased by 4%. The key sector in HCB emission in 2022 was the energy sector and two key categories: 1.A.4.b.i residential (65.5% contribution to the total emission) and 1.A.1.a public electricity and heat production (contribution of 23.4% to the total national emission). Combustion of biomass in the category 1.A.1.a has been growing since 2011 with a growing impact on HCB emissions, due to the increase in the use of biomass in the production of energy and heat. The only key sector in HCB emission in 1990 was the agricultural sector and category 3.D.f use of pesticides (96% contribution to the total national emission in 1990).

The high level of HCB emission in the period 1990 - 2002 is the result of the use of pesticides with a high level of HCB impurities in the active substances, which have recently been banned for use. In the historical trend, the Republic of Croatia reports HCB emissions from the active substances of the following pesticides: Lindane, Atrazine, Simazine, Picloram, Chlortalonil and Propazin. The key source of HCB emission in the 1990s is the NFR category 3.D.f Use of pesticides in agriculture and forest, and in recent years HCB emission has been dominated by biomass combustion in residential appliances and in public heating plants, and pesticide use.

The Republic of Croatia has the obligation toward the Protocol on POPs to keep the overall HCB emission beyond the value in base year 1990. In 2021, this obligation was fulfilled, and in recent years the HCB emissions have been dominated by the burning of biomass in residential and in public heating plants.

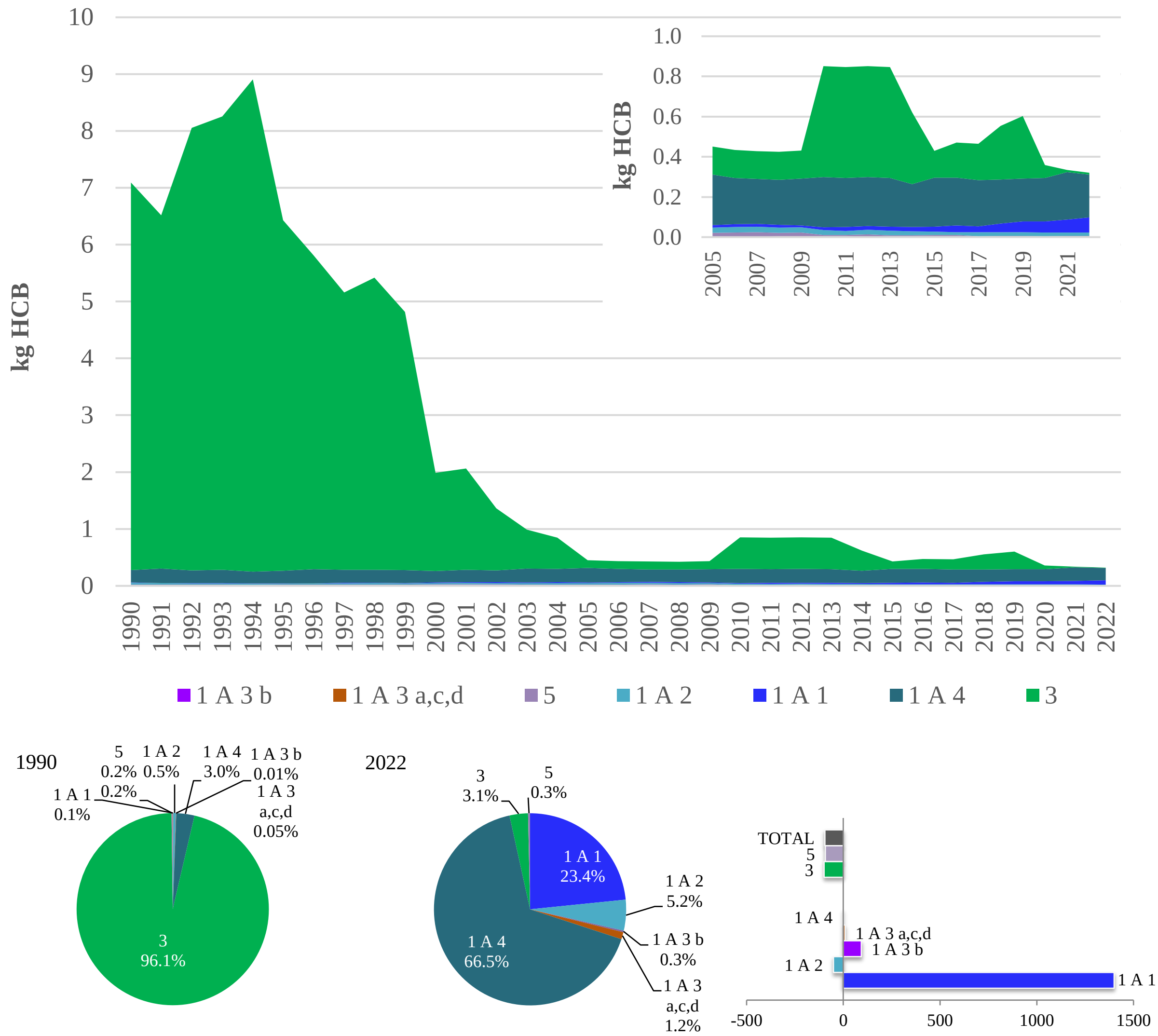


Figure 2.10.3-1 The HCB emission (kg/yr.), percentage share by sector and variation in HCB emissions

Table 2.10.3-1 The HCB emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		HCB emission in kg			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**0.26**	**0.32**	**0.31**	**20%**	**-4%**	**4%**	**97%**
1A	FUEL COMBUSTION	0.26	0.32	0.31	20%	-4%	4%	97%
1A1	Energy Industries	0.01	0.06	0.08	1400%	17%	0%	23%
1A1a	Public electricity and heat production	0.00	0.06	0.08	1404%	17%	0%	23%

Category		HCB emission in kg			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A2	Manufacturing Industries and Construction	0.03	0.02	0.02	-51%	-8%	0%	5%
1A2f	Non-metallic Minerals	0.03	0.02	0.01	-48%	-9%	0%	4%
1A3	Transport	0.004	0.005	0.005	19%	3%	0%	1%
1A4	Small combustion	0.22	0.24	0.21	-1%	-9%	3%	67%
1A4b	Residential	0.21	0.23	0.21	-2%	-9%	3%	66%
3	**AGRICULTURE**	**6.82**	**0.011**	**0.010**	**-100%**	**-10%**	**96%**	**3%**
3D	AGRICULTURAL SOILS	6.82	0.011	0.010	-100%	-10%	96%	3%
3Df	Use of pesticides	6.82	0.011	0.010	-100%	-10%	96%	3%
5	**WASTE**	**0.01**	**0.001**	**0.001**	**-93%**	**-6%**	**0%**	**0%**
	NATIONAL TOTAL	**7.09**	**0.33**	**0.32**	**-95%**	**-4%**	**100%**	**100%**

2.10.4. Polychlorinated biphenyls (PCBs)

In this and previous inventory Croatia reports the emissions of category 2.K Consumption of POPs and heavy metals with the notation key "NE", with a detailed explanation in IIR2023.

Polychlorinated biphenyls (PCBs) are industrial chemicals.

PCB emissions in 2022 amounted to 3.2 kg (figure and table 2.10.4-1). Compared to 1990, PCB emissions decreased by 35% and increased by 3% compared to the previous year. The key sources of emissions in 2022 were the energy sector with key category 1.A.1.a public electricity and heat production (contribution of 74.3% to the total national emission) and the sector of industrial processes with key category 2.C.1 iron and steel production (contribution of 13.1% to the total emission), and the key activity is steel production with electric arc furnaces.

Three categories have the greatest influence on the reduction of PCB emissions in the historical trend: 1A2 industry and construction (recording a reduction of 81%) with the dominance of the iron and steel category (1.A.2.a), category 1A4 small combustion and working machinery (recording a reduction of 99%) with the dominance of residential (1.A.4.b.i) and metal production (records a decrease of 50%) due to the stoppage of pig iron steel production (2.C.1). In the historical period, an increase in the dominance of category 1.A.1 can be observed, especially since 2000, when the second coal-fired thermal power plant entered production, and since 2017, the dominance has decreased due to the shutdown of the first coal-fired thermal power plant.

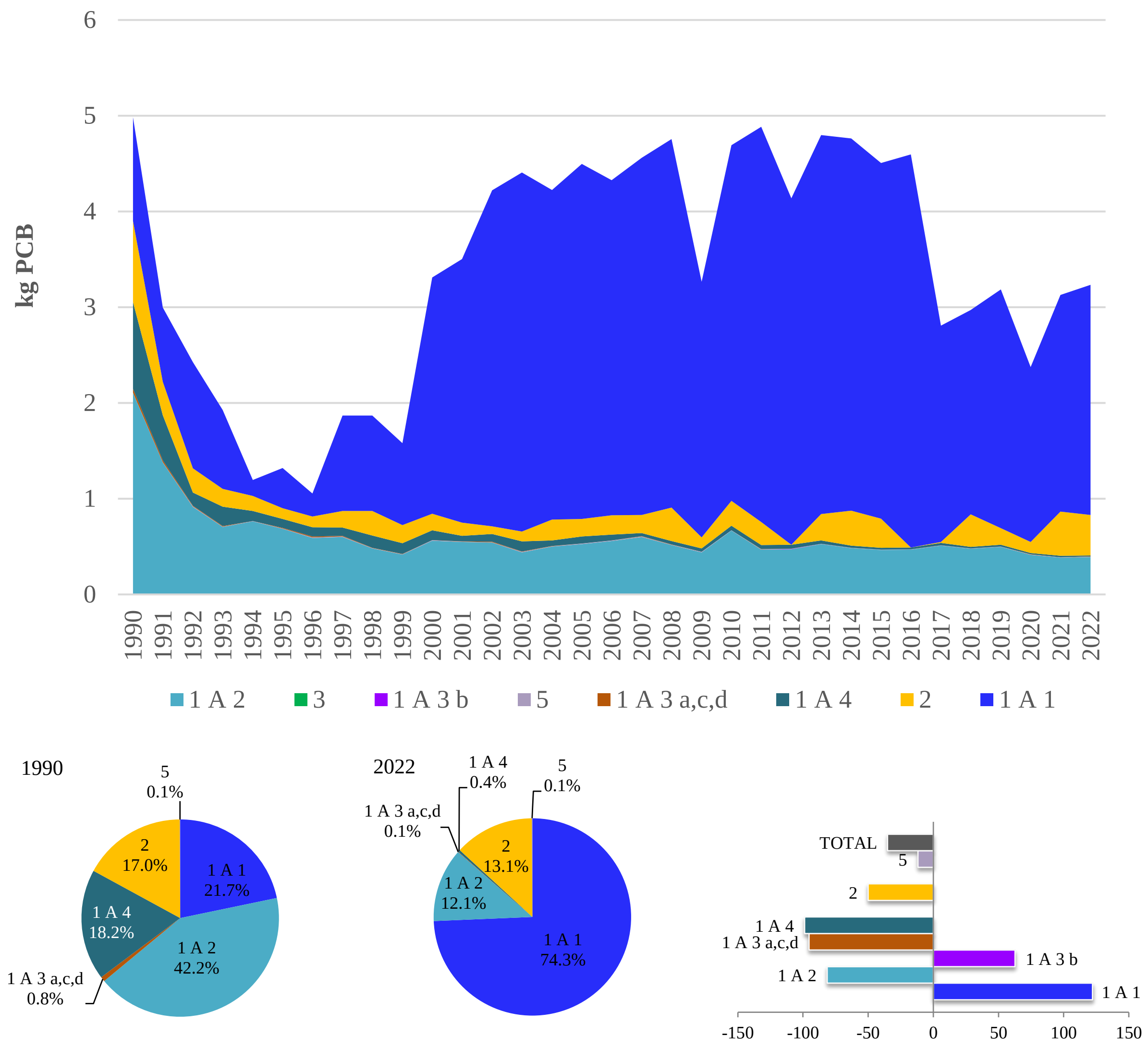


Figure 2.10.4-1 The PCBs emission (kg/yr.), percentage share by sector and variation in PCBs emissions

Table 2.10.4-1 The PCBs emissions per NFR Category 1990, 2021 and 2022, trend changes 1990–2022, 2021-2022 and share in total emissions

Category		PCBs emission in kg			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1	**ENERGY**	**4.13**	**2.66**	**2.81**	**-32%**	**6%**	**83%**	**87%**
1A	FUEL COMBUSTION	4.13	2.66	2.81	-32%	6%	83%	87%
1A1	Energy Industries	1.08	2.26	2.41	122%	6%	22%	74%
1A1a	Public electricity and heat production	1.08	2.26	2.41	122%	6%	22%	74%
1A2	Manufacturing Industries and Construction	2.11	0.38	0.39	-81%	2%	42%	12%
1A2a	Iron and Steel	1.00	0.02	0.02	-98%	15%	20%	1%
1A2c	Chemicals	0.18	NE	NE	-	-	4%	-
1A2d	Pulp, Paper and Print	0.12	0.00	0.00	-100%	20%	2%	0%
1A2e	Food Processing, Beverages and Tobacco	0.36	0.01	0.01	-96%	39%	7%	0%
1A2f	Non-metallic Minerals	0.45	0.36	0.36	-21%	0%	9%	11%

Category		PCBs emission in kg			Trend change		Share in National Total	
NFR Code	Description	1990	2021	2022	1990-2022	2021-2022	1990	2022
1A3	Transport	0.04	0.00	0.00	-95%	3%	1%	0%
1A3c	Railways	0.04	NE	NE	-	-	1%	-
1A4	Small combustion & other non-road mobile sources and machinery	0.91	0.01	0.01	-99%	-22%	18%	0%
1A4a	Commercial/Institutional	0.15	3E-05	3E-05	-100%	3%	3%	0%
1A4b	Residential	0.75	0.01	0.01	-99%	-22%	15%	0%
2	**INDUSTRIAL PROCESSES AND PRODUCT USE**	**0.85**	**0.46**	**0.42**	**-50%**	**-9%**	**17%**	**13%**
2C	METAL PRODUCTION	0.85	0.46	0.42	-50%	-9%	17%	13%
5	**WASTE**	**0.003**	**0.003**	**0.003**	**-12%**	**-6%**	**0%**	**0%**
	NATIONAL TOTAL	**4.98**	**3.13**	**3.24**	**-35%**	**3%**	**100%**	**100%**

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3. Energy (NFR 1)

Sector 1 Energy considers emissions originating from fuel combustion activities (NFR 1.A) and fugitive emissions from fuels (NFR 1.B). Following energy activities are reported in Croatian inventory:

- 1.A.1 Energy Industries
  - 1.A.1.a Public electricity and heat production
  - 1.A.1.b Petroleum refining
  - 1.A.1.c Manufacture of solid fuel and other energy industries
- 1.A.2 Manufacturing industries and construction
  - 1.A.2.a Iron and steel
  - 1.A.2.b Non-ferrous metals
  - 1.A.2.c Chemicals
  - 1.A.2.d Pulp, paper and print
  - 1.A.2.e Food processing, beverages and tobacco
  - 1.A.2.f Non-metallic minerals
  - 1.A.2.g.vii Mobile Combustion in manufacturing industries and construction
- 1.A.3 Transport
  - 1.A.3.a Aviation (civil)
    - 1.A.3.a.i (i) International aviation LTO (civil)
    - 1.A.3.a.ii (i) Domestic aviation LTO (civil)
    - Memo item: 1.A.3.a.i (ii) International aviation cruise (civil)
    - Memo item: 1.A.3.a.ii (ii) Domestic aviation cruise (civil)
  - 1.A.3.b Road transport
    - 1.A.3.b.i Road transport: Passenger cars
    - 1.A.3.b.ii Road transport: Light duty vehicles
    - 1.A.3.b.iii Road transport: Heavy duty vehicles
    - 1.A.3.b.iv Road transport: Mopeds & motorcycles
    - 1.A.3.b.v Road transport: Gasoline evaporation
    - 1.A.3.b.vi Road transport: Automobile automobile tyre and brake wear
    - 1.A.3.b.vii Road transport: Automobile road abrasion
  - 1.A.3.c Railways
  - 1.A.3.d Navigation (shipping)
    - 1.A.3.d.ii National navigation (shipping)
    - 1.A.3.d.i(ii) International inland waterways
    - Memo item: 1.A.3.d.i(i) International maritime navigation
  - 1.A.3.e.i Pipeline transport
- 1.A.4 i Small combustion
  - 1.A.4.a.i Commercial / institutional
  - 1.A.4.b.i Residential
  - 1.A.4.c.i Agriculture/Forestry/Fishing

- 1.A.4 ii Non-road mobile source and machinery
    - 1.A.4.a.ii Commercial / institutional: Mobile
    - 1.A.4.b.ii Residential: Mobile
    - 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
    - 1.A.4.c.iii Agriculture/Forestry/Fishing: National fishing
- 1.A.5 Other (including military)
    - 1.A.5.a Other stationary (including military)
    - 1.A.5.b Other, Mobile (including military, land based and recreational boats)
- 1.B.1 Fugitive emissions from solid fuel
    - 1.B.1.a Coal mining and handling
    - 1.B.1.b Solid fuel transformation
    - 1.B.1.c Other fugitive emissions from solid fuel
- 1.B.2 Fugitive emissions from oil and natural gas
    - 1.B.2.a.i Oil - Exploration, production, transport
    - 1.B.2.b Natural gas - Exploration, production, transport
    - 1.B.2.a.iv Refining, storage
    - 1.B.2.a.v Distribution of oil products
    - 1.B.2.c Venting and flaring
    - 1.B.2.d Other fugitive emissions from energy production

For emissions that occur in sector 1.A.3.d.i(ii) International inland waterways Croatia is using notation key “IE” and those emissions are included in the memo item: 1.A.3.d.i(i) International maritime navigation.

For emissions that occur in sector 1.A.3.e i Pipeline transport Croatia is using notation key “NO”.

For emissions that occur in sector 1.A.4.c.iii Agriculture/Forestry/Fishing: National fishing Croatia is using notation key “IE” and those emissions are included in NFR 1.A.3.d.ii (based on total amount of fuel for national navigation, maritime and river transport).

Emissions that occur in sector 1.A.5.a are included in NFR code 1.A.4.a Combustion in commercial and institutional plants. Emissions that occur in sector 1.A.5.b Other, Mobile (including military, land based and recreational boats) are for military noted as confidential, and for land based and recreational boats are included in NFR codes 1.A.4.a.i and 1.A.3.b (i-iv).

Information on the inclusion / exclusion of the condensing component in the PM_{10} and $PM_{2.5}$ emission factors according to the NFR emission categories is presented in Appendices 2 and 6.

3.1. Fuel combustion (NFR 1.A)

This chapter gives an overview of source categories included the scope of NFR code 1.A Fuel combustion, and their contributions in fuel consumption in Croatia. The overview is given for the non-transport sectors (stationary and non-road mobile sources) and for the transport sectors. Non-transport sector includes following NFR source categories: 1.A.1 Energy Industries, 1.A.2 Manufacturing industries and construction, 1.A.4 Small combustion and Non-road mobile source and machinery. Transport sector includes following NFR source categories: 1.A.3.a Aviation (civil), 1.A.3.b Road transport, 1.A.3.c Railways and 1.A.3.d Navigation (shipping).

In Croatia, the dominance in fuel combustion in 2022 had source category 1.A.4 Small combustion and mobile machinery (Figure 3.1-1), which recorded a decrease in energy consumption of 6.5% compared to 1990 and 7.5 % compared to the previous year. Categories 1.A.1 Energy industries and 1.A.2 Manufacturing industries and construction recorded a significantly greater decrease in energy consumption compared to 1990, 36.2% and 59.2% respectively. Compared to the previous year, category 1.A.1 recorded an increase of 7.1%, while category 1.A.2 recorded a decrease in energy consumption by 5.4%. A large reduction in fuel consumption occurred in 1991, caused by the war for Croatian independence in the period (1991-1995). In recent history, after 2007, fuel consumption began a downward trend due to the economic crisis. After 2014, the fuel consumption trend is slightly increasing. In category 1.A.4, energy consumption in 1.A.4.b.i residential dominates, which mostly depends on climatic conditions.

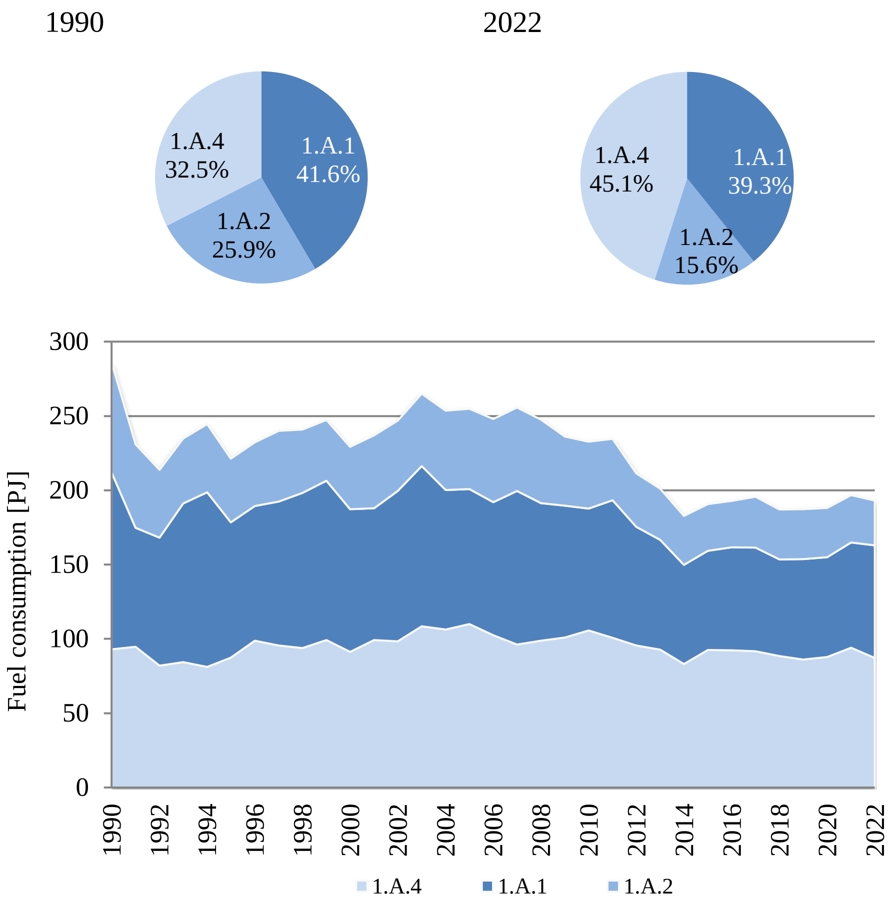


Figure 3.1-1 Activity data on fuel consumption for NFR codes 1.A.1, 1.A.2, 1.A.4

The structure of fuel consumption by type in the Republic of Croatia is shown in Figure 3.1-2.

Overall fuel consumption in NFR categories 1.A.1, 1.A.2 and 1.A.4 decreased by 32.5% in the historical period. The consumption of liquid fuel decreased by 74.5%, solid fuel by 37%, gas by 2.9%, while the consumption of biomass increased by 33.1%, which is mostly the result of an increase in consumption in category 1.A.1, which began to be used in this category in 2010. The consumption of other fuels has been represented in NFR category 1.A.2 since 2007 and its representation is continuously increasing, but the importance of this fuel in the energy structure is still negligible (0.4% of the total consumption of all fuels in 2022 in observed NFR categories).

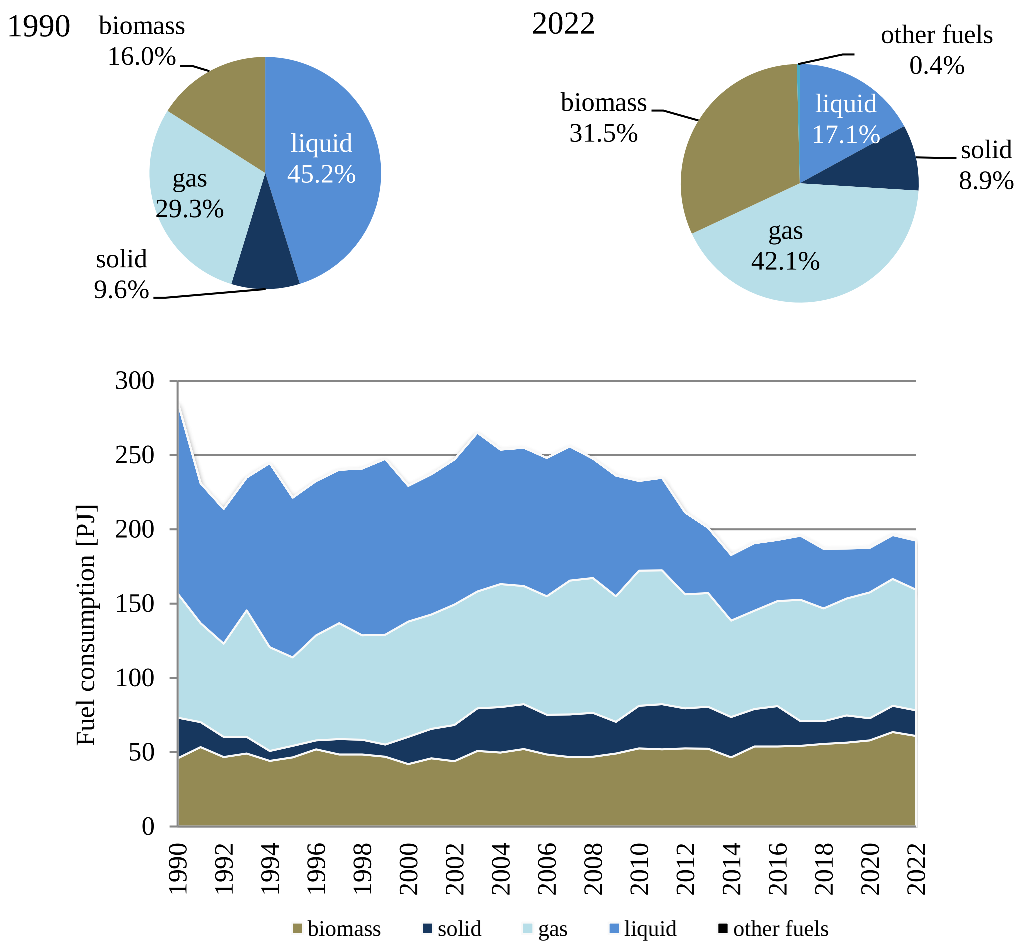


Figure 3.1-2 Activity data on fuel consumption by type for NFR codes 1.A.1, 1.A.2, 1.A.4

Category 1.A.3 transport includes fuel combustion in road transport, civil aviation, railways and navigation. The dominant NFR category in 1.A.3 with regard to fuel consumption in the entire historical period is 1.A.3.b road transport (Figure 3.1-3). Since 1990, road transport has recorded an increase in fuel consumption by 98.3%, aviation (LTO) (1.A.3.a) by 2.7% and navigation by 16.4%. (1.A.3.d), while railway (1.A.3.c) reduced consumption by 65.5%. All types of transport, except for aviation, recorded an increase in fuel consumption in 2022 compared to the previous year, as a result of the increase in the transport of people and goods. The decrease in fuel consumption in aviation (LTO) is the result of lower consumption in international transport, while domestic (LTO) is on the rise compared to the previous year.

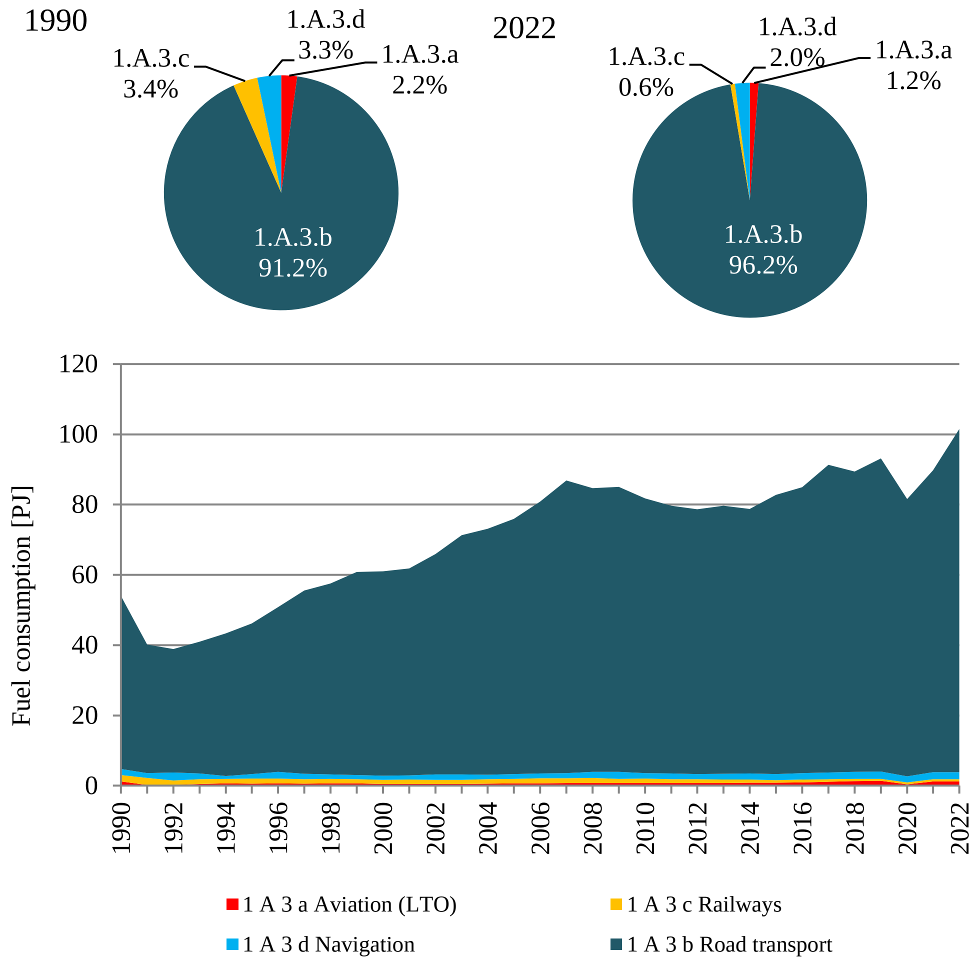


Figure 3.1-3 Consumption and percentage share for fossil fuel by types in 1.A.3 Transport

Key categories for the Energy sector - stationary sources are shown in table 3.1-1, and for Energy - mobile sources in table 3.1-2. Key Category Analysis (KCA) is presented in Section 1.5 and Appendix 1.

Table 3.1-1 Key sources of sector Energy - stationary

NFR Category	NFR Category Name	Key Categories	
		Pollutant	KCA
1A1a	Public electricity and heat production	NOX	L1, T1
		SO2	L1, T1
		PM2.5	L1, T1
		PM10	L1, T1
		TSP	L1, T1
		Cd	T1
		Hg	L1, T1
		As	L1, T1
		Cr	L1, T1
		Cu	T1
		Ni	L1, T1
		Se	T1
		Zn	T1
		HCB	L1

NFR Category	NFR Category Name	Key Categories	
		Pollutant	KCA
		PCBs	L1, T1
1A1b	Petroleum refining	NOX	T1
		SO2	L1, T1
		PM2.5	T1
		Ni	L1, T1
		Se	T1
		Zn	T1
1A2a	Iron and Steel	NOX	T1
		PM2.5	T1
		PM10	T1
		TSP	T1
		Zn	T1
		PAH	T1
		PCBs	T1
1A2c	Chemicals	NOX	T1
1A2e	Food Processing, Beverages and Tobacco	PAH	T1
1A2f	Non-metallic Minerals	NOX	L1, T1
		SO2	L1, T1
		PM2.5	T1
		PM10	T1
		TSP	T1
		BC	T1
		Hg	L1, T1
		As	L1, T1
		Ni	T1
		Se	L1, T1
		Zn	T1
1A4ai	Commercial/Institutional: Stationary	Ni	L1
1A4bi	Residential: stationary	NOX	L1, T1
		NMVOC	L1, T1
		SO2	L1
		PM2.5	L1, T1
		PM10	L1, T1
		TSP	L1, T1
		BC	L1, T1
		CO	L1, T1
		Pb	L1, T1
		Cd	L1, T1
		Hg	L1
		Cr	L1, T1
		Cu	T1
		Se	L1
		Zn	L1
		DIOX	L1, T1
		PAH	L1, T1
		HCB	L1, T1
		PCBs	T1

L1 = level assessment, tier 1, 2022

T1 = trend assessment, tier 1, 1990–2022

Table 3.1-2 Key sources of sector Energy - Transport and Mobile machinery

NFR Category	NFR Category Name	Key Categories	
		Pollutant	Pollutant
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	PM2.5	T1
		BC	T1
1A3bi	R.T., Passenger cars	NOX	L1
		NMVOC	T1
		PM2.5	T1
		PM10	T1
		TSP	T1
		BC	L1, T1
		CO	L1, T1
		Pb	T1
1A3bii	R.T., Light duty vehicles	NOX	L1, T1
1A3biii	R.T., Heavy duty vehicles	NOX	L1, T1
		PM2.5	T1
		BC	T1
1A3bv	R.T., Gasoline evaporation	NMVOC	L1
1A3bvi	R.T., Automobile tyre and break wear	PM2.5	T1
		PM10	T1
		TSP	T1
		BC	T1
		Pb	L1, T1
		As	L1
		Cr	L1, T1
		Cu	L1, T1
		Ni	L1, T1
		Se	T1
		Zn	L1, T1
		PAH	T1
1A3bvii	R.T., Automobile road abrasion	TSP	T1
1A3dii	National Navigation (Shipping)	NOX	L1, T1
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	NOX	L1, T1
		PM2.5	T1
		PM10	T1
		TSP	T1
		BC	T1
		Cu	T1

L1 = level assessment, tier 1, 2022

T1 = trend assessment, tier 1, 1990–2022

3.2. Energy industries (NFR 1.A.1)

This chapter gives an overview of source category 1.A.1 Energy industries and it includes information on methodologies, activity data, emission factors and planned improvements.

Source category description

This source category comprises emission from fuel combustion in public electricity and heat production plants (NFR 1.A.1.a), petroleum refining plants (NFR 1.A.1.b), solid transformation plants, oil and gas extraction and coal mining (NFR 1.A.1.c).

Public Electricity and Heat Production (NFR 1.A.1.a)

The source category NFR 1.A.1.a Public electricity and heat production takes into account consumption of fossil fuel from eight LPSs owned by legal entity HEP-Production Ltd, HEP Group. In public electricity and heat production sector the following types of plants are distinguished in Croatia:

- Thermal Power Plants (TPPs), which produce only electricity;
- Public Cogeneration Plants (PCPs), which produce combined heat and electricity;
- Public Heating Plants (PHPs), which produce only heat.

The installed electricity generating capacities in the Republic of Croatia include hydro and thermal power plants, increasing number of wind power plants and other power plants on renewable energy sources and certain number of industrial power plants.

By the end of 2022 electricity generation capacities in Croatia encompassed 17 locations with large hydropower plants, 7 with thermal power plants, one half of the installed capacities of the nuclear power plant Krško (located in the territory of Slovenia) and large number of Renewable Energy Systems (RES) (wind and sun). Thermal power plants use coal, gas and fuel oils. Most gas-fired power plants can use extra light fuel oil as a replacement fuel. The majority owner of the production capacities of the Republic of Croatia is the HEP Group (state-owned company). Private producers mostly own RES-powered power plants, which have been developing more intensively since 2006, i.e. after the introduction of the system of encouraging the production of electricity from RES.

Total available capacities of all power plants in the Republic of Croatia by the end of 2022 amount to 4946.8 MW (including TE Plomin and without nuclear power plant Krško). Out of this amount, 1534.6 MW is placed in thermal power plants, 2203.4 MW in hydro power plants, 986.9 in wind power plants, 222.0 MW in solar power plants. There is also 348 MW in the nuclear unit Krško (50 % of total available capacity) used for Croatian power system.

The stated capacity of power plants does not include generating units in other countries from which the Croatian electric power system has the right to withdraw electricity on the basis of capacity and power lease or share-ownership arrangements. The capacities in other countries are the following: Thermal power plant Gacko in Bosnia and Herzegovina with total installed capacity of 300 MW, coal-fired; Legal basis – shared ownership for 1/3 of capacity and power for a 25-year period and thermal power plant Obrenovac in the Republic of Serbia with installed capacity 305 MW, coal-fired; Legal basis – capacity and power lease on the basis of a credit for construction. The capacity and power from the above-mentioned facilities is not available, as the status of these facilities has not been resolved yet. The open issues regarding the agreements on investments in these facilities refer to the duration period, the way of treatment of the invested funds and what pricing methods should be applied to electricity deliveries. Generating capacities of HPPs, TPPs and NPP Krško are presented in the Table 3.2-1.

Table 3.2-1 Generating capacities of HPPs, TPPs and NPP Krško

Facility	Available Power (MW)	Fuel type
HPPs	2203.4	-
NPP Krško*	348	uranium oxide (UO_2)
TPP Plomin 1	-	coal
TPP Plomin 2**	199	coal
TPP Rijeka	303	fuel oil
CHP Sisak	235	fuel oil / natural gas
CHP Zagreb (east)	300	fuel oil / natural gas
CHP Zagreb (west)	48	fuel oil / natural gas / extra light oil
CPP Osijek	66	fuel oil / natural gas / extra light oil
KTE Jertovec	76	fuel oil / natural gas / extra light oil
Other biogas plants	59.3	biogas
Other biomass plants	101.2	biomass
Geothermal plants	10.0	
CHP in Industry	132.8	coal / natural gas / fuel oil/ wood
Other small CHP	4.3	natural gas
Total (HE+NE+TE)	3739.4	

* 50% of NPP Krško is owned by HEP Group, ** TPP Plomin 2 (HEP and RWE Power Co-ownership – share 50% : 50%)

Source: Energy in Croatia - 2022, Annual energy report, MESD

Petroleum Refining (NFR 1.A.1.b)

The sub-sector 1.A.1.b Petroleum refining takes into account consumption of fossil fuel from two LCPs oil refineries owned by legal entity INA- Oil industry dd. in Rijeka and Sisak, while lubricants are produced in Rijeka and Zagreb. Crude oil is produced from 33 oil fields and gas condensation products from 8 gas-condensations fields, which covers about 35% of the total domestic demand. In the refineries, there are two types of fuel combustion – for heating and/or cogeneration and for own use of energy for production processes. Processing capacities of the Croatian refineries are presented in the Table 3.2-2.

Table 3.2-2 Processing Capacities of Oil and Lube Refineries

Processing Capacities	Installed Capacities (1000 t/year)	Status of work
Oil Refinery Rijeka (Urinj)		In operation
atmospheric distillation	4500	
reforming	563	
fluidized-bed catalytic cracking (FCC)	689	
visbreaking	600	
isomerization	235	
hydrodesulphurization (HDS)	1204	
mild hydrocracking (MHC)	622	
hydrocracking	2600	
Oil Refinery Sisak		Out of operation
atmospheric distillation	3800	
reforming	670	
fluidized-bed catalytic cracking (FCC)	490	
coking	280	
vacuum distillation	895	
bitumen	200	
Lube Refinery Zagreb Ltd.		In operation
lubricants	60	

Source: Croatian NIR 2024 and EPR database; MESD

Manufacturing of Solid Fuels and Other Energy Industries (NFR 1.A.1.c)

Subsector 1.A.1.c Manufacture of solid fuel and other energy industries takes into account consumption of fossil fuel in following activities: Oil and gas extraction, Coal production, Coke plant and NGL-plant. In Croatia, the coal production in the period 1990-1998 was rather low. Last coal mines in Istria were closed in 1999. Coke-oven plant in Bakar, nearby Rijeka, was closed in 1994.

Natural gas is produced from 17 Pannon exploitation fields and three exploitation areas in the Adriatic meeting 29.5% of total domestic demand in 2022 (lit. 40). However, when gas produced in the Adriatic that actually belongs to Croatia is included in the calculation, domestic gas amounts to 25.4 % of Croatian total gas demand. The production of gas from Pannon is larger than the production from the Adriatic Sea and it amounted to 74%. The largest part of natural gas production is related to the gas fields Duboka Podravina and Međimurje (Molve, Gola duboka, Kalinovac, Vučkovec, Vukanovec and Zebanec gas fields). The processing and preparation of gas for transportation from these fields is carried out at the Central Gas Station Molve III, whereby the C3+ fraction is separated, which is then sent by pipeline towards fractionation facility Ivanić Grad. The installed production capacity of Central gas stations Molve III is 5 million m^3 of gas per day. In the Posavina exploitation fields, significant production of natural gas and oil gas was achieved in the Žutica, Okoli, and Stružec fields. The preparation of this gas for transport takes place at the Ivanić Grad fractionation facility, where after processing and separation of C3+ fraction, dry gas is shipped to the transmission system, while the C3+ fraction together with the one from CGS Molve is used as a feedstock for the production of liquefied petroleum gas. The installed production capacity of the fractionation facility is 1.2 million m^3 of gas per day.

Methodology, emission factors and activity data

For all pollutants, except for SO_2, the recommended emission factors from GB2023 are used. For SO_2, the national emission factors for all liquid fuels are used for the entire reported range. National data are given in table Appendix 2.

Public Electricity and Heat Production (NFR 1.A.1.a)

Emission sources such as facilities in the scope of source category public electricity and heat production plants observed as a large point source (LPS). For LPS emissions calculation a bottom-up approach is used. Double-check with the national energy balance is always performed. Bottom-up approach is used in a way that available direct emission for pollutants from the national Environmental Pollution Register (EPR) entered into CollectER database for each of facilities. According to the Ordinance on the monitoring of emissions of pollutants into air from immovable sources (OG 47/21) all LPSs for emission monitoring have installed continuous emission measurement system (CEM). Each year this system as well as emissions are subject to inspections of verified laboratories. Methods of measurements according to the requirements of the standards in the Annex I of this Ordinance are used to measure the parameters of the waste gas and the concentrations of the substance in the waste gases. For determining emissions in waste gas, the original measured weighted concentrations are used. The CEM system algorithm is designed to calculate emissions from raw (data before validation) data. The raw measured value (concentration) is multiplied by the raw amount of flue gas. In that way, determined emissions are correct and not underestimated. Validated average values are used only for the purposes of comparison with the emission limit values prescribed by the Regulation. Validated average values are not used for emission calculation.

According to the data from the EPR database, national energy balance and available information in the Republic of Croatia, no waste is currently co-incinerated in thermal power plants. Waste incineration takes place only in cement plants (sector 1.A.2.f) and in very small quantities.

For emission calculation for area sources (not LPSs) Tier 1 EMEP/EEA methodology was used, with a top-down approach and based on aggregated fuel consumption from the annual national Energy balance.

Emission factors are expressed as the quantity of emissions of pollutant per GJ fuel consumed. It should be noted that emission factors are changing during the observation period due to: (I) chemical composition of each type of fuel (e.g., sulphur content in the solid and liquid fuel), (II) lower heating different values for the same type of fuel and (III) introduction of technologies to reduce emissions. For 1.A.1.a (Electricity production and Combined heat and power generation) emission factors for large-scale boiler capacity> 50 MW are used, while for 1.A.1.a (Heat plants) used the recommended FE sector 1.A.4.c.i (capacity <50 MW) of GB2023.

In the 2017 inventory review cycle the TERT notes that this underestimate may be because annual emissions are calculated based on stack measurements. When continuously measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED and have used validated average values (after having subtracted the value of the confidence interval). This results in an underestimated emission of up to 20-30% depending on the pollutant and the confidence limits. The recommendation of the TERT was to organize and conduct surveys among operators, and obligors of continuous measurements according to the Ordinance on the monitoring of emissions of pollutants into the air from stationary sources (OG 47/21) who reports annual emission based on direct measurements.

As part of the inventory improvement project, the Contractor conducted surveys to HEP-Production d.o.o. which showed that all measured mass concentrations on the CEM system are used for the emission calculation. An example of a survey with a response is given below:

The type of data used to calculate the annual emissions reported to the EPR database	**YES/NO**
Validated mean mass concentration values (uncertainty corrected)	NO
All measured mass concentrations on the CEM system	YES

Country specific EF for SO_2

For SO_2 emission calculation from combustion of fuel oil and gas oil for area sources (not LCPs), Croatia calculates national emission factors on yearly base. These are calculated on the base of annual fuel amount by type (produced and put on the market) and sulphur amount in fuel by type.

Activity data for each type of fuel consumed in each of the plant along with measured direct emissions for NOx, SO_2, CO and PM_{10} were used, from the EPR database (Tier 2), i.e. the plant specific emission factors were used. For those pollutants for which the LPS doesn’t have obligation to report in the EPR database, the default emission factors from GB2023 were used.

In the case of heavy metals, for which emission factors are not available in GB2023, recommended emission factors from PARC ATMOS were used. Also, chemical analyses were made for facilities in the scope of public electricity and heat production plants for fuel oil and different coal used in Croatia and emission factors for each of heavy metals (Pb, Cd, Hg and Ni) were determined by comparing with default emission factors for different sources.

Activity data on fuel used by type in sector 1.A.1.a are presented in Figure 3.2-1.

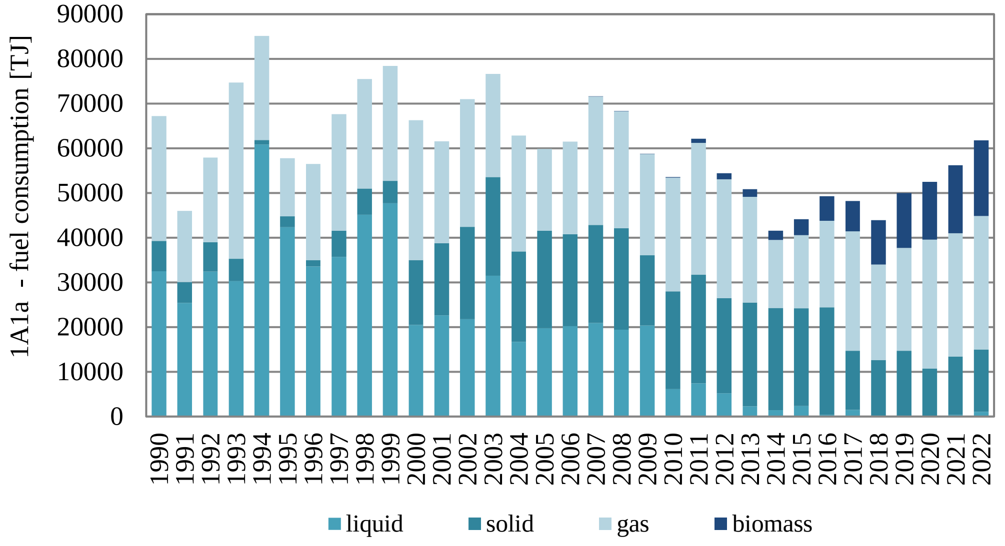


Figure 3.2-1 Activity data on fuel consumption by type for NFR 1.A.1.a

Petroleum Refining (NFR 1.A.1.b)

Methodology for emission calculation is Tier 2 EMEP/EEA, performed by multiplying total fuel sold for petroleum refining activities (disaggregated by fuel type) with emission factors.

The default Tier 2 emission factors from GB2023 are used for emission calculations.

Country specific EF for SO_2

For SO_2 emission calculation from combustion of fuel oil and gas oil, Croatia calculates national emission factors on yearly base. These are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type.

Activity data on fuel used by type in sector 1.A.1.b are presented in Figure 3.2-2.

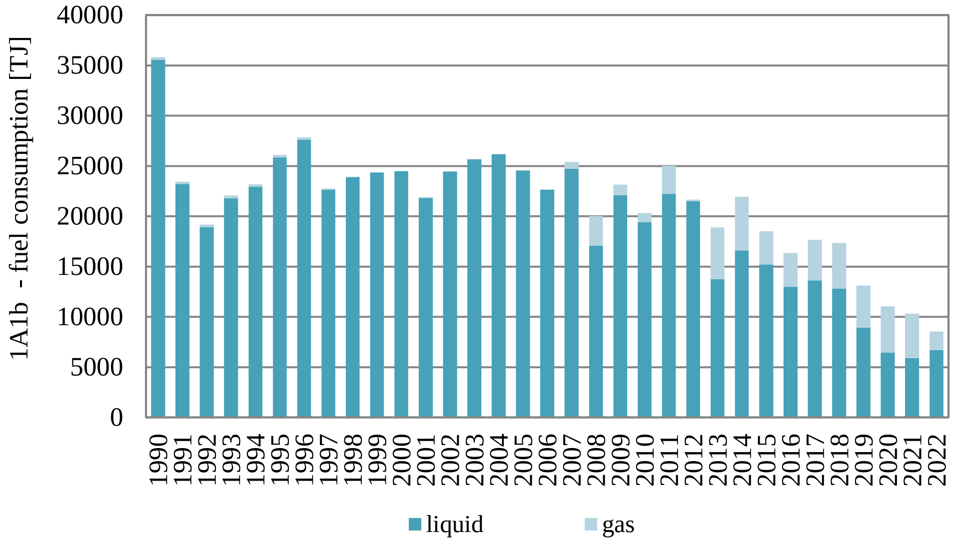


Figure 3.2-2 Activity data on fuel consumption by type for NFR 1.A.1.b

Manufacturing of Solid Fuels and Other Energy Industries (NFR 1.A.1.c)

In NFR category 1.A.1.c in the period from 2007 to 2019, only the consumption of gaseous fuels was recorded because in that period no transformation of solid fuels existed in Croatia. This category contains fuel consumption and emissions for own consumption in the production of oil and natural gas and biogas plants. Emission factors are taken from the GB2023 in which EF ($PM_{2.5}$) equals EF (PM_{10}).

Methodology for emission calculation is Tier 1 EMEP/EEA, performed by multiplying total fuel sold for activities in the scope of category Manufacturing of solid fuels and other energy industries (disaggregated by fuel type) with emission factors.

The default Tier 1 emission factors from GB2023 are used for emission calculations. For ammonia emission estimation Tier 1 default EMEP/CORINAIR (1999) emission factor was used by fuel type.

Activity data on fuel used by type in sector 1.A.1.c is presented in Figure 3.2-3.

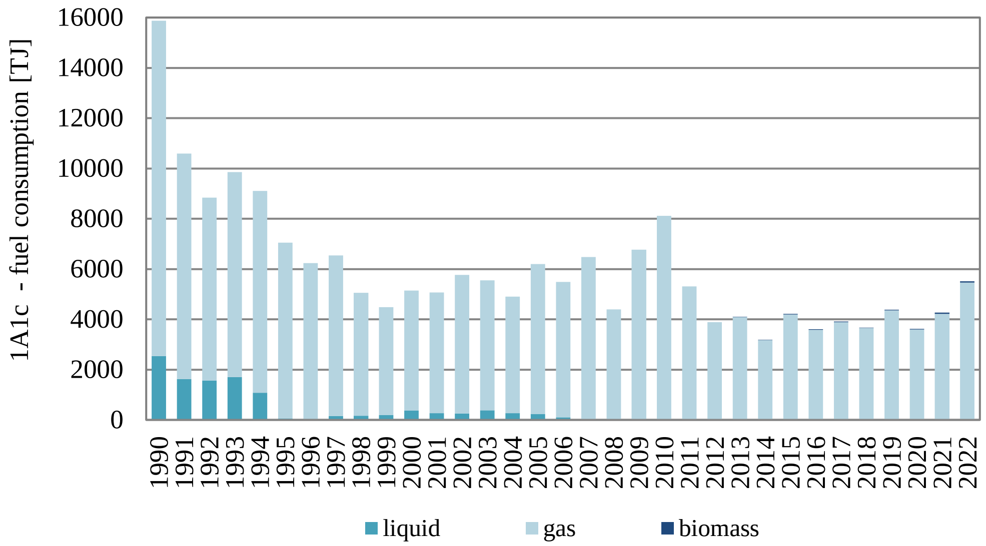


Figure 3.2-3 Activity data on fuel consumption by type for NFR 1.A.1.c

Recalculations and improvements

There were no recalculations or other improvements.

3.3. Manufacturing industries and construction (NFR 1.A.2)

Source category description

Manufacturing Industries and Construction (NFR 1.A.2) includes emissions from fuel combustion in different industries in Croatia, such as Iron and steel (NFR 1.A.1.a), Non-ferrous metals (NFR 1.A.1.b), Chemicals (NFR 1.A.1.c), Pulp, paper and print (NFR 1.A.1.d), Food processing, beverages and tobacco (NFR 1.A.2.e) and Non-metallic minerals (NFR 1.A.2.f). These are all stationary sources of fuel combustion. In the scope of this source category is also one mobile source Mobile Combustion in manufacturing industries and construction (NFR 1.A.2.g.vii) which is observed within the source category NFR 1.A.4 ii Non road mobile source and machinery.

This sector also includes the emissions from fuel used for the generation of electricity and heat in industry (industrial cogeneration plants and industrial heating plants). In the national energy balance, the fuel used in industrial heating plants and cogenerations are not divided according to the relevant industrial branches, so in addition to the annual national energy balance, an annual "Industry Analysis" is prepared to report according to NFR categories.

Methodology, emission factors and activity data

For all pollutants, except for SO_2, the recommended emission factors from GB2023 are used. For SO_2, the national emission factors for all liquid fuels are used for the entire reported range. National data are given in table Appendix 2.

Methodology for emission estimation for almost all NFR codes in the scope of source category 1.A.2 Manufacturing Industries and Construction is default Tier 1 EMEP/EEA, along with Tier 1 emission factors (GB2023). Croatia estimates all emissions for all pollutants which EF are provided in GB2023 for 1.A.2.a, 1.A.2.b, 1.A2.c, 1.A.2.e for all fuel types specified in annual national energy balances.

For NFR 1.A.2.f Non-metallic minerals code, plant-specific emission factors for SO_2, NOx, CO and PM were used for the whole observed period. The Non-metallic minerals sector includes all cement production plants in Croatia that dominate emissions within sector 1.A.2.f Non-metallic minerals and within the overall source category 1.A.2.

For emissions calculation for LPSs in NFR sector 1.A.2.f Non-metallic minerals, a bottom-up approach is used. Bottom-up approach is used in cement production and the mineral wool production in a way that direct emissions available from the national EPR are entered into CollectER database. Double-check with the national energy balance is always performed.

Fuel amounts related to those direct emissions are subtracted from the amount of fuel from an energy balance depending on the fuel type and activities. For facilities for cement production, since 2007 the emissions reported in the EPR are used for SO_2, NOx, CO and NMVOC, which include all the specifics related to fuel, raw materials and production technology in each of facilities. For trend 1990 - 2006 for each plant the plant-specific emission factor are defined.

Country specific EF for SO_2

For SO_2 emission calculation from combustion of fuel oil and gas oil, Croatia calculates national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type. Furthermore, for source categories: 1.A.2.c and 1.A.2.e there is no Tier 2 SO_2 EFs provide in GB2023 (chapter 1.A.2). In respect of all mentioned above, Croatia considers that SO_2 emission calculation methodology is more detailed than Tier 1.

NOx emission factor

For NOx emission calculation Croatia uses methodology disaggregated by fuel types (gas oil, fuel oil, natural gas, etc.) but not disaggregated by technology. For now Croatia does not have plan for moving from Tier 1 to Tier 2 in respect of technology disaggregation. This recommendation is included in IIR's improvement plan as long-term goal.

Activity data on fuel used by type for all activities in the scope of source category 1.A.2 are presented in Figure 3.3-1.

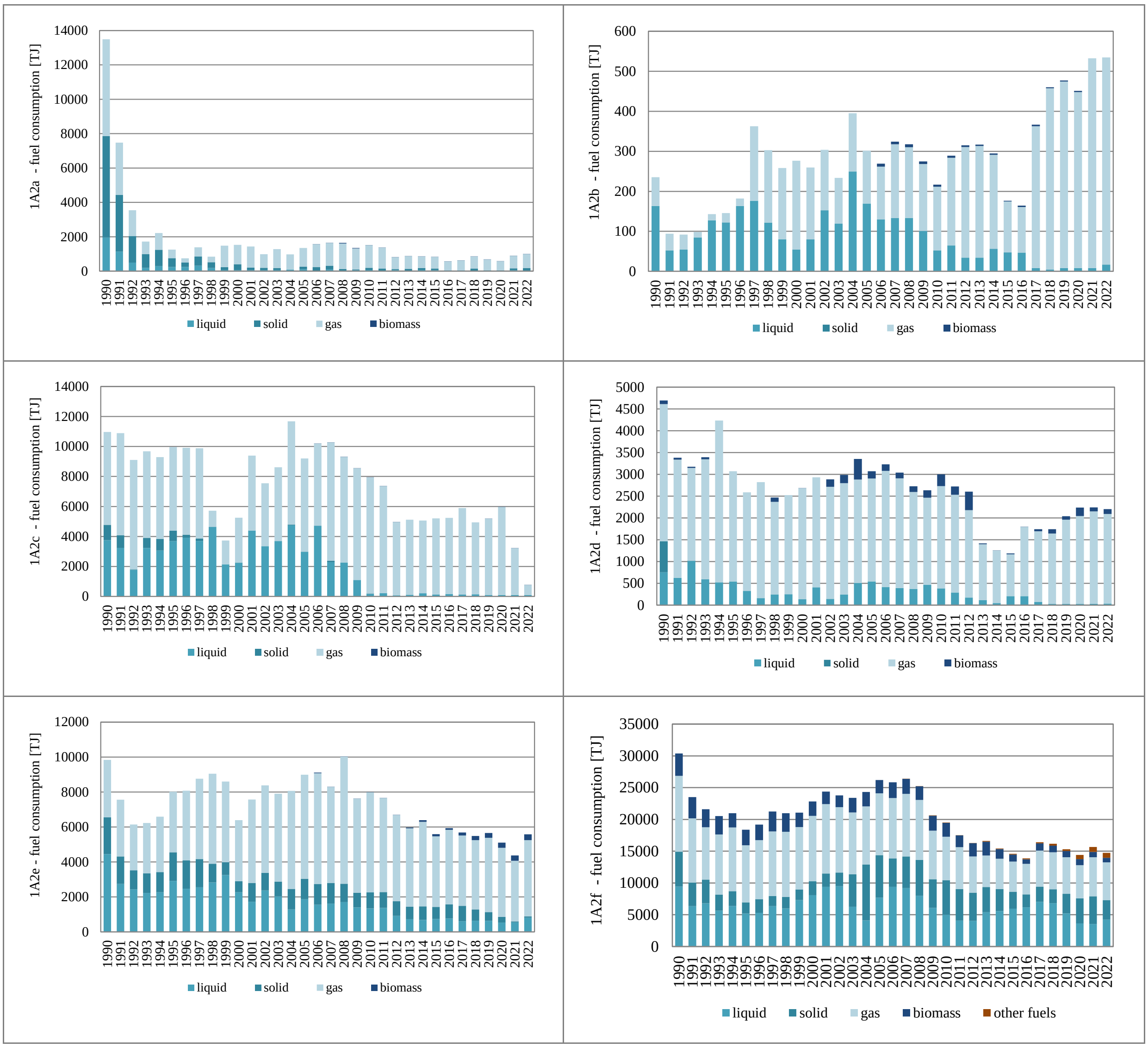


Figure 3.3-1 Activity data on fuel consumption by type for NFR codes 1.A.2.a, 1.A.2.b, 1.A.2.c, 1.A.2.d, 1.A.2.e, 1.A.2.f.

Recalculations and improvements

Manufacturing industries and construction (NFR 1.A.2)

In category 1A2c Fuel combustion in industry and construction: Chemicals for the series 2019-2021 the consumption of wood biomass was lacking, so it was added. In category 1A2e Fuel combustion in industry and construction: Food, drink and tobacco, an error was observed when entering liquid fuel in 2021 in the CollectER database, so it was corrected. The recalculation applied to all pollutants. Compared to last year's submission, emissions changed by about 1%.

3.4. Transport (NFR 1.A.3)

Source category description

Fuel consumption in sector 1.A.3 takes into account fossil fuel consumed in sub-sectors: 1.A.3.a Aviation, 1.A.3.b (i-iv) Road transport, 1.A.3.c Railways, and 1.A.3.d.ii Navigation (shipping). Fuel consumption in sub-sector 1.A.3.d.ii National navigation (Shipping) takes into account fuel consumption for sea and river transport. For emissions that occur in sector 1.A.3.d.i(ii) International inland waterways Croatia is using notation key “IE” and those emissions are included in the memo item: 1.A.3.d.i(i) International maritime navigation. For emissions that occur in sector 1.A.3.e i Pipeline transport Croatia is using notation key “NO”.

Aviation (civil) (NFR 1.A.3.a)

The Republic of Croatia has 9 airports: Zagreb, Split, Dubrovnik, Zadar, Osijek, Rijeka, Pula, Brač and Mali Lošinj for aircraft in commercial air transport.

The scope of the emissions to be included comprises the civil aviation portion of combustion emissions from mobile sources that concerns the movement of people and/or freight by air. The activities comprise of international airport transport (LTO-cycles < 914 m), international cruise transport (>914 m), domestic airport transport (LTO-cycles < 914 m) and domestic cruise transport (>914 m). Emissions from two source categories International aviation LTO (civil) (NFR 1.A.3.a.i (i)) and Domestic aviation LTO (civil) (NFR 1.A.3.a.ii (i)) counts in national emission totals, and emissions from two other International aviation cruise (civil) (NFR 1.A.3.a.i (ii)) and Domestic aviation cruise (civil) (NFR 1.A.3.a.ii (ii)) are concerned as memo items, which are excluded from national totals. The scope of the emissions that are included comprises civil commercial use of airplanes, including scheduled and charter transport for passengers and freight, air taxiing and general aviation. Fuel used at airports for ground transport is excluded from these NFR codes and are reported under 1.A.3.b Road transport. Fuel for stationary combustion at airports is also excluded and reported under the appropriate stationary combustion category.

Road transport (NFR 1.A.3.b)

Emissions from Road transport source category in Croatian inventory are reporting in following categories of road vehicles: passenger cars (NFR 1.A.3.b.i), light commercial vehicles (< 3.5 t) (NFR 1.A.3.b.ii), heavy-duty vehicles (> 3.5 t) and buses (NFR 1.A.3.b.iii), mopeds and motorcycles (NFR 1.A.3.b.iv), which are exhaust emission sources, gasoline evaporation (NFR 1.A.3.b.v), and automobile tyre and brake wear (NFR 1.A.3.b.vi), and road abrasion (NFR 1.A.3.b.vii) which are fugitive emission sources.

Railways (NFR 1.A.3.c)

Emissions from rail transport concern the movement of goods or people by rail. Exhaust emissions from railways arise from the combustion of liquid fuels in diesel engines, and solid or liquid fuels in steam engines to provide propulsion. Railway locomotives by type in Croatia are: diesel, electric and on steam (the last one in inventory years 1990 and 1991). Today, there are several coal-powered locomotives, but they are used only for exhibition purposes. The length of railways last increased in in 2019, from 2,604 km to a total of 2,617 km, and in 2022 it remained the same. Of that number, 2,343 km (90 %) are single-lane, and 274 km are twolane (10 %). 37.5 % of the total length of the railway is electrified (980 km). Source category Railway transport is not a key source of emissions in Croatia.

Navigation (shipping) (NFR 1.A.3.d)

Navigation (shipping) source category covers all water-borne transport from recreational craft to large ocean-going cargo ships that are driven primarily by high-, slow- and medium-speed diesel engines and occasionally by steam or gas turbines. Exhaust emissions from navigation arise from engines used as main propulsion engines and auxiliary engines used to provide power and services within vessels.

Emissions from Navigation (shipping) source category in Croatian inventory are reporting in following NFR categories: 1.A.3.d.ii National navigation (shipping) and memo item: 1.A.3.d.i(i) International maritime navigation.

Source category NFR 1.A.3.d.ii National navigation (shipping) – Includes emissions from fuels used by vessels of all flags that depart and arrive in the same country (excludes fishing, which should be reported under NFR 1.A.4.c.iii and military vessels which should be reported under NFR 1.A.5.b). Includes small recreational boats. This category may include journeys of considerable length between two ports in a country. The Republic of Croatia uses the "IE" (included elsewhere) for emissions from categories NFR 1.A.4.c.iii and NFR 1.A.5.b. Emissions from the NFR category 1.A.4.c.iii Agriculture / Forestry / Fishing: National fishing are included in the NFR category 1.A.3.d.ii.

The Republic of Croatia has 6 ports of international economic interest in the cities: Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik. The network of inland waterways of the Republic of Croatian is 804 km, of which 539 km are international waterways. Inland ports open to international public transport are: Osijek, Sisak, Slavonski Brod and Vukovar.

Fuels used for international inland waterways are covered in category 1.A.3.d.ii. The use of bunker fuels for international inland navigation, for example from a Croatian sea port upstream a river to a neighboured country (Hungary, Serbia) is not possible. Vessels fuelling in Croatia for a trip on the Danube river to are covered in category 1.A.3.d.ii and that trips from seaport upstream a river are not possible.

Pipeline transport (NFR 1.A.3.e.i)

In Croatia all compressor stations are electric one, so no emissions occurred from this source category. As a confirmation of this claim, in IEA and EUROSTAT energy balance data on consumption of all fuel use for pipeline transport can be found for the whole historical period. In IEA and EUROSTAT energy balance for the whole period, consumption of gas and oil in pipeline transport was 0 TJ. In 2022 for Pipeline transport 3,0 ktoe electricity is consumed.

In Croatian NGL plant natural gas is consumed in compressor station, but according to IEA methodology only fuel used in compressor stations for oil and natural gas transport through pipelines are part of Pipeline transport sector (excluding compressors on plant location).

Data on input and output fuels from NGL plant Ivanić Grad are collected via annual questionnaire (for the whole historical period). Although according to IEA methodology only input and output of fuels in NGL plant accounts in energy balance (excluding own use), in National energy balance own use of fuels in NGL plant are accounted too. Total amount of fuel used for own use in NGL plant is specified in national energy balance in section Energy sector own use-NGL plant. For 2022 in NGL plant only natural gas was used in own use purposes

($42,8*10^6$ m^3). This amount of fuel with all other oil and gas extraction in energy industries are summed in 1.A.1.c sector.

Methodology, emission factors, activity data

For all pollutants, except for SO_2, the recommended emission factors from GB2023 are used. For SO_2, the national emission factors for all liquid fuels are used for the entire reported range. National data are given in table Appendix 2.

Aviation (civil) (NFR 1.A.3.a)

Emissions from Aviation (civil) source category were calculated using Tier 1 EMEP/EEA methodology, along with the recommended Tier 1 emission factors from GB2013. The methodology consists of fossil fuel distribution into domestic and international transport, along with distribution of jet fuel into the LTO and cruise cycle. For process of jet fuel distribution the Eurocontrol data were used. The Eurocontrol (European Organisation for the Safety of Air Navigation) data are recommended by ERT and secured over the EEA (European Environment Agency). Quality of Eurocontrol data is checked by the ETC/ACM and can be used for reporting and for checking the quality of data on emissions from aviation to the UNFCCC and the CLRTAP reporting. Eurocontrol data are available for the period 2005 – 2022. The Eurocontrol database contains aggregate data on the quantities of fuel, number of flights and emissions for each country as well as for the Republic of Croatia. These aggregated amount of fuel and emissions were calculated using Tier 3 methodology by applying "Advanced Emissions Model" (AEM). Quantities of fuel in the Eurocontrol database do not match completely to the amount of fuel in the energy balance of the Republic of Croatia for the period 2005 - 2022 due to estimation with model. With respect to previously mentioned, for jet fuel distribution, real amounts of jet fuel from national energy balance were used and were distributed in accordance with the Eurocontrol jet fuel data distribution. Methodological issues remain a Tier 1, because aviation sector is not a key source category in Croatian inventory.

Two type of activity data are used for emission calculation from Aviation source category: fuel sold for aviation activities and data for number of LTO cycle regarding Croatia, (preferably with a destination for international LTO and general knowledge of the type of aircraft performing the aviation activity). Sources for those activity data are annual national energy balances for fuel sold, and Eurocontrol database for number of LTO cycle for national and international movements. Two types of fuels are used for aviation activities in Croatia: Jet kerosene for national and international transport and aviation gasoline only for domestic LTO aviation. The Eurocontrol data will be used as alternative source as long as Croatia will not have available and reliable data regarding number of LTO cycle. Based on Eurocontrol data for Croatia on the number of flights in the LTO cycle on domestic and international routes, the average number of flights on domestic LTO routes is about 10 %, and the rest (90 %) are international LTO flights. The Eurocontrol data on the amount of fuel for international long distances flights (flights outside the territory of Europe) were also taken into account to calculate the average share of fuel used for international LTO long distances flights in total fuel consumption for international LTO flights.

The Tier 1 emission factors from GB2013 were used for emission calculation. Default emission factors are stratified due to fuel type (jet kerosene or aviation gasoline), and additional for jet kerosene four different NFR codes and representative aircraft basis. For emission calculation from jet kerosene combustion proposed emission factors for average fleet were used both for LTO and cruise. Additionally, for international LTO transport the average fleet emission factors regarding short or long distance flights were used. Regarding combustion of gasoline, heavy metals and ammonia emission factors from COPERT 5 model were used. Regarding combustion of kerosene, heavy metals, PCDD/PCDF and PAHS emission factors for stationary combustion NFR 1.A.2 were used.

According to the methodology described in GB2023, it is necessary to designate a characteristic aircraft for the country, for which it is necessary to collect detailed data on aircraft at all airports in the Republic of Croatia. Given that this is an improvement of the calculation that requires the collection of additional data, the methodology according to GB2023 was not used for this report, but according to GB2013. The methodology according to GB2023 will be implemented in one of the following submissions.

Country specific EF for SO_2

For SO_2 emission calculation from combustion of fuel gasoline and kerosine, Croatia calculatess national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type and are presented in Appendix 2.

Activity data on fuel used for all activities in the scope of source category 1.A.3.a are presented in Figure 3.4-1.

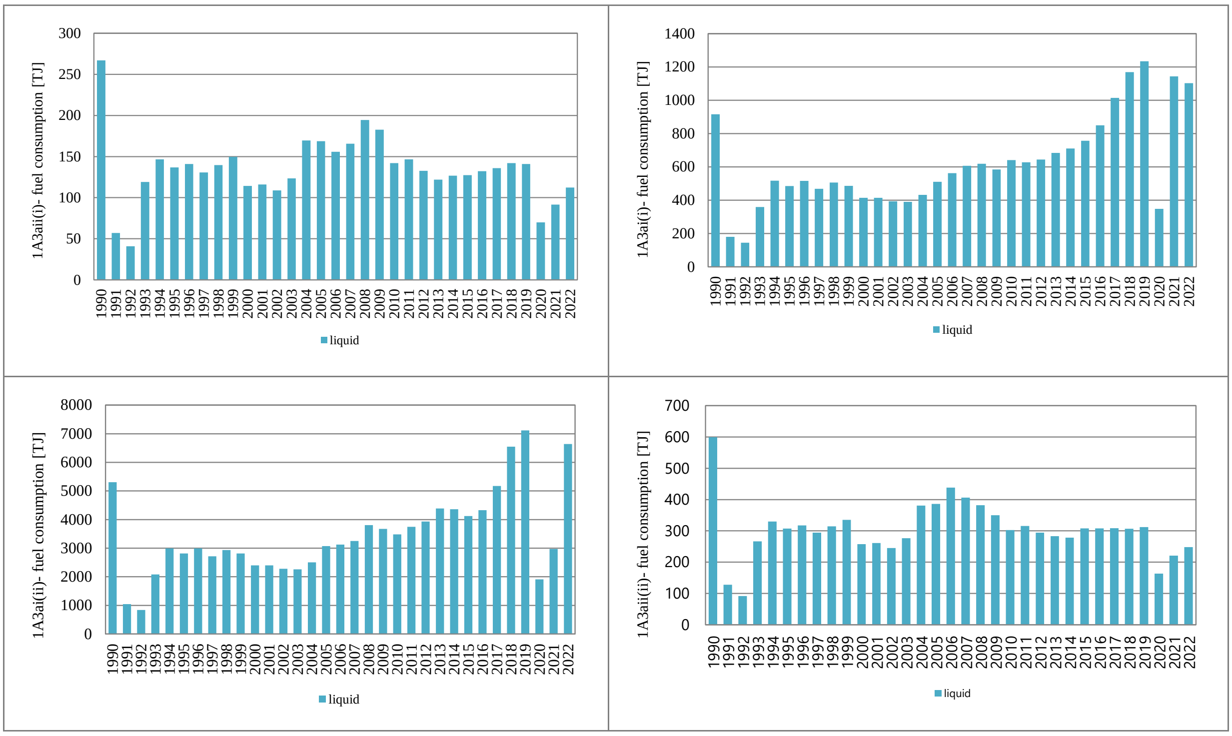


Figure 3.4-1 Activity data on fuel consumption for NFR codes 1.A.3.a.i(i), 1.A.3.a.ii(i), 1.A.3.a.i(ii), 1.A.3.a.ii(ii)

The amount of gasoline for 1A3aii(i) Domestic aviation LTO (civil) category reported in the National energy balance of the Republic of Croatia is significantly lower for the 2000-2002 period than for the following period (i.e. 2003-2019). For the year 2003 the amount of gasoline is significantly higher, and in the following period (i.e. until 2019), the amount gradually decreases, with the lowest emission in the year 2020 due to the COVID pandemic. For this reason, IEF values for CO and PM_{10}, for the period 2000-2002 are low in comparison with the following years.

Road transport (NFR 1.A.3.b)

The COPERT 5 package (Tier 2/3 method) was used for air emission calculation from sub-sectors 1.A.3.b (i-vi) Road transport, which requires a detailed set of data as following:

a) type of vehicles (passenger cars, light duty vehicles, heavy duty vehicles, buses, mopeds, motorcycles),
b) type of motor (gasoline four-stroke, gasoline two-stroke, diesel, rotation motor and electromotor),
c) cylinder capacity (<0.8 lit, 0.8-1.4 lit 1.4-2.0 lit, >2.0 lit),
d) weight class (Rigid<7.5 t, 7,5-12 t, 12-14 t, 14-20 t, 20-26 t, 26-28t, 28-32 t, >32t, Articulated 14-20 t, 20-28 t, 28-34 t, 34-40 t, 40-50 t, 50-60 t) and
e) age of vehicles (distribution of vehicles per ECE categories according to EC directives).

Required detail dataset regarding vehicles characteristics are contained in the Croatian vehicle database. Besides mentioned data, data on amounts of all types of liquid and gaseous fuels consumed in road transportation are also required. The source of fuel sold for road transport is annual national energy balances. Also, the COPERT model requires data on average monthly minimum and maximum temperatures collected on an annual basis for the 10 largest cities in Croatia.

To calculate the SO_2 emissions from gasoline and diesel combustion, Croatia uses national values of the amount of S in each type of fuel (produced and placed on the market) and enters the annual calculated factors into the COPERT.

For the calculation of NMVOC emissions, national vapor pressure values for petrol are used in a way that they are in accordance with the legal regulations of the Republic of Croatia instead of using the values recommended by the COPERT 5 model.

Additional data like: highway, rural and urban transport mileage, average speed of various vehicles and different road types, average daily trip distance, beta value (the fraction of the monthly mileage driven before the engine and any exhaust components have reached their nominal operation temperature) are expert judgement or COPERT default data.

Two assumptions/adjustments were applied when using COPERT model:

- gasoline or diesel oil tank-filled abroad and consumed in Croatia is equal to amount of same type of fuels tank-filled in Croatia and consumed abroad (this is due to a large number of tourist destination and transit trips in Croatia), so effect of this consumption pattern in neutral to fuel balance;
- fuel consumption calculated by COPERT, taking into account number of vehicles and annual average vehicle mileage, should be to a highest possible degree equal to consumption of fuels from the national energy balance (the difference should not be greater than 1%).

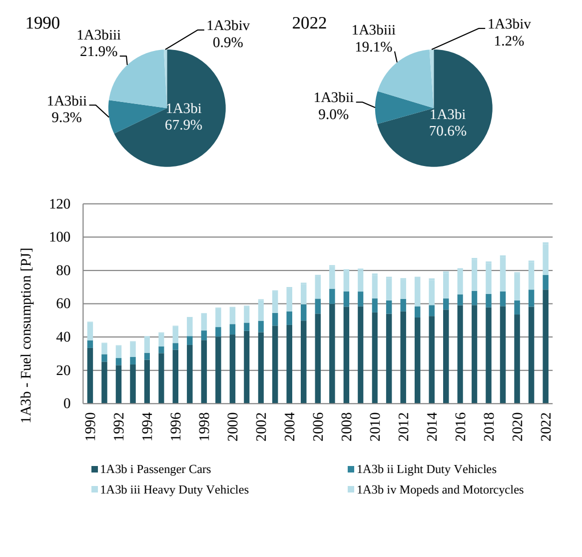
Country specific EF for SO_2

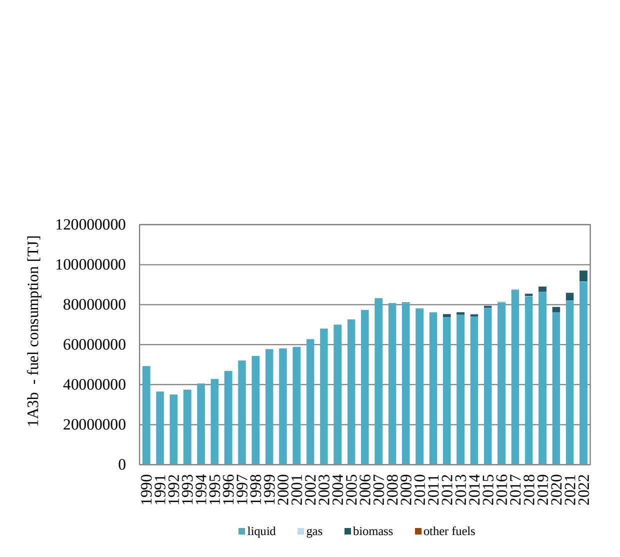
For SO_2 emission calculation from combustion of fuel gasoline and kerosine, Croatia calculatess national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type.

In 2022, the NFR category 1.A.3.b.i passenger cars (70.6%) had the dominance in fuel consumption in the road transport. Other NFR road transport categories contribute to fuel consumption as follows: 1.A.3.b.ii Light Duty Vehicles with 9%, 1.A.3.b.iii Heavy duty vehicles with 19.1% and 1.A.3.b.iv Mopeds and Motorcycles with 0.9%.

The trend of fuel consumption in road transport has been growing in the historical period (by 96.9%), which is a result of the growing trend of all NFR categories of road transport. The most common fuel is liquid fossil fuel. Consumption of biomass and gaseous fuels in road transport is still negligible at the national level (Figure 3.4-2).

The Figure 3.4-2 shows the fuel consumption by type of vehicle in road transport.





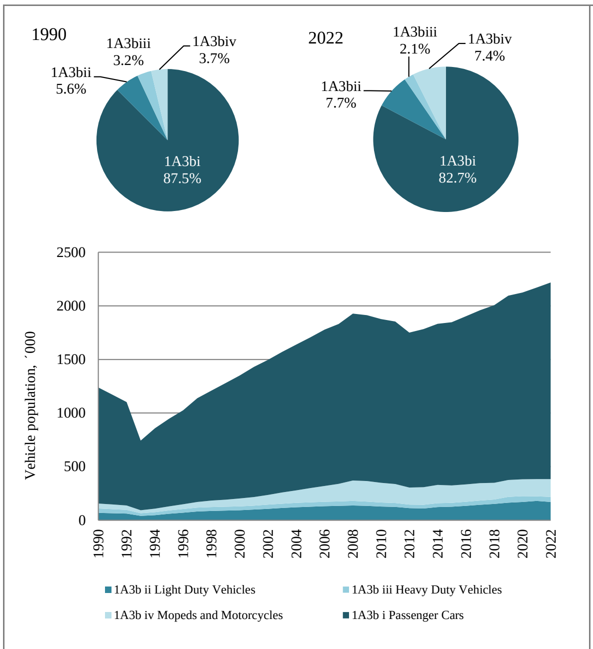
Fuel consumption by type of vehicle	*Fuel consumption by fuel type*

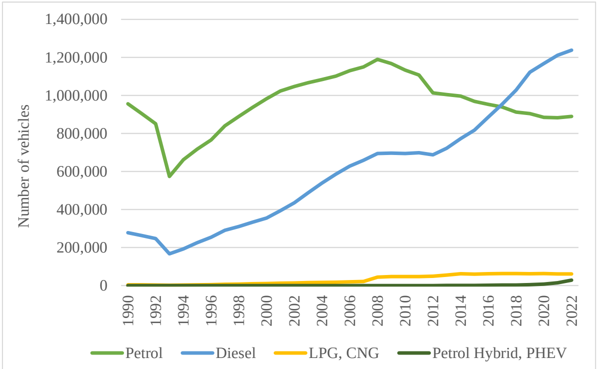
Figure 3.4-2 Fuel consumption by type of vehicle and type of fuel used in road transport

The total number of vehicles has increased by 60.8% in the historical period (Figure 3.4-3 and Table 3.4-1). The reason for the increase is mostly the increase in the number of passenger cars by 69.4% since 1990, which represented 92.2% of the total number of vehicles in road transport in 2022. The number of light duty vehicles increased by 2.5 times, mopeds and motorcycles by 3.6 times, and the number of heavy duty vehicles and buses by 1.2 times since 1990. The number of diesel vehicles has been continuously increasing since 1993, with a period of stagnation from 2008 to 2012 as a result of the economic crisis. The number of gasoline vehicles also increased from 1993 to 2008, after which a downward trend began until 2020, followed by a slight increase. In the period from 1990 to 1993, there was a downward trend in the number of diesel and gasoline vehicles as a result of the war for Croatian independence. The number of LPG and CNG vehicles in the observed period is not significant, and it recorded a slight increase after 2008. Gasoline hybrid vehicles appeared in Croatia in 2005 in the category of passenger cars and have recorded a slight growth since then. Electric vehicles (PHEVs) appeared in Croatia in 2019 in the category of passenger cars, and in 2022 their number has increased significantly compared to previous years, but at the national level this number is still negligible.

Observing the entire historic series, it was noticed that in 2002, compared to 2001, was a significant drop in $PM_{2.5}$ emissions in the passenger cars subsector, due to the drop in the number of conventional SUVs and medium-sized vehicles that use diesel as fuel (Figures 2.7.3-1 and 3.4-2).

The type and class of vehicle, their speed and driving share on each type of road are shown in Table 3.4-2.





Vehicle number by type of vehicle	*Vehicle number by type of energy used*

Figure 3.4-3 Number of vehicles in the road transportation

Table 3.4-1 Number of road motor vehicles, using fossil fuels, by type ('000)

Vehicle type	Passenger Cars	Light Duty Vehicles	Heavy Duty Vehicles	Mopeds Motorcycles
Year / unit	´000	´000	´000	´000
1990	1083.111	68.789	39.887	46.166
1991	1024.491	65.068	37.727	43.668
1992	964.257	61.241	35.504	41.100
1993	649.782	41.269	23.923	27.696
1994	750.494	47.665	27.635	31.989
1995	817.290	59.526	31.283	37.596
1996	877.072	69.847	33.923	44.525
1997	966.986	81.576	36.219	52.937
1998	1025.723	86.299	36.370	59.891
1999	1088.304	89.549	36.188	66.301
2000	1147.519	93.195	36.257	72.800
2001	1213.592	98.779	37.123	80.455
2002	1260.431	106.338	38.512	90.974
2003	1311.403	114.565	39.908	104.299
2004	1360.190	120.870	40.629	117.637
2005	1405.499	126.630	40.819	132.904
2006	1458.011	131.089	41.210	147.931
2007	1491.828	133.836	41.259	163.645
2008	1558.131	137.680	42.699	190.078
2009	1546.680	133.298	40.654	191.584
2010	1526.800	127.920	38.031	183.619
2011	1517.328	123.849	36.421	176.582
2012	1446.673	112.988	33.101	158.487
2013	1475.062	109.693	34.408	164.400
2014	1503.412	106.389	35.742	170.296
2015	1523.720	110.039	35.389	162.599
2016	1570.167	117.682	38.219	161.581
2017	1614.445	127.218	39.230	162.252
2018	1658.528	135.687	40.533	156.088

Vehicle type	Passenger Cars	Light Duty Vehicles	Heavy Duty Vehicles	Mopeds Motorcycles
Year / unit	´000	´000	´000	´000
2019	1719.826	147.551	54.104	157.839
2020	1742.428	153.624	54.446	157.170
2021	1788.124	163.065	43.723	159.383
2022	1835.307	170.777	47.427	164.977

Source: MIA, Processing: Ekonerg Ltd.

Table 3.4-2 Type and class of vehicle, their speed and driving share on each type of road

Sector	Subsector	Trip speed (km/h)			Driving share, %		
		Urban	Rural	Highway	Urban	Rural	Highway
Passenger Cars	Gasoline 0.8 - 1.4 l	30	60	110	40	35	25
	Gasoline 1.4 - 2.0 l	30	60	110	40	35	25
	Gasoline >2.0 l	30	60	110	40	35	25
	Diesel 1.4 - 2.0 l	30	60	110	40	35	25
	Diesel >2.0 l	30	60	110	40	35	25
	LPG	30	60	110	40	35	25
	CNG	30	60	110	40	35	25
	2-Stroke	30	60	110	40	35	25
	Hybrid Gasoline	30	60	110	40	35	25
Light Duty Vehicles	Gasoline <3.5 t	30	60	100	30	50	20
	Diesel <3.5 t	30	60	100	30	50	20
Heavy Duty Vehicles	Gasoline >3.5 t	30	50	80	30	55	15
	Rigid <=7.5 t	30	50	80	30	55	15
	Rigid 7.5 - 12 t	30	50	80	30	55	15
	Rigid 12 - 14 t	30	50	80	30	55	15
	Rigid 14 - 20 t	30	50	80	30	55	15
	Rigid 20 - 26 t	30	50	80	30	55	15
	Rigid 26 - 28 t	30	50	80	30	55	15
	Rigid 28 - 32 t	30	50	80	30	55	15
	Rigid >32 t	30	50	80	30	55	15
	Articulated 14 - 20 t	30	50	80	30	55	15
	Articulated 20 - 28 t	30	50	80	30	55	15
	Articulated 28 - 34 t	30	50	80	30	55	15
	Articulated 34 - 40 t	30	50	80	30	55	15
	Articulated 40 - 50 t	30	50	80	30	55	15
	Articulated 50 - 60 t	30	50	80	30	55	15
Buses	Urban Buses Midi <=15 t	30	50	0	90	10	0
	Urban Buses Standard 15 - 18 t	30	50	0	90	10	0
	Urban Buses Articulated >18 t	30	50	0	90	10	0
	Urban CNG Buses	30	50	0	90	10	0
	Coaches Standard <=18 t	30	50	90	25	65	10
	Coaches Articulated >18 t	30	50	90	25	65	10
Mopeds	2-stroke <50 cm^3	30	50	0	70	30	0
	4-stroke <50 cm^3	30	50	0	70	30	0
Motorcycles	2-stroke >50 cm^3	30	50	0	60	40	0
	4-stroke <250 cm^3	30	50	70	48	50	2
	4-stroke 250 - 750 cm^3	30	50	80	45	51	4
	4-stroke >750 cm^3	30	50	90	35	60	5

Data source: COPERT default

Railways (NFR 1.A.3.c)

Emissions from Railway source category were calculated using Tier 1 EMEP/EEA methodology, due to this sector is not a key source. The default Tier 1 emission factors, stratified by fuel types, are from GB2023. For diesel and gas oil recommended FE for NFR 1.A.3.c are used, while for the solid fuel (coal and lignite), heavy fuel oil, kerosene and diesel recommended FE for NFR 1.A.4.a are used. Relevant activity data for Tier 1 approach is fossil fuel consumption data by fuel types from annual national energy balances (Figure 3.4-4).

Country specific EF for SO_2

For SO_2 emission calculation from combustion of following fuels: coal, residual fuel oil, gas oil, diesel, kerosine and gasoline, Croatia calculates national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type.

In the national energy balance there is no recorded coal consumption in rail transport since the 1991. Despite that, two coal locomotives were identified in the national register of locomotives. However, they are used only for exhibition purposes and the symbol “NO” is used for the coal consumption in rail transport, which is in accordance with the national energy balance.

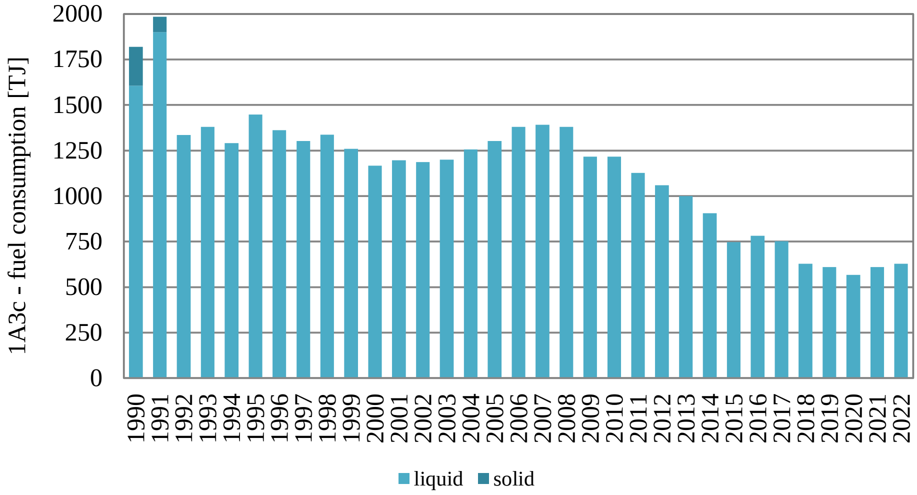


Figure 3.4-4 Activity data on fuel consumption for NFR 1.A.3.c

Navigation (shipping) (NFR 1.A.3.d)

Emissions from Navigation source category for NFR codes 1.A.3.d.ii (i) and 1.A.3.d.i (i) were calculated using Tier 1 EMEP/EEA methodology, due to these sectors are not a key source. Emissions from 1.A.3.d.i (i) International bunkers of ships are not included in the national total emissions and are shown as memo items.

It has to be noted that inland navigation is strongly dependent on the navigability and that therefore fluctuations of this size are rather likely.

As the fuel consumption data for national navigation and international inland waterways are not separated in the national energy balance, emissions from Category 1.A.3.di (ii) International inland waterways are included in Category 1.A.3.d.ii National navigation (shipping), and the mark "IE" was used. International inland waterways transport can take place along the river Danube, and since international inland waterways transport with the beginning in the Croatian sea is not possible, there is no risk of underestimating national emissions by this approach.

It should be noted that in the national energy balance, all consumption of biofuels is allocated to the road transport sector. The calculations in this report are done accordingly, even though biofuels can be used in other sectors, i.e. in railways, navigation, small non-road vehicles and machinery and aviation.

Country specific EF for SO_2

For SO_2 emission calculation from combustion of following fuels: residual fuel oil, diesel and gasoline, Croatia calculates national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type.

For Bunker Fuel Oil the sulphur content of fuel for pre-2006 was 2.7% wt. [source: Lloyd's Register, 1995]; For European Union as specified in the Directive 2005/33/EC 1.5 % wt. from 11th August 2006 for Baltic sea and in EU territorial seas, exclusive economic zones and pollution control zones; and 0.1 % wt. from 1 January 2010 for inland water way vessels and ships at berth in Community.

International maritime navigation (NFR 1.A.3.d.i (i))

Emissions from International maritime navigation source category (NFR 1.A.3.d.i (i)) are calculated using the Tier 1 EMEP / EEA methodology, as this source category is not a key source. Emissions from 1.A.3.d.i (i) are not included in the national total emissions and are shown as memo items.

Emission factors are expressed as the quantity of pollutant emissions per GJ fuel consumed by types. Recommended Tier 1 EF from GB2023 were used for fuel: fuel oil and diesel. For pollutants for which EF are not recommended in GB2023, EF from *The EMEP / CORINAIR Atmospheric emission inventory Guidebook - Second Edition (1999)* and *The Emission factors manual PARC ATMOS - Emission factors for air pollutants (1992)* were used.

Relevant activity data for Tier 1 approach is fossil fuel consumption data by fuel types from annual national energy balances. International bunkers of ships are included in the national energy balance as a separate data only from 1994 onwards, while for period from 1990 to 1994 the data is based on expert judgment.

Trends of fuel consumed in NFR sector 1.A.3.d.i (i) are shown in Figure 3.4-5.

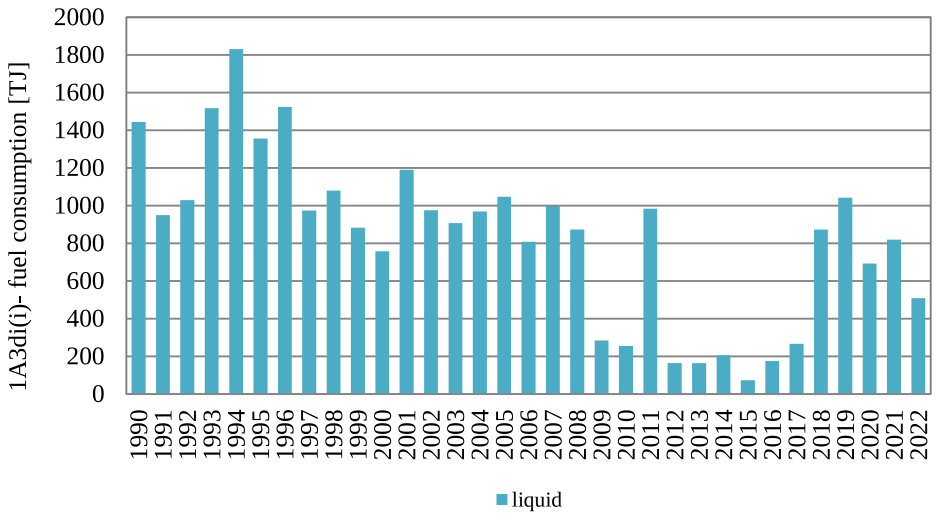


Figure 3.4-5 Activity data on fuel consumption for NFR 1.A.3.d.i (i)

National navigation (shipping) (NFR 1.A.3.d.ii)

In the national inventory, the NFR source category 1.A.3.d.ii national navigation (shipping) is a key source of NOx emissions and therefore emissions from this category are calculated by EMEP/EEA Tier 2 methodology according to GB2023.

Lubricants used in domestic maritime and inland navigation are included in the emission calculation.

For all pollutants, except for NOx, NMHOS i PM (TSP, PM_{10} and $PM_{2,5}$), Tier 2 emission factors for a given fuel type are equal to the recommended Tier 1 emission factors for each of the different fuel types according to GB2023.

Using the proposed methodology and recommended Tier 2 EF's according to GB2023 (Table 3-4, Chapter: 1-a-3-d-navigation) for NOx and PM, that are provided for 2000, 2005 and 2010, together with specific fuel consumption (fuel/kWh) by engine type, NOx emission factors were calculated for all years from 1990 to 2022 and are given in Table 3.4-3.

Table 3.4-3 Estimated Tier 2 NOx emission factors for NFR 1.A.3.d.ii, 1990-2022

Engine type	Gas turbine	High-speed diesel	Medium-speed diesel	Slow-speed diesel	Steam turbine
Fuel type	MDO/MGO	MDO/MGO	MDO/MGO	MDO/MGO	MDO/MGO
1990 - 2000*	19.7	59.1	65.0	91.9	6.9
2001	19.6	58.7	64.6	91.2	6.8
2002	19.4	58.3	64.2	90.6	6.8
2003	19.3	57.9	63.9	89.9	6.7
2004	19.1	57.5	63.5	89.3	6.7
2005*	19.0	57.1	63.1	88.6	6.6
2006	18.9	56.7	62.6	88.2	6.6
2007	18.7	56.3	62.1	87.8	6.5
2008	18.6	55.9	61.6	87.3	6.5
2009	18.4	55.5	61.1	86.9	6.4
2010	18.3	55.1	60.6	86.5	6.4
2011	18.2	54.7	60.2	85.7	6.4
2012	18.1	54.3	59.7	84.9	6.3
2013	17.9	53.9	59.3	84.1	6.3
2014	17.8	53.5	58.8	83.3	6.2
2015	17.7	53.1	58.4	82.5	6.2
2016	17.6	52.7	57.9	81.9	6.1
2017	17.4	52.3	57.5	81.3	6.1
2018	17.3	51.9	57.0	80.7	6.1
2019	17.2	51.5	56.6	80.0	6.0
2020	17.0	51.1	56.2	79.4	6.0
2021	16.9	50.7	55.8	78.7	5.9
2022	16.8	50.4	55.5	78.3	5.9

** - Default emission factors from the table 3-3-4, GB2023, 1-a-3-d-navigation*
MDO/MGO –Marine Diesel Oil / Marine Gas Oil

NMVOC factors were derived as being 98 % of the original HC value (based on reported CH4 factors from IPCC (1997)) and taken from the Table 3-9 (GB2023, 1-a-3-d-navigation).

For small recreational craft, the recommended Tier 2 emission factors according to Tables 3-5 of GB2023 (1-a-3-d-navigation) were used.

The Tier 2 approach 2 (like Tier 1) uses fuel consumption by fuel type (bunker fuel oil, marine diesel oil/gas oil) from annual national energy balances, but requires country specific data on the proportion of fuel used by fuel type and engine type (slow, medium or high speed diesel engines, steam turbines, gas turbines) which are calculated on the basis of data on the annual number of ship arrivals in sea and river ports of the Republic of Croatia. The trend of fuel consumption in NFR 1.A.3.d.ii is given in Figure 3.4-6.

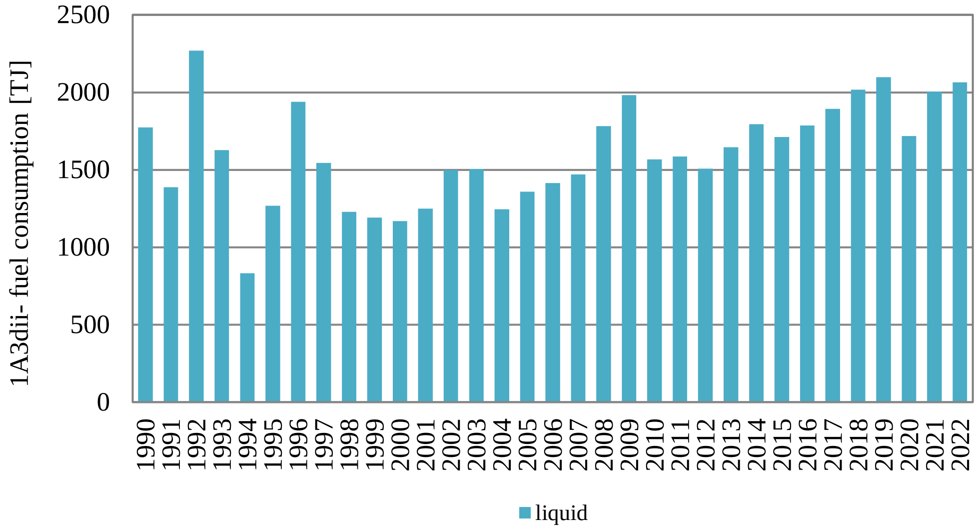


Figure 3.4-6 Activity data on fuel consumption for NFR 1.A.3.d.ii

Data on the annual number of ship arrivals in Croatian seaports were obtained for the period from 2013 to 2022 and classified according to the required ship categories (GB2023) and shown in Table 3.4-4. Data for the period from 1990 to 2013 are not available, and data on annual arrivals at seaports for 2013 were used for that period.

Table 3.4-4 Data on the annual number of arrivals at seaports by ship category, 1990-2021

Ship category	1990 - 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Liqiud bulk ships	163	841	965	1051	1405	1302	997	1059	782	1019
Dry bulk ships	131	278	241	334	281	263	160	134	94	362
Container	168	431	410	424	440	451	458	490	220	368
General cargo	601	1635	1843	1317	1254	1170	2796	2920	2275	3223
Ro ro cargo	5	784	1088	1830	1508	3975	4444	4724	3400	5018
Passenger	1900	168478	292160	320746	315345	350749	361184	238775	60788	347153
Fishing	99	19332	26704	30139	27603	24940	22630	18362	741	17867
Tugs	51	570	883	1039	1049	823	813	1003	22	9669
Other	292	2463	2952	3156	4807	5233	5995	5695	3952	1120

Data on the annual number of ship arrivals in river ports of the Republic of Croatia for domestic transport were obtained for the period from 2003 to 2022 and are shown in Table 3.4-5. For the period from 1990 to 2002, data on the annual number of arrivals in river ports for 2003 were used. Data on the annual number of ship arrivals in river ports of the Republic of Croatia for domestic river transport for the period 2003 - 2021 were obtained only for the port of Osijek, while for the port of Vukovar data for international river transport were obtained. No data were available for the ports of Sisak and Slavonski Brod. For the year 2022 data for all rivers ports were obtained.

Table 3.4-5 Data on the annual number of arrivals at river ports by ship category, 1990 – 2022

Ship category	1990 - 2003	2004	2005	2006	2007	2008	2009	2010	2011
Tugs	10	15	19	23	20	14	17	2	1
Other	15	10	21	18	14	11	12	5	1

Ship category	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Tugs	0	9	11	2	8	10	10	5	8	43	458
Other	1	7	4	9	7	9	5	5	5	381	503

For recreational craft, existing data on the quantities of gasoline from the official national energy balances for the period 1990 to 2003 were used, which are distributed between maritime and inland navigation on two-stroke and four-stroke gasoline engines, as shown in Table 3.4-7. The shares of two-stroke and four-stroke gasoline engines are given in table 3.4-6.

Quantities of diesel fuel for recreational vessels in the official National energy balances have not yet been separated from the total consumption of diesel fuel in maritime transport. Given the above, it was not possible to calculate emissions from diesel fuelled recreational craft. Given that the quantities of diesel sold to recreational craft are included in the quantities of diesel for "large ships", the calculated emissions will be "slightly" overestimated. The overestimation of emissions results from higher recommended emission factors for „large ships”, than for recreational craft in accordance with GB2023.

Table 3.4-6 Share of 2-stroke and 4-stroke gasoline engines in maritime and river transport for recreational craft

Share	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2-stroke engine	66%	66%	66%	65%	65%	65%	64%	64%	64%	63%
4-stroke engine	34%	34%	34%	35%	35%	35%	36%	36%	36%	37%

Share	2000	2001	2002	2003
2-stroke engine	63%	63%	63%	62%
4-stroke engine	37%	37%	37%	38%

Source: MESD, 2020, lit. 39

Table 3.4-7 Data on gasoline quantities for 2-stroke and 4-stroke gasoline engines for maritime and river transport

Unit: GJ	Maritime navigation		Inland navigation	
	2-stroke gasoline	4-stroke gasoline	2-stroke gasoline	4-stroke gasoline
1990	21626	10952	1402	710
1991	13830	7108	897	461
1992	222924	116259	14456	7539
1993	5477	2898	355	188
1994	2725	1463	177	95
1995	16268	8857	1055	574
1996	8093	4469	525	290
1997	8053	4509	522	292
1998	8013	4549	520	295
1999	7973	4589	517	298
2000	7933	4629	514	300

Unit: GJ	Maritime navigation		Inland navigation	
	2-stroke gasoline	4-stroke gasoline	2-stroke gasoline	4-stroke gasoline
2001	10525	6224	683	404
2002	7855	4708	509	305
2003	7816	4747	507	308

Source: MESD, 2020, lit. 39

Using the Tables 3-6 and 3-7 from GB2023, 1-a-3-d-navigation, the average main engine power for all years 1990-2020 were calculated by applying the 1997 values for all years up to 1997. For the years between 1997 and 2010, the data were interpolated by the existing data, and for the years after 2010 the values for 2010 were used. These data are given in the table 3.4-8.

Table 3.4-8 Estimated average main engine power (kW) by ship category for the period 1990-2022

Ship category	Liquid bulk ship	Dry bulk ship	Container	General cargo	Ro Ro Cargo	Passenger	Fishing	Other	Tugs
1990 – 1997	6695	8032	22929	2657	7898	3885	837	2778	2059
1998	6683	7752	22309	2649	7613	4370	829	2754	2057
1999	6672	7473	21689	2641	7328	4856	821	2730	2055
2000	6660	7193	21069	2633	7043	5341	813	2707	2053
2001	6648	6914	20450	2626	6758	5827	805	2683	2051
2002	6637	6634	19830	2618	6473	6312	797	2659	2049
2003	6625	6354	19210	2610	6188	6798	789	2635	2047
2004	6613	6075	18590	2602	5904	7283	782	2612	2045
2005	6601	5795	17970	2594	5619	7769	774	2588	2043
2006	6590	5515	17350	2586	5334	8254	766	2564	2041
2007	6578	5236	16731	2579	5049	8740	758	2540	2039
2008	6566	4956	16111	2571	4764	9225	750	2517	2037
2009	6555	4677	15491	2563	4479	9711	742	2493	2035
2010 - 2022	6543	4397	14871	2555	4194	10196	734	2469	2033

Recreational craft and work boats are not included in the category "maritime transport and inland navigation". Recreational vessels include boats, personal boats, yachts and other recreational vessels.

Emissions from the combustion of gasoline from recreational craft were calculated using the Tier 2 methodology for the period from 1990 to 2003, when data were available in the annual national energy balances, and it is assumed that all gasoline engines are of the conventional type.

Activity data used for emission calculation for the category NFR 1.A.3.d.ii are presented graphically in the figure 3.4-7.

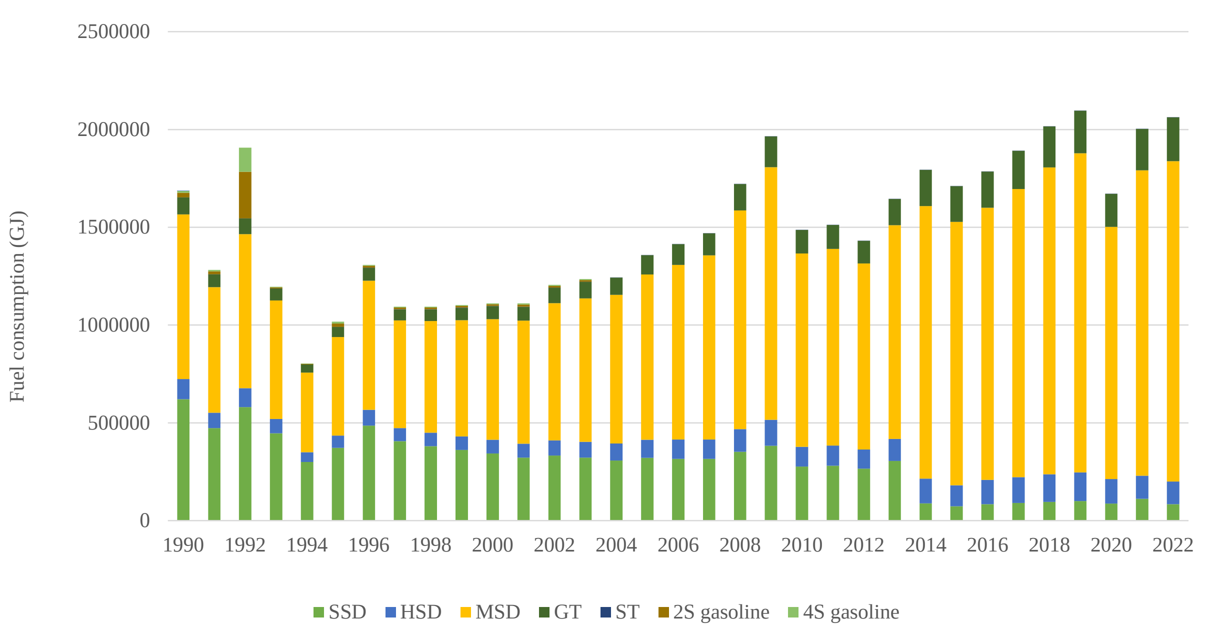


Figure 3.4-7. Fuel consumption broken down by engine type for NFR category 1.A.3.d.ii.
* SSD – Slow speed diesel, MSD – Medium speed diesel, HSD – High speed diesel, GT – Gas turbine, ST – Steam turbine; 2S gasoline – two stroke gasoline engine; 4S gasoline – four stroke gasoline engine

Recalculations and improvements

Road transport (NFR 1.A.3.b)

Emissions has been recalculated due to the transition to a new version of the COPERT model (5.7.2). In the COPERT database vehicles that are classified as light trucks with a load capacity above 3.5 t in the MUP's vehicle database are added. They have been added for the series from 2012 to 2021 in the Light duty vehicles in NII category. For the series from 2012 to 2021, electric vehicles were added to the database. Due to the aforementioned changes, the recalculations of the emissions of all reported pollutants have changed. Compared to last year's submission, emissions changed between 1% and 7% for all pollutants except heavy metals. In 2022, emissions are higher by over 100% in category 1A3bvi Tire and brake wear. The reason for such a large increase is, apart from the use of a new version of the COPERT model in which the FE has been revised and the inclusion of electric vehicles in the database.

Navigation (shipping) (1.A.3.d)

The emissions of heavy metals for 2021 were recalculated due to the correction of the AD for lubricants, and the emissions of all pollutants for the year 2007 were recalculated due to the corrections of the AD for diesel fuel, which resulted in a reduction of emissions.

3.5. Small combustion (NFR 1.A.4.i)

Source category description

The source category 1.A.4.i Small combustion takes into account stationary combustion under NFR sectors 1.A.4.a.i Commercial/Institutional, 1.A.4.b.i Residential, 1.A.4.c.i Agriculture/Forestry, and cover combustion installations with a thermal capacity ≤ 50 MW_{th}. Small combustion activities are commercial and institutional heating, residential heating and cooking, agriculture/ forestry and other stationary combustion (including military). Residential heating includes fireplaces, stoves, cookers, small boilers (< 50 kW) while institutional/

commercial/ agricultural/ other heating include heating - boilers, space-heaters (> 50 kW), and smaller-scale combined heat and power generation (CHP).

Emissions from smaller combustion installations are significant due to their numbers, different type of combustion techniques employed, and range of efficiencies and emissions. Many of them have no abatement measures nor low efficiency measures. In the residential sector in particular, the installations are very diverse, strongly depending on national and regional factors including quality of fuel supply.

Methodology, emission factors, activity data

For all pollutants, except for SO_2, the recommended emission factors from GB2023 are used. For SO_2, the national emission factors for all liquid fuels are used for the entire reported trend. National data are given in table Appendix 2.

Commercial/Institutional (NFR 1.A.4.a)

Methodology for emission calculation is Tier 1 EMEP/EEA, performed by multiplying total fuel sold (disaggregated by fuel type) with emission factors. Sector NFR 1.A.4.a Commercial/Institutional is not a key source.

Country specific EF for SO_2

For SO_2 emission calculation from combustion of following fuels: coals, residual fuel oil, kerosene and gas oil, Croatia calculates national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type.

For SO_2 emission calculation from combustion of following fuels: petroleum coke, gas works gas, LPG, natural gas and wood, Croatia use default EF SO_2 from GB2023.

Emission factors are expressed as the quantity of emissions of pollutants per GJ fuel consumed.

Structure of fuel combustion in Commercial/Institutional sector for the historic period is presented in Figure 3.5-1.

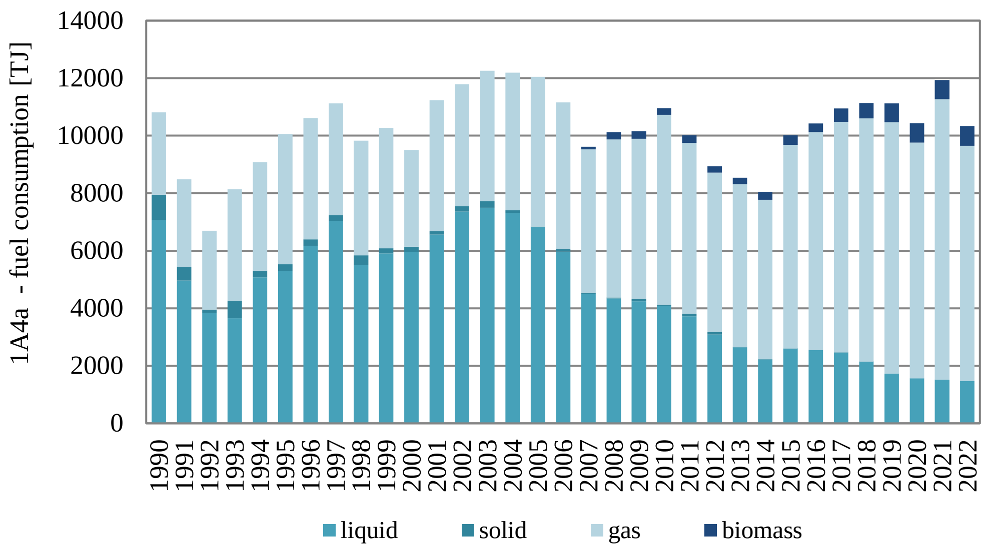


Figure 3.5-1 Activity data on fuel consumption by fuel type for NFR 1.A.4.a

Residential (NFR 1.A.4.b.i)

Within Small combustion source category only 1.A.4.b.i Residential is a key source, so Tier 2 EMEP/EEA methodology was applied for emission calculation. Tier 2 methodology was applied. The application of Tier 2 methodology implies knowledge of the structure and combustion techniques applied in residential since 1990 onwards for the territory of the Republic of Croatian. The model was created for solid and biomass fuel types on technology (furnaces) installed with assumed time of entering of certain technologies into usage.

The improvement of the emission calculation for biomass combustion in Residential combustion was carried out in 2019, on the basis of which a new model for biomass was created. Until then, the inventory has used a model that included IIASA GAINS data for the Republic of Croatia and expert assessment of the share for technologies with low emissions according to Table 3.5-1. These shares were also used to create the current emission projections. For the years between the years listed in the Table 3.5-1, the shares of each technology are calculated using the linear interpolation method.

Table 3.5-1 Technology shares according to IIASA GAINS model and expert assessment for the Republic of Croatia

Technology type for biomass combustion	GAINS model		Expert assessment
	1990	2005	2010
Open fireplaces	4.4%	5.9%	6.0%
Boilers (manual feed)	39.4%	29.4%	18.4%
Conventional stoves	56.2%	64.7%	44.5%
Advanced /ECO-labelled stoves	0%	0%	31.0%
Pellet stoves and boilers	0%	0%	0.1%

Source: IIASA GAINS; Ekonerg Ltd.

During 2017, households were surveyed in four agglomerations of the Republic of Croatia, five zones and one city related to the use of energy in households and present biomass combustion technologies. The surveys were carried out within the framework of the project: "Creating a register of pollutants with spatial distribution in the high resolution EMEP grid". In addition to these surveys, the creation of a new model for biomass also includes surveys conducted in 2019 by the EIHP on the same topic and surveys conducted with sellers of biomass stoves and boilers. As the surveys conducted in 2017 did not provide any response for the presence of technology - ECO-labelled stoves / boilers that were included in the previous emission inventory (Table 4.5-1), and answers were provided for the existence of highly efficient stoves / boilers it was necessary to further explore the representation of these two technologies in the domestic market. The study confirmed that ECO-labelled stoves/boilers are sold domestically, but because of the expensiveness of these and the absence of subsidies, their sales are not high. Based on the information received, it is estimated that they are installed in households at a slightly higher percentage than pellet stoves / boilers. The results of the surveys, statistical analysis of the results, proposed and selected new shares of biomass combustion technologies in small combustion plants and other details related to the creation of a new model for biomass within this emission category are presented in the document "The Report on improvement made for the Energy Sector" part of the Agreement for the service for preparation of Improvement of emission inventories under LRTAP Convention for sectors: Energy, Agriculture and Production Processes 800/02-19/39JN, Executor: Ekonerg Ltd. for the Client: MESD.

A combined set of averages for zones and agglomerations with processed results of surveys conducted in 2019 was selected for the proposal of new shares (Table 3.5-2) were considered, which takes into account the whole of Croatia. In this way, a more complete picture of the representation of a particular technology is obtained, which also includes the specifics of each of agglomeration, one city and zones, since they are used in the assessment of air quality.

Table 3.5-2 Three sets of combustion technology share according to the results of the surveys in 2017 and 2019 with the estimated set share for 2017

Technology type for biomass combustion	Survey analysis results for 2017 for agglomerations and one city	Survey analysis results for 2017 for zones	EIHP survey analysis results for 2019 for Croatia	Estimated set for 2017
Open fireplaces	12.5%	5.3%	13.29%	10.4%
Boilers (manual feed)	11.2%	21.4%	22.39%	18.3%
Conventional stoves	32.9%	34.7%	39.72%	35.8%
Advanced /ECO-labelled stoves	14.1%	10.6%	10.93%	11.9%
high-efficiency stoves	28.1%	21.1%	12.86%	20.7%
Pellet stoves and boilers	1.3%	7.0%	0.80%	3.0%
Total	100.0%	100.0%	100%	100.0%

Source: Ekonerg Ltd.

The estimated set for 2017, i.e. new shares of biomass combustion technologies in residential, indicated that the share of fireplaces technology proposed by IIASA GAINS for Croatia was partially underestimated, so new estimation of share for 1990 and 2005 were started. The estimate included a linear interpolation method using the results of surveys, i.e. the estimated set of technology shares for 2017, GAINS share data for Croatia for 1990, 2005 and 2010 as a starting point for correction and GAINS increase / decrease factors between 2005 and 1990 and between 2010 and 2005. With the help of the increase / decrease factors for the years 2005 and 2010 and the estimated set of technology shares for 2017, the shares for the historical year 2005 were first corrected. With the help of the increase / decrease factors for 1990 and 2005 and the obtained corrected shares for the historical 2005, the shares for the historical 1990 were then adjusted. For the years between 1990-2005, 2005 - 2010, 2010 - 2017, the shares of each technology were calculated using the linear interpolation method. The results of the corrections made and the newly proposed model for biomass are presented in Table 3.5-3.

The assumption used for wood biomass combustion appliances is that the influence of new technologies has been going on since 2005, when the market sale / use of technologies with lower emissions were approximately start in Croatia. It is believed that this increase will, from the PM emission point of view, give a more realistic national picture of both the emissions and the correlation of these emissions with the concentrations of particulate matter in the air and the assessment of air quality in zones and agglomerations. From 2020, the shares of wood biomass combustion technologies are being modelled. The modelling includes the use projected national energy demand data to achieve a competitive low-carbon economy by 2050, in line with the European Strategic Guidelines and in accordance with the obligations of the United Nations Framework Convention on Climate Change (UNFCCC) and projected shares of wood biomass technologies that are being changed to achieve the set national reduction commitments for 2030 for $PM_{2.5}$ according to the National Emission Ceilings Directive and the amended Gothenburg Protocol under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention). The shares in 2050 remain the same as in 2030, assuming a conservative approach without further inflow of new technologies (see Chapter 9). The shares of wood biomass technologies used in Tier 2 method in the period from 2000 to 2021 are listed in table 3.5-3.

Table 3.5-3 Technology structure for biomass distribution in residential sector used for Tier 2 method for emission estimation

Year	Open fireplaces	Boilers (manual feed)	Conventional stoves	Advanced /ECO-labelled stoves	High-efficiency stoves	Pellet stoves and boilers
2000	9.5%	26.4%	64.2%	0%	0%	0%
2001	9.6%	25.7%	64.7%	0%	0%	0%
2002	9.7%	25.0%	65.3%	0%	0%	0%
2003	9.8%	24.4%	65.9%	0%	0%	0%
2004	9.9%	23.7%	66.4%	0%	0%	0%
2005	10.0%	23.0%	67.0%	0%	0%	0%
2006	10.0%	22.7%	64.4%	1.0%	1.7%	0.3%
2007	10.0%	22.3%	61.8%	2.0%	3.5%	0.5%
2008	10.1%	21.9%	59.2%	3.0%	5.2%	0.8%
2009	10.1%	21.5%	56.6%	4.0%	6.9%	1.0%
2010	10.1%	21.1%	54.0%	4.9%	8.6%	1.3%
2011	10.2%	20.7%	51.4%	5.9%	10.4%	1.5%
2012	10.2%	20.3%	48.8%	6.9%	12.1%	1.8%
2013	10.2%	19.9%	46.2%	7.9%	13.8%	2.0%
2014	10.3%	19.5%	43.6%	8.9%	15.5%	2.3%
2015	10.3%	19.1%	41.0%	9.9%	17.3%	2.5%
2016	10.3%	18.7%	38.4%	10.9%	19.0%	2.8%
2017	10.4%	18.3%	35.8%	11.9%	20.7%	3.0%
2018	10.1%	17.8%	34.8%	12.2%	21.3%	3.9%
2019	9.8%	17.3%	33.9%	12.7%	22.2%	4.0%
2020	9.6%	16.9%	32.9%	13.3%	23.2%	4.2%
2021	9.3%	16.4%	32.0%	13.8%	24.1%	4.4%

Source: Ekonerg Ltd.

For coal, two types of technology were assumed: (I) coal combustion in heating stoves and (II) coal combustion in single house boilers (<50 kW). For years in the period 1990 - 2005 the representation of each of technology are calculated by linear regression method, and for years between 2010 and 2030, the extrapolation method was used (table 3.5-4).

Table 3.5-4 Technology structure for solid fuel (coal) distribution in residential sector used for Tier 2 method for emission estimation

Year	single house boilers (<50 kW)	heating stoves
1990.	46.2%	53.8%
2000	56.4%	43.6%
2001	57.4%	42.6%
2002	58.5%	41.5%
2003	59.5%	40.5%
2004	60.5%	39.5%
2005	61.5%	38.5%
2006	62.6%	37.4%
2007	63.6%	36.4%
2008	64.6%	35.4%
2009	65.6%	34.4%
2010	66.7%	33.3%
2011	63.4%	36.6%
2012	60.2%	39.8%
2013	56.9%	43.1%
2014	53.7%	46.3%
2015	50.4%	49.6%
2016	47.2%	52.8%
2017	44.0%	56.0%
2018	40.7%	59.3%

Year	single house boilers (<50 kW)	heating stoves
2019	37.5%	62.5%
2020	34.2%	65.8%
2021	31.0%	69.0%
2030	1.8%	98.2%

Source: the GAINS model (for years 1990, 2005, 2010, 2030), Ekonerg Ltd.

For liquid and gaseous fuels, the GAINS model does not presume different technologies, so for those fuels it is assumed that correspond technologies defined by the GB2023 are represented in equal proportions for the period since 1990 (Table 3.5-5). For liquid fuels two possible technologies in accordance with GB2023 were considered: (I) liquid fuel combustion in heating stoves and (II) liquid fuel combustion in single house boilers (<50 kW). For gaseous fuels two possible technologies in accordance with GB2023 were considered: (I) gaseous fuel combustion in fireplaces and (II) gaseous fuel combustion in single house boilers (<50 kW). It is also assumed that advanced technologies such as energy efficient stoves burning wood, advanced / ecolabelled stoves and boilers burning wood and pellet stoves and boilers burning wood pellets are for now minimally represented in Croatia and as such are neglected in the calculation.

Table 3.5-5 Technology structure for liquid and gaseous fuel distribution in residential sector

Fuel type	Technology	Period since 1990
Liquid fuel	heating stoves	50%
	single house boilers (<50 kW)	50%
Gaseous fuel	fireplaces	50%
	single house boilers (<50 kW)	50%

Source: the EMEP/EEA GB2023

Two types of solid fuel were used in Residential sector in the Republic of Croatia; lignite and sub-bituminous coal, of liquid fuel: residual fuel oil, gas oil and kerosene, and of gaseous fuels: liquefied petroleum gas and natural gas. Structure of fuel combustion in Residential sector for the historic period is presented in Figure 3.5-2.

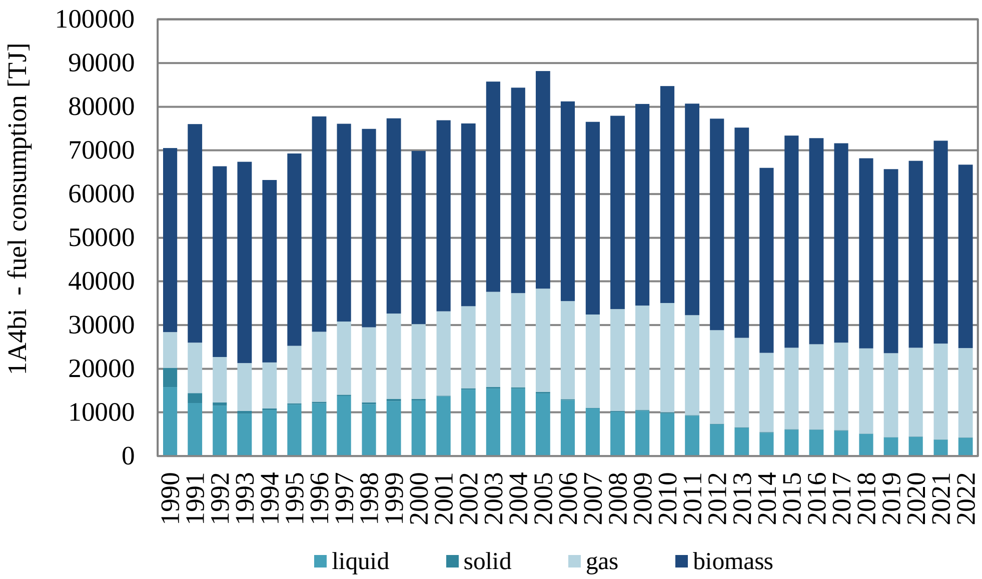


Figure 3.5-2 Activity data on fuel consumption by fuel type for NFR 1.A.4.b.i

Emission factors are expressed as the quantity of emissions of pollutants per GJ fuel consumed. Emission factors are stratified by fuel types and are default Tier 2 from GB2023 except for SO_2.

Country specific EF for SO_2

For SO_2 emission calculation from combustion of following fuels: coals, residual fuel oil, gas oil and kerosine, Croatia calculatess national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type. National SO_2 emission factor for solid fuels assumed two type that are used in Croatia: lignite and sub-bituminous coal with net calorific value of 12.25 GJ/t and 18.2 GJ/t respectively, with their average value of sulphur content of 1.67%, and sulphur ash retention factor of 0.1.

For SO_2 emission calculation from combustion of following fuels: petroleum coke, gas works gas, liquefied petroleum gases, natural gas and wood, Croatia use default EF SO_2 from GB2023.

Agriculture/Forestry (NFR 1.A.4.c.i)

Methodology for emission calculation is Tier 1 EMEP/EEA, performed by multiplying total fuel sold (disaggregated by fuel type) with emission factors. Sector NFR 1.A.4.c.i Agriculture/Forestry is not a key source. Emission factors are expressed as the quantity of emissions of pollutants per GJ fuel consumed. All emission factors are default Tier 1 from GB2023.

Structure of fuel combustion in Agriculture/Forestry sector for observed period is presented in Figure 3.5-3.

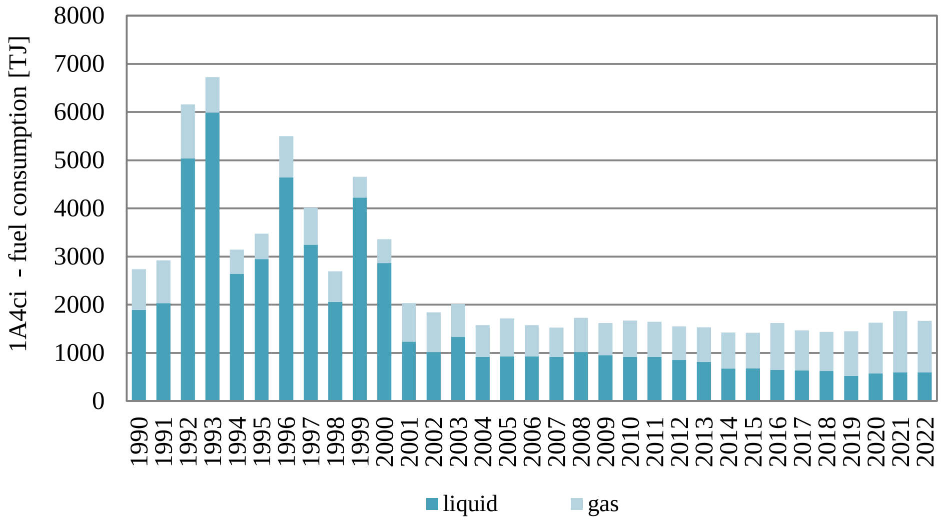


Figure 3.5-3 Activity data on fuel consumption by fuel type for NFR 1.A.4.c.i

Recalculations and improvements

Residential (1.A.4.b.i)

Emissions have been recalculated for the entire historical period due to the update of EFs in GB 2023 for fossil fuels, i.e. natural gas, working gas, LPG (reduced level 1 FEs for As, Hg, and PCDD/F and PAHs have been removed from inventory), for solid fuels in boilers (reduced EFs of level 1 for Cd) and biomass - firewood (reduced FEs of level 2 for NH_3).

3.6. Non-road mobile sources and machinery (NFR 1.A.4.ii, 1.A.2.g.vii)

Source category description

Non-road mobile sources and machinery source category covers a mixture of 'other' equipment. In Croatian inventory emissions are reported in following NFR sectors in the scope of 1.A.4.ii Non road mobile source and machinery: 1.A.4.b.ii Residential, 1.A.4.c.ii Agriculture/Forestry and 1.A.2.g.vii Mobile Combustion in manufacturing industries and construction. Types of equipment used in manufacturing industries and construction (hereafter Industry) include: Asphalt pavers/concrete pavers (SNAP 080801), Plate compactor/tampers/rammers (SNAP 080802), Rollers (SNAP 080803), Trenchers/mini excavators (SNAP 080804), Excavators (wheel / crawler type) (SNAP 080805), Cement and mortar mixers (SNAP 080806), Cranes (SNAP 080807), Graders/scrapers (SNAP 080808), Off-highway trucks (SNAP 080809), Bulldozers (SNAP 080810), Tractors / loaders/backhoes (SNAP 080811), Skid steer loaders (SNAP 080812), Dumpers/tenders (SNAP 080813), Aerial lifts (SNAP 080814), Fork lifts (SNAP 080815), Generator sets (SNAP 080816), Pumps (SNAP 080817), Air/gas compressors (SNAP 080818), Welders (SNAP 080191), Refrigerating units (SNAP 080820), Other general industrial equipment (sweepers, scrubbers, broomers, pressure washers, slope and brush cutters, swappers, piste machines, ice rink machines, blowers, vacuums, etc.) (SNAP 080821), Other material handling equipment (conveyors, tunnel locomotives, snow clearing machines, industrial tractors, pushing tractors) (SNAP 080822), and Other construction equipment (paving and surfacing equipment, bore/drill rigs, crushing equipment, peat break machines, concrete breakers/saws, pipe layers, etc.) (SNAP 080823). Types of equipment used in Agriculture/Forestry include: Two-Wheel Tractors (SNAP 080601), Agricultural tractors (SNAP 080602), Harvesters/combiners (SNAP 080603), Others (e.g. sprayers, manure distributors, mowers, balers, tillers, swatchers) (SNAP 080604), Professional chain saws/clearing saws (SNAP 080701), Professional chain saws/clearing saws (SNAP 080701), Forest tractors/harvesters/skidders (SNAP 080702), Others (tree processors, haulers, fellers, forestry cultivators, shredders and log cultivators) (SNAP 080703). Types of equipment used in Residential (Household and gardening) include: Trimmers/edgers/brush cutters (SNAP 080901), Lawn mowers (SNAP 080902), Hobby chain saws (SNAP 080903), Snow mobiles/skidoos (SNAP 080904), Other household and gardening equipment (SNAP 080905), Other household and gardening vehicles (all-terrain vehicles, off-road motor cycles, golf carts, etc.) (SNAP 080906).

For all types of equipment, the emissions originate from fuel combustion that powers the equipment.

For emissions that occur in sector 1.A.4.c.iii Agriculture/Forestry/Fishing: National fishing Croatia is using notation key "IE" and those emissions are included in NFR 1.A.3.d.ii (based on total amount of fuel for national navigation, maritime and river transport).

Methodology, emission factors and activity data

For all pollutants, except for SO_2, the recommended emission factors from GB2023 are used. For SO_2, the national emission factors for all liquid fuels are used for the entire reported range. National data are given in table Appendix 2.

The source categories 1.A.4.b.ii, 1.a.2.g.vii and 1.A.4.c.ii form the category Non-road mobile sources and machinery is a key source in Croatian inventory and Tier 2 technology-dependent advance method proposed in EMEP/EEA GB2023 is used. In essence, this advance method involves sub-dividing the fuel consumption of fuel type used by the NFR sectors into the different technology types.

In the category 1.A.4.b.ii, emissions from lubricants are calculated with Tier 1 methodology.

Emission factors are expressed as the quantity of emissions of pollutants per tonnes of fuel consumed. All emission factors are default Tier 2 from GB2023, stratified by fuel type, NFR sector, pollutant and are grouped according to the EU emission legislation stages, and three additional layers are added to cover the emissions from engines prior to the first EU legislation stages.

For heavy metals and POPs, GB2023 is proposing the use of emission factors for Tier 1. That is because for some pollutants (e.g. heavy metals, SO_2 and CO_2,) the emission factors are independent of the equipment technology, i.e. are simply fuel derived. The key species, which do vary with differing equipment technologies, are particulate matter, NOx, NMVOC and CO.

Country specific EF for SO2

For SO_2 emission calculation from combustion of following fuels: diesel, gasoline, kerosene, gas oil and residual fuel oil, Croatia calculates national emission factors on yearly base. This SO_2 EFs are calculated on the base of annual fuel (produced and put on the market) by type and sulphur amount in fuels by type.

For SO_2 emission calculation from combustion of following fuels: gas works gas, liquefied petroleum gases and natural gas, Croatia use default EF SO_2 from GB2023.

Basic activity data is the fuel consumption data for the different NFR categories from national energy balance annually (Figure 4.6-1). These fuel consumption data are split by the relative proportion of engine technology (< 1981, 1981–1990, 1991–Stage I, Stage I, Stage II, Stage IIIA, Stage IIB, Stage IV) for each particular inventory year. Alternative approach uses data derived from Winther & Nielsen (2006) to split the total fuel consumption into engine technology layers for each inventory year. The percentage split of total fuel consumption as a function of engine age are given for diesel machinery in 1.A.2.g.vii, and 1.A.4.c.ii (Agriculture) and for gasoline two-stroke and four-stroke machinery. The layer share of fuel consumption per engine age and inventory year for diesel-fuelled non-road machinery and gasoline fuelled non-road machinery are used. For splitting gasoline consumption between two-stroke and four-stroke gasoline machinery, the Danish fuel consumption percentage split (25/75) is used in all inventory years, having in mind that it is regarded as very uncertain.

In accordance with the distribution in the national energy balance, the consumption of fuels for off-road mobile machinery in category 1.A.4.a.ii Commercial / institutional: Mobile are included in Category 1.A.4.b.ii Residential: Mobile and 1.A.4.c.ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery, therefore the "IE" mark is used.

Also, fuel consumption in category 1.A.4.c.iii is included in category 1.A.3.d.ii National navigation (shipping) (based on the total amount of fuel intended for combustion in domestic air, sea and river transport) and the “IE” mark is used accordingly.

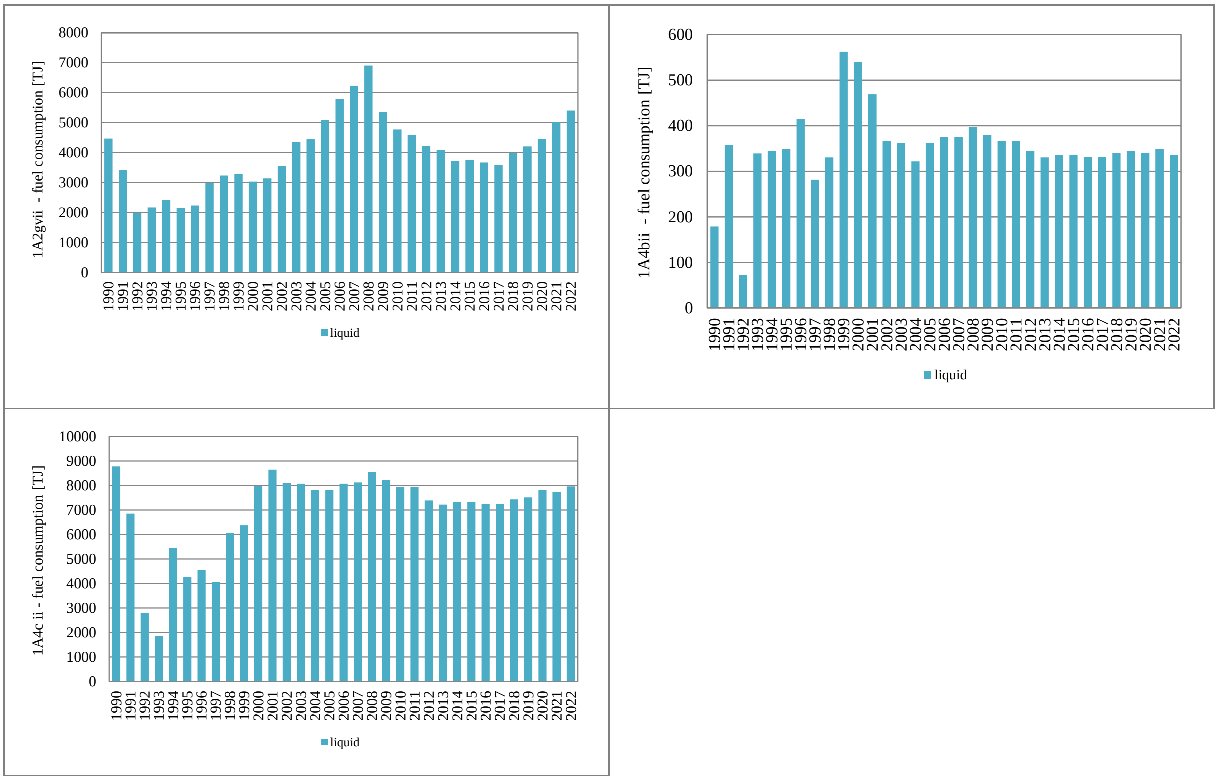


Figure 3.6-1 Activity data on fuel consumption for NFR codes 1.A.2.g.iv, 1.A.4.b.ii and 1.A.4.c.ii

Recalculations and improvements

There was no recalculation.

3.7. Other sectors (NFR 1.A.5.a, 1.A.5.b)

Source category description

Category 1.A.5 is included in IIR in order to improve the transparency of inventory information on military emissions. All military emissions in sector 1.A.5 are specified as included elsewhere (IE).

In national energy balance military fuel consumed are included in 1.A.4.a.i, 1.A.3.a, 1.A.3.b and 1.A.3.d. Data on fuel sold for each category are collected via annual questionnaire by Croatian statistical office. This amount of fuel includes as well fuel used for military purposes. Table 3.7-1 shows the link between the source category 1.A.5 and other source categories, where military emissions are included.

Dividing military from national specification is not possible because data for military only are not available and it is not economically justified because fuel used for military purposes is negligibly small for the whole historical period. It is most likely that contribution of military is below the threshold of significance.

Table 3.7-1 Military emissions specification

NFR code	Sector name	Notation key	NFR code where emissions are reported	Sector name where emissions are reported
1.A.5.a	Other stationary (including military)	IE	1.A.4.a.i	Commercial/Institutional: Stationary

NFR code	Sector name	Notation key	NFR code where emissions are reported	Sector name where emissions are reported
1.A.5.b	Other, Mobile (including military)	IE	1.A.3.a.i(i), 1.A.3.a.ii(i)	Domestic and International aviation LTO (civil)
			1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv	Road transport
			1.A.3.d.ii	National navigation (shipping)
			1.A.3.a.i(ii), 1.A.3.a.ii(ii)	International and Domestic aviation cruise (civil)
			1.A.3.d.i(i)	International maritime navigation

3.8. Fugitive emissions from fossil fuel (NFR 1.B)

Source category description

Source category NFR 1.B encompasses fugitive emissions from coal, oil and natural gas. During all stages of the production and use of fossil fuels, from the extraction to their final use, fuel components can be released in the form of fugitive emissions.

Key categories for the Energy sector - fugitive sources are shown in table 3.8-1. Key Category Analysis (KCA) is presented in section 1.5 and Appendix 1.

Table 3.8-1 Key sources of sector Energy - Fugitive

NFR Category	**NFR Category Name**	**Key Categories**	
		Pollutant	**KCA**
1B2aiv	Refining / Storage	SO2	L1, T1
		PM10	T1
		CO	L1
		Cd	T1
		Hg	L1
		Cu	T1
		Ni	L1
		Se	T1
1B2av	Distribution of oil products	NMVOC	L1
1B2b	Natural gas	Hg	T1

L1 = level assessment, tier 1, 2022

T1 = trend assessment, tier 1, 1990–2022

Below is a description of each category of fugitive emission sources from fuels present in Croatia in the observed historical period.

Fugitive emissions from solid fuels (NFR 1.B.1)

This source category refers to emissions from coal, which include activities coal mining and handling (NFR 1.B.1.a), solid fuel transformation (NFR 1.B.1.b) and other fugitive emissions from solid fuels (NFR 1) .B.1.c), for which Croatia does not report emissions but uses the code "NO".

In Croatian inventory, this category encompasses emissions from coal mining and handling, which was present in Croatia until 1999, as well as emissions from coal transformation (coke production), which was present until 1994. From 1990 to 1999, coal production in Croatia has been on a steady decline. Only Istrian underground coal mines were active and they produced 0.015 - 0.174 mil. tone of coal.

For other fugitive emissions from solid fuels (NFR 1.B.1.c) Croatia does not report emissions, i.e. the notation key "NO" is used.

All underground and surface coal mines activities result in fugitive emissions of CH_4, NMVOC and particulate matter, which arise during coal mining and handling. In addition, coke plant is a major source of fugitive emissions such as: SO_2, NOx, NMVOC, CH_4, CO_2, CO, NH_3, particulate matter and heavy metals as well as PAHs.

Fugitive emissions from oil and natural gas (NFR 1.B.2)

This source category includes subcategories: Oil - Exploration, production, transport (NFR 1.B.2.a.i), Fugitive emissions oil - Refining, storage (NFR 1.B.2.a.iv), Distribution of oil products (NFR 1.B.2.a.v), Natural gas – Exploration, production, transport (NFR 1.B.2.b), Venting and flaring (NFR 1.B.2.c), and Other fugitive emissions from energy production (NFR 1.B.2.d) – for which Croatia does not report emissions, i.e. the notation key "NO" is used.

This category encompasses fugitive emissions from various activities of exploration and production, refining, storage transport, processing and distribution of crude oil, petroleum products (gasoline) and natural gas. Fugitive emissions in this category also include emissions arising from gas flared on oil-and gas-production installations for safety, and emissions due to venting activities in oil and gas production.

Oil - Exploration, production, transport (NFR 1.B.2.a.i)

Exploration, production and transport of oil in the Republic of Croatia is carried out by the company INA Ltd. Number of active oil fields has changed over the years of the time series. The greatest quantities of oil come from the eight most significant fields, which contain 83% of total reserves discovered in Croatia. During the war (1991-1995), a significantly smaller number of oil fields were active. All fields in Croatia are “on shore” fields.

Natural gas - Exploration, production, transport (NFR 1.B.2.b)

Exploration and production of natural gas in Croatia is carried out by the company INA Ltd. Main gas fields, with 70 % of total reserves, are located in the three largest gas and gas condensate fields: Molve, Kalinovac and Stari Gradac. Molve provides between 70 % - 75 % of gas and condensate per year in Croatia. One of the old gas fields - Okoli, in the Sava Depression, has been turned into underground gas storage of the capacity of 500 mil. m^3. Additional information are provided in subchapter 4.2. (NFR 1.A.1), under the NFR 1.A.1.c category description.

Transmission is carried out by the transmission system operator - Plinacro Ltd and distribution system operators (36 companies). In addition, this category includes Hg emission that originates from the process of cleaning natural gas at the central gas station (Molve). Natural gas produced in Croatian gas fields contains a significant amount of Hg (516 $\mu g/m^3$), which has not been extracted from natural gas until 1992. In 1993, technology for Hg emission reduction was put in operation, resulting in reduced emission to about 0.12 $\mu g/m^3$.

Transmission system consists of international, main, regional and branch pipelines and supporting facilities, reducing and metering stations of various capacities, and other facilities and systems that enable reliable and secure gas transmission.

Fugitive emissions oil - Refining, storage (NFR 1.B.2.a.iv)

Refining/storage is carried out in oil refineries at two locations, in Rijeka (RNR) and Sisak (RNS). Production capacities of the refineries are shown in Table 4.2-2. Emissions calculation for RNS refinery includes emissions from FCC regenerators (without CO boiler), catalytic reforming unit, coking plant (since 1994) and Claus installation (since 2007). Since 2018, the unit for FCC has not been in operation, and since 2020, neither have the other units: the unit for catalytic reforming, the coking plant and the Claus plant. During 2021, only one source of emissions was active – Boiler K2 connected to Outlet 15 Central Chimney K2. Other discharges, including venting and flaring, were not active. During 2022, not a single emission source was active. Conservation of the RNS refinery is underway. For RNR refinery, emissions include FCC regenerators (without CO boiler), catalytic reforming unit (two units) and Claus installation (since 1997). In addition, emissions from storage and handling of petroleum products in refineries are included in calculations.

Distribution of oil products (NFR 1.B.2.a.v)

In Croatia, distribution of oil products takes place through the following activities:

- shipping and delivery of products at refinery dispatch stations (SNAP 050501),
- transport and depot stations (SNAP 050502), and
- reloading and handling of oil products at service stations (retail trade) (SNAP 050503).

Distribution is carried out by the company INA Ltd. Only gasoline is considered to be significant oil product for NMVOC emission occurring at the refinery site.

Shipping and delivery of products at refinery dispatch stations

Shipping and delivery of oil products is carried out at two refinery dispatch stations - in Sisak and Rijeka.
Shipping and delivery of gasoline in RNS refinery is carried out by road and rail transport, and by barge transport on the Sava River, at the port for receiving and unloading of crude oil and for loading the products on the barges. Shipping and delivery of gasoline, derivatives and tert-butyl methyl ether (MTBT) in RNR refinery is carried out through the terminals for road, rail and marine transport.

Gasoline transport and depot stations

Emissions from gasoline transport, in accordance with GB2023, were identified as negligible. This section includes emissions from gasoline storage at terminals. According to GB2023, the methodology for calculating emissions from gasoline storage at terminals in refineries is covered under the category 1.B.2.a.iv.

Service stations

Handling and manipulation of gasoline is carried out and at service stations. Majority of emissions at service stations are emissions from gasoline tanks, and GB2023 proposes only gasoline emission factors.

Venting and flaring (NFR 1.B.2.c)

Flaring represents controlled release of pollutants, including NOx, NMVOC, SO_2, CO, particles and heavy metals into the atmosphere. The inventory includes emissions from the two subcategories: flares in refineries and flares in gas and oil extraction.

Methodology, emission factors and activity data

Coal mining and handling (NFR 1.B.1.a)

Fugitive emissions from NFR 1.B.1.a (SNAP 050102 Underground mining and SNAP 050103 Storage of solid fuel) are calculated by Tier 1 EMEP/EEA methodology and with „top-down“ approach – by multiplying process specific activity data by corresponding EMEP/EEA Tier 1 emission factors (GB2023).

The source of activity data for the total mass of coal produced by underground mining for NFR 1.B.1.a is national energy balance. Annual amounts of coal produced are presented in Table 3.8-2.

Solid fuel transformation (NFR 1.B.1.b)

Fugitive emissions from NFR 1.B.1.b Fugitive emissions from solid fuel: solid fuel transformation (SNAP 040201 Coke oven (door leakage and extinction)) are calculated by Tier 1 EMEP/EEA methodology and „top-down“ approach, i.e. by multiplying process specific activity data by corresponding EMEP/EEA Tier 1 emission factors (GB2023).

Source of activity data for the production of coke is national energy balance. Annual amounts of coke produced are presented in Table 3.8-2.

Other fugitive emissions from solid fuel (NFR 1.B.1.c)

This category is not present in Croatia, thus notation key "NO" is used.

Oil - Exploration, production and transport (NFR 1.B.2.a.i)

Fugitive emissions from NFR 1.B.2.a.i are calculated by Tier 2 EMEP/EEA methodology, i.e. by multiplying process specific activity data by corresponding Tier 2 emission factors (GB2023).

Relevant activity data is annual mass of crude oil produced, which is taken from the national energy balance (Table 3.8-1).

Table 3.8-1 Activity data for NFR 1.B.1.a, 1.B.1.b, 1.B.1.c, 1.B.2.i and 1.B.3

NFR	1.B.1.a	1.B.1.b	1.B.1.c	1.B.2.a.i	1.B.3
Name	Coal mining / handling (quantities of coal produced)	Solid fuel transformation (quantities of coke produced)	Other fugitive emissions from solid fuel	Oil - Exploration, production and transport (quantities of crude oil produced)	Other fugitive emissions not included in 1.B.2
Unit	kt	kt	-	kt	-
1990	173.7	556.0	NA	2696.2	NO
1991	154.8	456.0	NA	1930.9	NO
1992	120.3	408.0	NA	1742.9	NO
1993	115.1	422.0	NA	1727.1	NO
1994	103.2	277.0	NA	1576.6	NO
1995	82.2	NO	NA	1500.3	NO
1996	66.3	NO	NA	1469.1	NO
1997	48.5	NO	NA	1496.2	NO
1998	50.8	NO	NA	1389.4	NO
1999	15.3	NO	NA	1292.7	NO
2000	NO	NO	NA	1213.9	NO

NFR	1.B.1.a	1.B.1.b	1.B.1.c	1.B.2.a.i	1.B.3
Name	Coal mining / handling (quantities of coal produced)	Solid fuel transformation (quantities of coke produced)	Other fugitive emissions from solid fuel	Oil - Exploration, production and transport (quantities of crude oil produced)	Other fugitive emissions not included in 1.B.2
Unit	kt	kt	-	kt	-
2001	NO	NO	NA	1120.8	NO
2002	NO	NO	NA	1108.5	NO
2003	NO	NO	NA	1052.1	NO
2004	NO	NO	NA	1001.0	NO
2005	NO	NO	NA	946.0	NO
2006	NO	NO	NA	917.4	NO
2007	NO	NO	NA	879.1	NO
2008	NO	NO	NA	835.4	NO
2009	NO	NO	NA	776.2	NO
2010	NO	NO	NA	720.4	NO
2011	NO	NO	NA	664.4	NO
2012	NO	NO	NA	599.9	NO
2013	NO	NO	NA	600.7	NO
2014	NO	NO	NA	593.2	NO
2015	NO	NO	NA	670.2	NO
2016	NO	NO	NA	737.1	NO
2017	NO	NO	NA	744.5	NO
2018	NO	NO	NA	732.1	NO
2019	NO	NO	NA	705.7	NO
2020	NO	NO	NA	631.8	NO
2021	NO	NO	NA	604.5	NO
2022	NO	NO	NA	584.0	NO

Sources: MESD with assistance of EIHP, CBS; Processing: Ekonerg Ltd.

Refining / storage (NFR 1.B.2.a.iv)

Fugitive emissions from refining / storage (NFR 1.B.2.a.iv) were calculated using the Tier 2 EMEP/EEA methodology (GB2023) and "bottom-up" approach; multiplying relevant activity data by recommended EMEP/EEA Tier 2 emission factors for specific process activities.

Activities within NFR 1.B.2.a.iv Refining/storage include: SNAP 040102a Catalytic Cracking unit regenerators, Partial burn without CO boiler, SNAP 040102b Catalytic reforming units, SNAP 040103 Sulphur recovery plants, SNAP 040104 Storage and handling of petroleum products in refinery, SNAP 040103 Other - Fluid coking units. For catalytic cracking unit regenerators, the proposed Tier 2 emission factors are for partial burn without a CO boiler, and with a primary cyclone installed. Other abatement technology was not taken into account. The existing facilities at refineries do not have abatement technology installed within the catalytic cracking activity (FCC).

Data on total annual amount of fresh feed for each type of unit, and annual sulphur production (Claus installation) were obtained from MESD (survey requests to refineries).

Activity data for calculating emissions from storage and handling of oil products in refineries is annual total throughput of crude oil in each refinery, which is taken from national energy balance. Detail activity data for NFR 1.B.2.a.iv are presented in Table 3.8-2.

Table 3.8-2 Activity data for NFR 1.B.2.a.iv, represented by the relevant SNAP codes

SNAP	040102a	040102b	040105	040103	040104
SNAP, Name	Catalytic Cracking unit regenerator (total amount of fresh feed)	Catalytic reforming unit (total amount of fresh feed)	Other - Fluid coking unit (total amount of fresh feed)	Sulphur recovery plant (sulphur production)	Storage and handling of petroleum products in refinery (crude oil throughput)
Unit	1000 m^3	1000 m^3	1000 m^3	kt product	kt product
1990	1281.4	1604.8	NO	NO	6860.7
1991	894.9	1025.8	NO	NO	4510.9
1992	698.1	765.2	NO	NO	3935.0
1993	945.7	1090.0	NO	NO	4914.8
1994	842.2	965.9	160.1	NO	4994.3
1995	883.4	1240.1	160.2	NO	5336.1
1996	702.8	1219.0	130.6	NO	5112.7
1997	699.9	1105.8	139.1	2.2	5112.0
1998	898.9	1035.1	154.9	5.3	5007.5
1999	1037.2	1136.6	194.7	5.9	5474.8
2000	1385.2	1208.7	190.5	8.3	5162.8
2001	1217.4	1159.5	190.5	6.7	4831.6
2002	1247.8	1028.7	214.2	7.1	4830.0
2003	1242.7	1204.5	189.3	7.5	4861.7
2004	1348.9	1184.5	176.8	8.5	5079.3
2005	1394.2	1048.2	149.6	8.1	4944.7
2006	1138.2	1033.7	192.0	6.7	4716.4
2007	1369.9	1067.4	181.2	8.9	5077.4
2008	1066.0	925.7	116.8	9.5	4308.7
2009	1330.0	1048.7	122.4	10.0	4824.4
2010	1027.8	931.0	184.8	6.4	4256.6
2011	836.2	743.1	91.2	16.3	3502.7
2012	906.2	775.1	109.4	17.5	2924.9
2013	753.7	729.7	83.7	15.9	3062.5
2014	632.8	661.9	38.5	19.4	2444.4
2015	664.6	681.1	90.0	17.5	2998.2
2016	665.4	718.6	62.0	21.7	3250.5
2017	744.3	871.7	107.9	24.2	3562.5
2018	567.4	847.7	127.7	23.3	3697.6
2019	392.1	694.3	134.3	11.8	2711.7
2020	418.9	514.5	0.0	7.9	2575.6
2021	413.9	497.0	0.0	8.9	2366.2
2022	350.8	398.4	0.0	7.1	2057.9

Sources: MESD (survey request: oil refineries); Processing: Ekonerg Ltd

Distribution of oil products (NFR 1.B.2.a.v)

Fugitive emissions from NFR 1.B.2.a.v Distribution of oil products, SNAP 050502 Refinery dispatch station, and SNAP 050503 Service stations (including refuelling of cars) were calculated by Tier 2 EMEP/EEA methodology (GB2023) and "bottom-up" approach, i.e. by multiplying relevant activity data by the recommended EMEP / EEA Tier 2 emission factors, both stratified according to different techniques in the distribution of oil products. According to the proposed methodology, emissions from refinery, storage tanks, are reported in 1.B.2.a.iv and emissions from loading of mobile containers in refinery are reported in 1.B.2.a.v.

For source category SNAP 050502 Transport and depots (except 050503), according to GB2023, emissions from transport were identified as negligible, emissions from filling mobile containers at depots are calculated in the scope of refinery dispatch stations, and emissions at depots (gasoline storage) are covered in 1.B.2.a.iv.

For source category SNAP 050400 Liquid fuel distribution (except gasoline distribution), there are no Tier 2 EFs in EMEP/EEA GB2023, thus EFs from Corinair (vol. 2, p. 57) were used:

- for 0504 – total crude oil, production + import and 040104 = 0.02 kg/t; related to VOC emission from crude storage and handling in external floating roof tanks;
- for 0504 – import = 0.3 kg/t; related to VOC emission from ballasting of crude oil tankers.

Detail country specific activity data are collected:

- loading facilities at refinery dispatch stations, depots and storages - volume of volatile products loaded into different transport modes (road, rail and marine tankers); loading practices for specific modes of transport (top, bottom or combined); type and extent of emission control measures in place (VRU). Data source is national oil company;
- service stations - quantity of gasoline sold; type and extent of emission control measures in place (Stage IB, Stage II). Data source is national oil company, together with national energy balance;
- average ambient temperature. Data source is Meteorological and hydrological service;
- Reid Vapour Pressure (RVP) of distributed volatile products (gasoline) is calculated from the annual average RVP value and average temperature data.

Data on crude oil production and imports are taken from the energy balance.

Activity data for NFR 1.B.2.a.v are presented in Table 3.8-3.

Table 3.8-3 Activity data for NFR 1.B.2.a.v, presented by relevant SNAP codes 0505

Activity	Service stations, Storage tank filling	Service stations, Storage tank breathing	Service stations, Automobile refuelling	Service stations, Automobile refuelling: drips and spills	Refinery dispatch stations, Road tankers	Refinery dispatch stations, Rail tankers	Refinery dispatch stations, Marine tankers
SNAP	50503	50503	50503	50503	50501	50501	50501
Unit	kt gasoline	kt gasoline	kt gasoline	kt gasoline	kt gasoline	kt gasoline	kt gasoline
1990	764.0	764.0	764.0	764.0	426.4	399.9	995.3
1991	590.5	590.5	590.5	590.5	324.5	304.3	757.5
1992	511.4	511.4	511.4	511.4	227.5	213.4	531.1
1993	497.0	497.0	497.0	497.0	298.6	280.0	697.1
1994	545.6	545.6	545.6	545.6	321.0	301.1	749.4
1995	575.1	575.1	575.1	575.1	360.7	338.2	842.0
1996	626.0	626.0	626.0	626.0	319.6	299.7	746.0
1997	678.0	678.0	678.0	678.0	325.7	305.5	760.4
1998	737.3	737.3	737.3	737.3	338.8	317.7	790.9
1999	781.7	781.7	781.7	781.7	296.2	277.8	691.5
2000	784.4	784.4	784.4	784.4	313.5	293.9	731.7
2001	753.8	753.8	753.8	753.8	293.1	274.8	684.1
2002	759.0	759.0	759.0	759.0	301.1	282.3	702.8
2003	757.3	757.3	757.3	757.3	315.9	296.3	737.5
2004	723.7	723.7	723.7	723.7	319.1	299.3	744.9
2005	709.6	709.6	709.6	709.6	333.5	312.7	778.5
2006	711.3	711.3	711.3	711.3	325.4	305.1	759.5
2007	725.3	725.3	725.3	725.3	341.1	319.9	796.3
2008	696.3	696.3	696.3	696.3	308.2	250.8	730.1
2009	692.3	692.3	692.3	692.3	269.8	286.5	871.4
2010	650.5	650.5	650.5	650.5	229.4	275.6	819.1
2011	634.9	634.9	634.9	634.9	192.0	243.3	651.6
2012	590.1	590.1	590.1	590.1	178.4	234.4	746.5

Activity	Service stations, Storage tank filling	Service stations, Storage tank breathing	Service stations, Automobile refuelling	Service stations, Automobile refuelling: drips and spills	Refinery dispatch stations, Road tankers	Refinery dispatch stations, Rail tankers	Refinery dispatch stations, Marine tankers
SNAP	50503	50503	50503	50503	50501	50501	50501
Unit	kt gasoline	kt gasoline	kt gasoline	kt gasoline	kt gasoline	kt gasoline	kt gasoline
2013	576.2	576.2	576.2	576.2	170.8	198.3	657.7
2014	532.7	532.7	532.7	532.7	141.8	241.7	562.9
2015	531.5	531.5	531.5	531.5	132.3	238.0	690.0
2016	533.4	533.4	533.4	533.4	278.5	177.5	557.8
2016	513.2	513.2	513.2	513.2	354.7	133.7	676.8
2017	498.7	498.7	498.7	498.7	329.3	249.3	450.1
2018	764.0	764.0	764.0	764.0	426.4	399.9	995.3
2019	476.6	476.6	476.6	476.6	341.9	235.3	288.8
2020	397.5	397.5	397.5	397.5	272.0	121.2	360.1
2021	444.0	444.0	444.0	444.0	274.0	138.5	340.8
2022	475.2	475.2	475.2	475.2	257.0	93.9	344.8

Source: MESDC with EIHP, MESD, INA Ltd; Processing: Ekonerg Ltd

Activity data related to production and import of crude oil for SNAP 0504 Liquid fuel distribution (except gasoline distribution), are shown in Table 3.8-4.

Table 3.8-4 Activity data for NFR 1.B.2.a.v, SNAP 0504

Activity	Production + import of crude oil	Import of crude oil
SNAP	050400	050400
Unit	kt crude oil	kt crude oil
1990	6854.1	4157.9
1991	4834.2	2903.3
1992	4468.2	2725.3
1993	4457.0	2729.9
1994	4728.7	3152.1
1995	5305.0	3804.7
1996	5569.4	4100.3
1997	5195.4	5195.4
1998	4926.1	3536.7
1999	5770.4	4477.7
2000	5128.2	3914.3
2001	5029.2	3908.4
2002	5003.9	3895.4
2003	4818.4	3766.3
2004	5198.6	4197.6
2005	4944.7	3998.7
2006	4716.4	3799.0
2007	5077.4	4198.3
2008	4308.7	3473.3
2009	4824.4	4048.2
2010	4256.6	3536.2
2011	3502.7	2838.3
2012	2924.9	2325.0
2013	3062.5	2461.8
2014	2444.4	1851.2
2015	2998.2	2328.0
2016	3250.5	2513.4
2017	3562.5	2818.0

Activity	Production + import of crude oil	Import of crude oil
SNAP	050400	050400
Unit	kt crude oil	kt crude oil
2018	3697.6	2965.5
2019	2711.7	2006.0
2020	2575.6	1943.8
2021	2366.2	1761.7
2022	2057.9	1473.9

Source: National energy balance

Venting and flaring (NFR 1.B.2.c)

Fugitive emissions from NFR 1.B.2.c Venting and Flaring are calculated for two SNAP categories: SNAP 090203 Flaring in oil refinery and SNAP 090206 Flaring in gas and oil extraction. For the calculation of emissions from SNAP 090203, EMEP/EEA Tier 2 approach is used (except for SO_2 and NMVOC emission). For the calculation of emissions from SNAP 090206 EMEP/EEA, Tier 1 approach is used. Both the activity data and the emission factors are stratified according to different activities that occur in Croatia. Emission calculation is carried out by multiplying process specific activity data for the specific technology by the corresponding EMEP/EEA emission factor (GB2023).

Activity data for SNAP 090203 is the annual flared amount in refineries. The data for the flared amount for each refinery were collected for the period since 2010. The source of data is INA Ltd. Quantities of gas flared in refineries in the period 1990-2009 are not available, thus they were estimated using the average value of known quantities of flared gas in the period 2010-2014 and estimated quantities of crude input for each refinery. The average crude oil density in Croatia is assumed to be 0.86 kg/dm^3.

For NMVOC and SO_2 emission calculation, Tier 1 approach is used, because data on flared gas composition are not available. Activity data used for Tier 1 approach is the annual total throughput of refineries. Furthermore, data on total amount of crude oil input to the refineries are used, along with amount of fuel used by type in each refinery.

Source of data for the total amount of crude oil is national energy balance. Source of data for the annual amount of fuels for the period since 2008 is the national EPR, and for the period 1990-2004 documentation for the preparation of the Energy Development Strategy of the Republic of Croatia (OG 130/09), obtained from the company INA Ltd. For the remaining period 2005-2007, amount of fuels by type and refinery were estimated by linear interpolation method. Data on annual fuel amounts are used to determine annual amount of crude oil input to each refinery. Data on total crude oil are confidential.

Activity data for SNAP 090206 is the annual volume of gas flared in oil and gas extraction. Data were collected for the period since 2009. Annual volume of gas flared in gas and oil extraction in the period 1990 - 2008 is not available, and it was estimated using average value of the known quantities of annual gas flared in the period since 2009 and the annual volume of total gas and crude oil extracted in Croatia. It is assumed that the average density of natural gas is 0.73 kg/m^3. Table 3.8-5 gives the overview of activity data for 1.B.2.c Venting and Flaring.

Table 3.8-5 Activity data for NFR 1.B.2.c Venting and Flaring

	Gas flared in refineries	Crude oil throughput in refineries	Gas flared in gas and oil extraction
Unit	TJ	Gg	1000 m^3
1990	939.1	6860.7	22313.5
1991	775.9	4510.9	19824.6

	Gas flared in refineries	Crude oil throughput in refineries	Gas flared in gas and oil extraction
Unit	TJ	Gg	1000 m^3
1992	402.2	3935	14265.6
1993	696.6	4914.8	18026.0
1994	675.7	4994.3	14848.5
1995	879.9	5336.1	12105.4
1996	850.6	5112.7	11294.2
1997	893.1	5112	13585.2
1998	1023.9	5007.5	12421.7
1999	1068.3	5474.8	14990.7
2000	1153.3	5162.8	12960.6
2001	1083.0	4831.6	15899.0
2002	1015.3	4830	16767.5
2003	1052.1	4861.7	17314.6
2004	907.2	5079.3	17381.3
2005	901.8	4944.7	18055.0
2006	922.7	4716.4	21453.9
2007	973.2	5077.4	22865.1
2008	998.5	4308.7	21578.8
2009	996.4	4824.4	19029.6
2010	638.0	4256.6	12015.5
2011	818.6	3502.7	14906.3
2012	939.0	2924.9	11197.6
2013	888.3	3062.5	10813.9
2014	947.7	2444.4	15176.4
2015	1159.4	2998.2	12451.5
2016	1336.3	3250.5	12911.5
2017	765.0	3562.5	11799.2
2018	832.3	3697.6	20263.2
2019	569.5	2711.7	16941.1
2020	320.4	2575.6	13574.8
2021	260.9	2366.2	10045.1
2022	292.7	2057.9	6503.0

Source: MESD with EIHP, MESD, INA Ltd. Processing: Ekonerg Ltd.

Natural gas - Exploration, production, transport (NFR 1.B.2.b)

Emissions from the exploration, production and transport of natural gas are calculated by applying the Tier 2 EMEP/EEA methodology (GB2023). To apply the Tier 2 approach, both the activity data and the emission factors need to be stratified according to the different activities within this source category – exploration/production and transport of natural gas.

For the calculation of NMVOC emission from natural gas exploration/production (1.B.2.b.i; SNAP 050300), data on gas production taken from energy balance are used together with recommended emission factor (GB2023).

For the activity of natural gas transmission (1.B.2.b.ii; SNAP 050600), for the calculation of NMVOC emission, data on annual CH_4 emission reported to the EPR by the company Plinacro Ltd were used (available since 2011). In natural gas transmission system, the only loss in the network occurs during the maintenance of pipeline sections. According to Plinacro Ltd, there is a very good network maintenance and loses are minimized, but they are considerably different for each year. NMVOC emission was calculated using the equation 1.

$$E_{NMVOC} = E_{CH4} \text{ x } (W_{NMVOC} / W_{CH4}) \quad (1)$$

where:

W_{NMVOC} - the weight-% NMVOC

W_{CH4} - the weight-% of CH_4, according to gas quality of the current year

E_{CH4} - the annual CH_4 emission reported in the EPR

All values refer to the volume of gas of 1 m^3 in standard conditions, in which absolute pressure of gas equals 101.325 Pa and temperature of gas is 15° C. Standard gas quality in Croatia is regulated by law, and gas quality monitoring and reporting is in the legal competence of Plinacro Ltd.

For activity data for natural gas transmission, data on gas transmission (consumption) for the whole time series were taken from national energy balance.

Based on specific data on CH_4 emission available since 2011 and specific data on mass composition of natural gas, specific NMVOC emission factors were calculated.

For all data that remained unavailable, an estimate was carried out, based on the available data. For CH_4 emission, average annual emission of the 5 closest years with available data was used, i.e. average of CH_4 emissions during 2011-2015. For 2016, CH_4 emission was not reported in EPR, thus average value of the years 2015 and 2017 was taken. Moreover, data on annual gas composition for the period 1990-1997 were estimated on the basis of average annual gas composition in the 5 closest years, i.e. 1998-2002.

NMVOC emission factors for natural gas transmission are given in Appendix 2.

Used activity data for NFR 1.B.2.b are given in Table 3.8-6.

Table 3.8-6 Activity data for NFR 1.B.2.b

NFR	1.B.2.b.i	1.B.2.b.i	1.B.2.b.ii	1.B.2.b.ii
SNAP	050300	050300	050600	050600
Name	Natural gas production	Natural gas production	Natural gas transmission	Natural gas transmission
Unit	1000 m^3	PJ	1000 m^3	TJ
1990	1982300	67.3	2686600	0.091
1991	1824300	64.0	2487400	0.087
1992	1803000	63.0	2578800	0.089
1993	2049000	73.1	2723000	0.096
1994	1792000	63.3	2562000	0.089
1995	1966400	69.1	2367900	0.083
1996	1785600	63.7	2653400	0.093
1997	1717200	66.1	2750500	0.101
1998	1570100	55.8	2644300	0.092
1999	1550550	55.6	2680800	0.094
2000	1638500	59.4	2704800	0.095
2001	2010400	70.9	2834200	0.099
2002	2120300	74.5	2901800	0.101
2003	2189600	76.8	2884400	0.100
2004	2198100	77.1	3009300	0.105
2005	2283400	79.8	2909900	0.101
2006	2713500	94.3	2877800	0.100
2007	2892100	100.1	3306700	0.114
2008	2729400	94.0	3205100	0.110
2009	2704800	93.5	2959400	0.102
2010	2727200	93.9	3241500	0.111
2011	2471400	85.0	3165000	0.109
2012	2013100	69.2	2971700	0.102
2013	1856100	63.1	2809900	0.096

NFR	1.B.2.b.i	1.B.2.b.i	1.B.2.b.ii	1.B.2.b.ii
SNAP	050300	050300	050600	050600
Name	Natural gas production	Natural gas production	Natural gas transmission	Natural gas transmission
Unit	1000 m^3	PJ	1000 m^3	TJ
2014	1747000	60.5	2443600	0.085
2015	1780500	61.6	2519200	0.087
2016	1647200	57.5	2611400	0.091
2017	1483500	51.8	3008300	0.105
2018	1230100	43.1	2770500	0.096
2019	1028900	36.1	2908000	0.101
2020	849000	29.9	3040700	0.106
2021	745900	26.4	2905900	0.102
2022	745000	26.6	2529700	0.090

Source: National energy balance; processing: Ekonerg Ltd.

Generally, emissions from production have increased significantly since 2002 due to an increase in the amount of extracted gas, and have dropped after 2010 due to a decrease in gas extraction. Emissions from transmission from 2011 onwards depend on the amounts of CH_4 released during maintenance activities (which vary considerably over the years) and on the composition of natural gas, making the emission trend uneven. In the period 1990-2010, these emissions are more uniform because they depend only on annual differences in the composition of natural gas, since the assumed amount of CH_4 released is the same for all years (average value of available data).

Other fugitive emissions from energy production (NFR 1.B.2.d)

Emissions in this category are calculated based on the use of geothermal energy for electricity generation. Such activities are not present in Croatia and the notation key "NO" was used.

Recalculations and improvements

In the fugitive emission sector, a recalculation has been carried out due to the change in factor according to the new GB 2023. The recalculation refers to the entire time series from 1990 until 2022, for the purpose of calculating diffuse emissions in NFR category 1.B.2.a.iv, for the relevant SNAP code 0401.

A recalculation from 2017 until 2022 has been also carried out due to implementation of emission control measures (VRU) when loading road tankers, rail tankers and marine tankers, which reduced emissions in NFR category 1.B.2.a.v, for relevant SNAP codes 0505.

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4. Industrial processes and product use (NFR 2)

This chapter gives an overview of Industrial processes and product use sector and contains information on methodologies, activity data, emission factors, recalculations and planned improvements. Industrial processes include emissions that originate from various process activities. Emissions from fuel combustion in industry are allocated to NFR 1.A.2.f.i. Product use covers solvents and solvent-based products. Solvents are chemical compounds, which are used to dissolve substances such as paints, glues, ink, rubber, etc. or for cleaning purposes (degreasing). Since solvents consist mainly of NMVOC, solvent use is a major source of anthropogenic NMVOC emissions. Once released into the atmosphere, NMVOCs react with reactive molecules (mainly HO-radicals) to form CO_2.

This source category includes the following sub-sectors:

- 2.A Mineral product
    - 2.A.1 Cement production
    - 2.A.2 Lime production
    - 2.A.3 Glass production
    - 2.A.5.a Quarrying and mining of minerals other than coal
    - 2.A.5.b Construction and demolition
    - 2.A.5.c Storage, handling and transport of mineral products
    - 2.A.6 Other mineral products
- 2.B Chemical industry
    - 2.B.1 Ammonia production
    - 2.B.2 Nitric acid production
    - 2.B.10.a Other (production of carbon black, ethylene, styrene, NPK fertilizers, ammonium phosphate, formaldehyde, ethyl benzene, polystyrene, polyvinylchloride, polyethylene LD, vinyl chloride, propylene, urea and sulfuric acid)
    - 2.B.7 Soda ash production
- 2.C Metal production
    - 2.C.1 Iron and Steel production
    - 2.C.1.1 Steel production
    - 2.C.1.2 Iron production
    - 2.C.1.5 Other (Rolling mills)
    - 2.C.2 Ferroalloys production
    - 2.C.3 Aluminium production
- 2 D – 2 L Other solvent and product use
    - 2.D.3.a Domestic solvent use including fungicides
    - 2.D.3.b Road paving with asphalt
    - 2.D.3.c Asphalt roofing

  - 2.D.3.d Coating applications
  - 2.D.3.e Degreasing
  - 2.D.3.f Dry cleaning
  - 2.D.3.g Chemical products
  - 2.D.3.h Printing
  - 2.D.3.i, 2.G Other solvent and product use

- 2 H Other industry production
  - 2.H.1 Pulp and paper industry
  - 2.H.2 Food and beverages industry
  - 2.H.3 Other industrial processes
- 2.L Other industrial processes including production, consumption, storage etc. of bulk products
- 2.I Wood processing
- 2.J Production of POPs
- 2.K Consumption of POPs and heavy metals

In general, method for emissions calculation includes multiplying activity data by the corresponding emission factors. The methodology for all activities within this sector is presented in detail in the following sections.

Emission factors are expressed as a quantity of pollutant emission per unit of production/consumption or per population. Used emission factors are for the most part taken from the *EMEP/EEA Guidebook – 2023*. The source of the emission factors used is indicated in the description of each category.

The following sources of information are generally used for activity (or emissions) data for Industrial processes and product use sector:

- National production statistics obtained from the CBS (Annual Statistical Reports, Industrial production, Annual PRODCOM Results),
- EUROSTAT database,
- Annual population estimates obtained from the CBS,
- Data on direct emissions as reported annually by facilities in legally required forms under the Croatian EPR and HLAP databases,
- Plant specific data collected by direct contacts with manufacturers, mainly for LCPs (e.g. plants producing cement, lime, sugar etc.),
- National energy balance.

Information on the inclusion / exclusion of the condensing component in the PM_{10} and $PM_{2.5}$ emission factors according to the NFR emission categories is found in Annexes 2 and 6.

Key categories for the IPPU sector are presented in Table 4-1. Key Category Analysis (KCA) is presented in Section 1.5 and Appendix 1.

Table 4-1 Key sources of the sector Production processes and product use

NFR Category	NFR Category Name	Key Categories	
		Pollutant	Pollutant
2A3	Glass production	Pb	L1
		Cd	L1
		As	L1, T1
		Ni	L1, T1
		Se	L1, T1
2A5a	Quarrying and mining of minerals other than coal	PM10	T1
		TSP	L1, T1
2A5b	Construction and demolition	PM2.5	T1
		PM10	L1, T1
		TSP	L1, T1
2B10a	Other chemical industry	NH3	T1
		PM2.5	T1
2C1	Iron and Steel Production	Cd	T1
		As	T1
		Cr	T1
		Ni	T1
		Zn	T1
		PAH	T1
		PCBs	L1
2D3a	Domestic solvent use including fungicides	NMVOC	L1
2D3b	Road paving with asphalt	PM2.5	T1
		PM10	T1
		TSP	T1
		BC	T1
2D3d	Coating applications	NMVOC	L1, T1
2D3e	Degreasing	NMVOC	T1
2D3i	Other solvent use	NMVOC	L1, T1
2G	Other product manufacture and use	BC	L1
		Pb	L1, T1
		Cd	L1
		Cu	T1
2H2	Food and beverages industry	NMVOC	L1, T1

L1 = level assessment, tier 1, 2022

T1 = trend assessment, tier 1, 1990–2022

4.1. Mineral products (NFR 2.A)

Source category description

This source category covers process-related emissions resulting from various activities in the production and use of a variety of mineral industry products. The following processes are included: Cement production (NFR 2.A.1, SNAP 040612), Lime production (NFR 2.A.2, SNAP 040614), Glass production (NFR 2.A.3, SNAP 040613), Quarrying and mining of minerals other than coal (NFR 2.A.5.a, SNAP 040623), Construction and demolition (NFR 2.A.5.b, SNAP 040624) and Storage, handling and transport of mineral products (NFR 2.A.5.c).

For source category 2.A.5.c, Croatia is using notation key “IE”, since PM emissions from this category are included in other NFR 2.A codes.

Cement production (NFR 2.A.1)

Cement production includes: raw materials extraction and pre-processing, heating the raw materials in a kiln to produce clinker, blending and grinding of clinker to cement, storage, packing and delivery of cement.

The main emissions from cement production are emissions from kiln systems. However, only emissions of particulate matter, which mainly originate from pre- and after-treatment are considered in this sector. Emissions from the kiln are a combination of combustion and process emissions but the emissions of other pollutants are assumed to originate mainly from fuel combustion, and are therefore allocated to the Energy sector.

During the reporting period, there were seven factories in operation in Croatia. Four factories were active during the whole time series. One of them produces aluminate (aluminous) cement, while all other factories in Croatia (including the ones that are inactive today) produced Portland cement. In the aluminate cement factory, Portland cement was also produced in another production line until 1997.

One factory was closed in July 1994 and two other factories worked intermittently during the reporting period (one of them was active from 1990 to 1995 and again since 1998 (and is still active), and the second one from 1990 to 2009 and during 2014).

Production varied depending on the economic situation and demand on the market. Overall production at the national level decreased in the period 1991-1995 as a result of the war. In the period 1996-2007, production increased with the escalation in construction sector activities. The trend after 2008 is a result of the economic crisis, followed by a slow recovery after 2012.

Lime production (NFR 2.A.2)

Basic types of processes occurring within the lime work operations include: quarrying and crushing of minerals, combustion of fuels in lime kilns, storage, packing and delivery of produced lime.

As in cement production, only emissions of particulate matter from lime production are considered in this sector. Emissions from the kiln are a combination of combustion and process emissions but the emissions of other pollutants are assumed to originate mainly from fuel combustion and are therefore allocated to the Energy sector.

During the reporting period, five lime factories were active in Croatia, with two of them producing both quicklime and dolomitic lime and three producing only quicklime. Lime production in factories has varied over the years. One factory ceased its operations in 2009 and one in 2011. Furthermore, two of the factories that were active since 1990 and are still in operation had a varying production and even periods of halted operations over the years (one did not produce lime from 1992 to 1997, as it was severely damaged during the war, and the second one during 2009 due to technical reasons. Also, one factory ceased production in 2010 and restarted its operations in 2019). Entire production of dolomitic lime was stopped in the period 1991-1995.

In addition, non-marketed quicklime is being produced for the needs of sugar refining in three sugar factories. Production data are available since 1991 for one factory, since 1992 for the second factory and since 1999 for the third factory. Sugar was being produced in those factories prior to these years but there are no records on lime production (factories report that those data have not been kept in their archives, and moreover, non-marketed lime is not included in national statistics)[26].

During 1990 and 1991, a certain amount of non-marketed quicklime reagent was also produced in pig iron production plant.

Apart from the abovementioned, there was no other identified non-marketed lime production in Croatia.

Production trend is very similar to trends in the cement industry due to the same dependence on the economic situation and market demands.

Glass production (NFR 2.A.3)

This source category includes production and processing of flat glass and container glass, as well as mineral wool production, which include a series of steps – from the preparation of raw materials, to melting in a furnace, to final steps in product finishing. Emissions from glass production (apart from the main emission - CO_2, originating from the carbonisation process) include heavy metals, black carbon and dust, while emissions from mineral wool production include NH_3, NMVOC and dust.

During the reporting period, two glass producing factories were in operation in Croatia; one of them producing container glass and the other producing flat glass. In 2009, the second factory has ceased its glass production operations, and since then, together with several other factories in Croatia, it only processes imported glass (using mostly operations like cutting, grinding, paint application, laminating etc.). Total national quantities of final glass products (including products from glass producing and glass processing factories) are included in this category.

There are two mineral wool plants in Croatia. One plant started its operations in 2007, and second plant was in operation during the whole time series.

Quarrying and mining of minerals other than coal (NFR 2.A.5.a)

Quarrying and mining of minerals other than coal in Croatia include quarrying of ornamental and building stone, limestone, gypsum, etc., gravel, sand and clay excavation, extraction of salt as well as mining and quarrying of other minerals.

These activities, which include extraction (with the use of mining explosives, if needed), transportation and crushing of minerals, result in emission of particulate matter. National production statistics by type of minerals is a source of activity data for emission calculation.

Construction and demolition (NFR 2.A.5.b)

Construction of infrastructure and buildings is an important source of fugitive particulate matter emissions. In construction industry, there are many activities that result in emissions, such as land clearing and demolition, equipment movements and other various construction activities.

Primary activity data are annual data on the total area affected by construction, for each individual type of construction - family houses, residential buildings, other buildings for non-residential purposes and roads. The source of data on constructed houses and buildings is the

[26] It should be noted that sugar factories were affected by warfare during and immediately after the war, and their production activities were discontinued or significantly reduced, with frequent interruptions. Since it was an atypical period of production, even taking aside the possibility of lime not being produced on-site, estimates of missing data are impaired by incomparability with typical production conditions during non-war years.

CBS[27], while the sources of data on roads are business entities engaged in road management, construction and maintenance, county road administration, local authority units, institutes for spatial planning of counties and the City of Zagreb, and the Statistical Yearbook 1994.

For other parameters included in the calculation (duration of construction, efficiency of emission control measures, Thornthwaite precipitation-evaporation index, soil silt content), the specifics of national conditions and the specifics of each type of construction were analysed. Also, in order to identify optimal parameters for calculations, inventories of other countries were analysed. After determining all input assumptions, the parameters were calculated or the recommended values from GB2023 were selected. The listed parameters and their values used in the emissions calculation are described in detail below in the subchapter Methodology, emission factors and activity data.

Methodology, emission factors and activity data

Cement production (NFR 2.A.1)

Methodology for emission calculation is based on Tier 2 EMEP/EEA approach, for all factories except one. For the one factory, which ceased its operations in 1994, it was not possible to collect the data needed for higher tier approach, thus Tier 1 method had to be used. All emission factors for cement production emission are taken from GB2023 (tab. 3-1 and 3-2, Ch. 2.A.1 Cement production).

As mentioned, for six factories, it was decided in direct contacts with operators to include Tier 2 emission factors for PM, with inclusion of existing abatement technologies in all facilities: ESP on main stack and smaller fabric filters for moderate control of fugitive sources, for the whole time series. Although measurements of PM_{10} emissions are carried out for these factories, it is assumed that the measurements do not cover all sources of fugitive emissions in the factories. Therefore, it was decided to calculate emissions for this category in accordance with the EMEP/EEA methodology, in order to avoid significant underestimation of emissions.

For the remaining, seventh factory, Tier 1 emission factors assume an „averaged“ or typical technology and abatement implementation and integrate all different sub-processes in the cement production between feeding the raw material into the process and the final shipment off the facility.

Besides TSP, $PM_{2.5}$ and PM_{10} emissions, BC emissions are reported for 1990 onwards and are calculated as a fraction of $PM_{2.5}$ according to GB2023, using the Tier 1 methodology (no abatement technologies are included since GB does not provide values related to BC).

Activity data on clinker production were taken from the NIR. Originally, these data were collected by a survey of all cement manufacturers and cross-checked with national statistics on clinker production. Activity data on clinker production are presented in Table 4.1-1.

Lime production (NFR 2.A.2)

Methodology for emission calculation is based on Tier 2 EMEP/EEA approach. Tier 2 controlled PM emission factors from GB2023 are used. In all facilities, kilns are equipped with fabric filters, and lime hydrators are equipped with de-dusting bag filters. Also, fabric filters for emissions control from conveyor belts are present in all facilities.

[27] Questionnaire, website https://www.dzs.hr/Hrv_Eng/Pokazatelji/MSI GRADEVINARSTVO.xlsx and Statistical Yearbooks 1994 and 1996.

Besides TSP, $PM_{2.5}$ and PM_{10} emissions, BC emissions are reported for 1990 onwards and are calculated as a fraction of $PM_{2.5}$ according to GB2023.

Data on the amount of lime produced in Croatia includes the amount of lime produced in lime factories and sugar factories, and lime produced for the needs of pig iron production (in 1990 and 1991). Activity data relating to lime factories and pig iron manufacturer were taken from the NIR. Originally, these data were collected by a survey of all lime manufacturers and cross-checked with national statistics on lime production. Activity data relating to sugar factories were collected from manufacturers.

Activity data on lime production are presented in Table 4.1-1.

Glass production (NFR 2.A.3)

Data on glass production activity were taken from the annual PRODCOM results (CBS) and from the EPR database. Methodology for calculation of emissions from glass production is based on Tier 1 EMEP/EEA approach, with recommended Tier 1 emission factors from GB2023.

Croatia recognizes the likelihood of overestimation of emissions from glass production since default emission factors include emissions from both melting and non-melting activities, while national statistics (which is a main source of activity data) does not distinguish between produced and processed glass. This results in products made from imported glass (without any melting activities occurring in Croatia) being included in activity data for this category.

Mineral wool production includes two plants for which different approaches have been applied.

Approach for emissions estimate for one mineral wool plant is based on Tier 3 EMEP/EEA methodology and continuously measured and verified annual emissions of NH_3, NMVOC and PM10 (emissions taken from EPR). Emissions of $PM_{2.5}$, TSP and BC were then calculated from measured values of PM_{10} emissions, using the Tier 2 ratio of emission factors from GB2023.

For the second plant, the level of available input data differs for the period 1990-2007 (only data on annual production are available), for the period 2008-2014 (available data on measured emissions, except NMVOC, but due to high inconsistency are considered highly unreliable), and for the period 2015-2022 (available data on measured emissions, except NMVOC). Therefore, different approaches had to be applied for these periods.

For the period 2015-2022, methodology for calculating NH_3, PM and BC emissions from the second mineral wool production plant is based on Tier 3 EMEP/EEA approach and periodically measured and verified annual emissions. NH_3 and PM_{10} emissions were taken from the EPR. Emissions of $PM_{2.5}$, TSP and BC were then calculated from measured values of PM_{10} emissions, using the Tier 2 ratio of emission factors from GB2023.

For the period from 2008 to 2014, data in the EPR show significant inconsistency, and it was found that the data are not reliable as the operator does not perform continuous measurements. Therefore, NH_3, PM and BC emissions were estimated using the IEF mean calculated from the ratio of emissions and activity data from 2015-2021, which were taken from the EPR, and are considered more reliable because they are more recent. Annual emissions are calculated by multiplying the average IEF by the annual activity data.

For the period 1990 to 2007, measured NH_3, PM and BC emissions are not available. Since periodic measurements are available for more recent time series, the same approach was used as previously described for the period 2008-2014 (multiplying the mean IEF from the period 2015-2021 with annual activity data for the period 1990 to 2007.

NMVOC emission values for the entire time series were calculated using the Tier 2 approach, as no measurement data are available for these emissions.

Emissions estimated as described above are imported into the CollectER database for each plant separately. The corresponding implied emission factors for each pollutant and year are created in the database, which are calculated as ratios of emissions and activity data.

Activity data on glass and mineral wool production are presented in Table 4.1-1.

Quarrying and mining of minerals other than coal (NFR 2.A.5.a)

Methodology for emission calculation for quarrying and mining of minerals other than coal is based on Tier 1 EMEP/EEA approach. The recommended Tier 1 emission factors from GB2023 were used. The activity data on quarrying and mining of minerals other than coal are taken from the Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS) and they are presented in Table 4.1-1.

Activity data for NFR NFR 2.A.1, 2.A.2, 2.A.3 and 2.A.5.a are given in table 4.1-1.

Table 4.1-1 Activity data for NFR 2.A.1, 2.A.2, 2.A.3 and 2.A.5.a

NFR	2.A.1	2.A.1	2.A.2	2.A.3	2.A.5.a
Name	Clinker (Tier 2 approach)	Clinker (Tier 1 approach)	Lime production	Glass and mineral wool production	Quarrying and mining of minerals other than coal
Unit	kt	kt	kt	kt	Mt
1990	1919.2	143.3	232.3	275.5	27.0
1991	1209.3	127.8	165.4	252.9	18.9
1992	1428.6	137.7	124.5	143.9	18.5
1993	1214.5	90.6	134.5	134.4	16.8
1994	1537.9	45.8	140.1	162.2	19.8
1995	1197.6	NO	139.7	166.8	20.4
1996	1306.3	NO	175.7	153.8	23.2
1997	1533.8	NO	186.9	127.3	17.6
1998	1649.1	NO	195.4	148.3	18.8
1999	2151.0	NO	189.1	136.3	19.4
2000	2382.1	NO	193.0	139.1	20.8
2001	2739.2	NO	239.4	150.3	23.7
2002	2698.6	NO	269.3	158.5	26.2
2003	2692.1	NO	249.3	187.0	31.2
2004	2852.2	NO	284.0	210.6	33.2
2005	2926.6	NO	308,1	227.8	30.9
2006	3104.4	NO	358,1	228.7	35.9
2007	3160.5	NO	367,0	237.5	37.5
2008	2995.1	NO	342,6	255.1	43.9
2009	2439.1	NO	246,8	280.9	35.0
2010	2320.5	NO	216,1	295.2	24.2
2011	2071.7	NO	182,1	320.5	25.6
2012	1996.5	NO	138,4	300.1	24.9
2013	2198.3	NO	127.0	327.4	23.7
2014	2318.5	NO	135.6	364.9	23.5
2015	2155.8	NO	134.2	334.8	24.3
2016	2055.2	NO	125.1	378.1	23.0
2017	2411.1	NO	145.7	395.0	23.7
2018	2325.8	NO	146.3	404.6	24.2
2019	2272.4	NO	146.1	452.5	26.6
2020	2350.7	NO	148.0	414.0	27.3
2021	2406.0	NO	165.6	467.0	29.9
2022	2252.9	NO	149.9	485.3	30.7

Source: CBS, survey results from producers and EPR data base; Processing: Ekonerg Ltd

Construction and demolition (NFR 2.A.5.b)

Activity data and methodology (GB2023 Tier 1) used to calculate emissions for this category are given below, for each type of construction separately.

Activity data – buildings

For the period since 2002, detailed data on the number of houses, residential (apartment) buildings and non-residential construction works are available, while for the period from 1990 to 2001 only data on the total number of constructed residential buildings and detailed data on number of non-residential construction are available. Since it is not possible to calculate emissions from the total number of residential buildings, for historical years it was necessary to estimate number of buildings by type - houses with one/two families and residential buildings. In addition, the methodology of data collection for 2000 and 2001 is based on partial data because for those years, the CBS did not conduct a survey of all data sources.

The share of each individual building type in the total number of buildings (mean value of ten closest years was taken, i.e., 2002-2011) was used to calculate missing data for the period 1990-2001.

The total area affected by construction was calculated by multiplying the number of individual types of construction and the unit area affected by construction (according to GB 2023).

Activity data (excluding road construction) are shown in Table 4.1-2.

Table 4.1-2 Activity data for NFR 2.A.5.b (without road construction)

NFR	Number of houses constructed (single or two family)	Affected area for construction of houses	Number of residential buildings constructed	Affected area for construction of residential buildings	Number of non-residential construction works	Affected area for non-residential construction
Unit	-	m^2	-	m^2	-	m^2
1990	9440	2636431	1906	1115034	2678	2142400
1991	5794	1618201	1170	684391	1396	1116800
1992	3660	1022181	739	432314	1049	839200
1993	4204	1174148	849	496586	1086	868800
1994	4955	1383743	1000	585231	1234	987200
1995	3598	1004753	726	424943	1735	1388000
1996	7150	1996959	1444	844580	1956	1564800
1997	6799	1898900	1373	803107	1789	1431200
1998	6008	1677919	1213	709647	1957	1565600
1999	5580	1558483	1127	659134	2139	1711200
2000	7138	2012743	1014	593082	2246	1796533
2001	8695	2467004	901	527031	2352	1881867
2002	10252	2921264	788	460980	2459	1967200
2003	8875	2484420	947	553995	2704	2163200
2004	8035	2244404	1034	604890	2279	1823200
2005	7053	1953724	1396	816660	2351	1880800
2006	7028	1965824	1629	952965	2240	1792000
2007	6346	1745656	2134	1248390	2081	1664800
2008	6149	1698092	1999	1169415	1775	1420000
2009	5145	1424444	1588	928980	1701	1360800
2010	4877	1364092	1231	720135	1383	1106400
2011	4443	1246100	1025	599625	1309	1047200

NFR	Number of houses constructed (single or two family)	Affected area for construction of houses	Number of residential buildings constructed	Affected area for construction of residential buildings	Number of non-residential construction works	Affected area for non-residential construction
Unit	-	m^2	-	m^2	-	m^2
2012	3983	1111236	965	564525	1099	879200
2013	3766	1046248	800	468000	1173	938400
2014	3172	889440	669	391365	1130	904000
2015	3047	858772	631	369135	963	770400
2016	3151	887396	660	386100	1013	810400
2017	2966	837048	733	428805	1241	992800
2018	3044	857760	780	456300	1109	887200
2019	3319	935556	997	583245	1205	964000
2020	3501	988028	1079	631215	1165	932000
2021	3340	943536	1028	601380	917	733600
2022	3794	1069096	1318	771030	968	774400

Source: CBS and data estimate (EKONERG Ltd.)

Activity data – roads

Annual data on the total length of roads of different categorizations are available, and by comparing the data by years, the annual net change in the length of roads could be calculated. For each type of road, it is assumed that the annual increase in road length represents the length of the new road built. The reported reduction in road length by road type is ignored and is assumed to be due to a change in methodology used to generate statistics (eg changes in categorization of individual roads) or the removal of parts of existing roads. Also, for multi-year periods in which the reported length of roads has remained unchanged, the length of the newly built section is distributed evenly over the relevant time period. It is assumed that the construction of larger sections took place over a longer period of time, but the new length of the section was recorded in the year of opening. Moreover, national data on the average width of individual road categories were used to calculate the affected area (Table 4.1-3).

Table 4.1-3 Average width of roads within the Croatian road network

Road category	Width	Unit
Highways	28.60	m
State roads	10.37	m
County roads	10.37	m
Local roads	10.37	m
Unclassified roads	7.90	m

Source: HC, HAC, Bina-Istra, AC Zagreb-Macelj, Decision on unclassified roads (OG of the City of Zagreb 20/18), Ordinance on basic conditions that public roads outside settlements and their elements must meet from the point of view of transport safety (OG 110/01)

Activity data (length of newly constructed sections) for source category 2.A.5.b - road construction, are shown in Table 4.1-4.

Table 4.1-4 Activity data for road construction

NFR	Total length of newly built roads	Total affected area
Unit	km	km^2
1990	1048.3	10.5
1991	935.9	9.6
1992	758.5	7.7
1993	960.6	9.3

NFR	Total length of newly built roads	Total affected area
Unit	km	km^2
1994	1297.7	12.0
1995	1360.7	12.5
1996	1258.1	12.1
1997	1237.0	11.9
1998	1059.4	10.5
1999	533.1	5.3
2000	660.5	6.0
2001	528.0	4.8
2002	587.9	8.6
2003	748.0	9.0
2004	725.8	9.4
2005	682.8	7.4
2006	628.5	6.4
2007	836.2	8.3
2008	920.2	10.3
2009	808.3	8.3
2010	937.6	9.4
2011	1188.5	11.2
2012	1554.1	12.3
2013	1574.5	12.8
2014	996.5	8.3
2015	635.4	5.1
2016	977.6	8.2
2017	461.1	3.7
2018	1147.7	9.1
2019	858.3	6.8
2020	1738.3	14.4
2021	1442.3	11.6
2022	497.9	5.4

Source: Hrvatske ceste d.o.o., CBS, local authority units

Methodology

Emissions from construction activities are estimated by Tier 1 approach (GB2023). Emissions are estimated separately for each construction activity. Recommended emission for $PM_{2.5}$, PM_{10} and TSP were used.

Affected area for buildings was taken from GB2023, while for roads it was calculated by multiplying the average width and unit length of the road.

For other parameters, it was necessary to analyse the specifics of national conditions as well as specifics of each type of construction. Correction for soil moisture and correction for soil silt content are the same for each of the analysed types of construction because they refer to values at the national level. Other parameters are considered in the context of the specifics of each type of construction. For duration of construction and control efficiency of applied emission reduction measures, recommended average values for each type of construction were used. Also, average silt content of 20%, specified by GB2023, was used.

PE index was calculated based on valuesof the total monthly precipitation and average monthly temperature for the 11 largest cities in which measurements are carried out (in various climatic regions of Croatia). In this way, the areas of largest construction (areas with the largest population) were taken into account, as well as all climatic regions represented in Croatia. The calculated value is 78.

It should be noted that NFR 2.A.5.b emissions, due to the complexity of the calculation, were not calculated within the CollectER database but the calculation was performed in Microsoft Excel and then the final data was imported into the CollectER database, with the purpose of archiving. In the database, the corresponding implied emission factors for TSP, PM_{10} and $PM_{2.5}$ were created, for each subcategory separately, which were calculated as ratios of emissions and activity data.

Recalculations and improvements

Construction and demolition (NFR 2.A.5.b)

Activity data for road construction have been updated due to the collection of more detailed data from the competent authorities compared to the previous submission. This mainly refers to the changes recorded in the length of unclassified roads, for which data is collected from local self-government units, and the Institute for Spatial Planning of Counties and the City of Zagreb. This has resulted in recalculation of PM2.5, PM10 and TSP emissions for the whole time series.

4.2. Chemical industry (NFR 2.B)

Source category description

This sub-chapter gives an overview of the production of various inorganic and organic chemicals in the Republic of Croatia. The following activities are included: Ammonia production (NFR 2.B.1, SNAP 040403), Nitric acid production (NFR 2.B.2, SNAP 040402), Other chemical industry (NFR 2.B.10.a, SNAP 0404 and 0405) and Storage, handling, transport of chemical products (NFR 2.B.10.b).

Other chemical industry includes production of various chemical products: Sulphuric acid (SNAP 040401), Ammonium phosphate (SNAP 040406), NPK fertilizers (SNAP 040407), Urea (SNAP 040408), Carbon black (SNAP 040409), Ethylene (SNAP 040501), Propylene (SNAP 040502), 1,2 dichloroethane (SNAP 040503), Vinyl chloride (SNAP 040504), Polyethylene LD (SNAP 040506), Polyvinylchloride (SNAP 040508), Styrene (SNAP 040510), Polystyrene (SNAP 040511), Formaldehyde (SNAP 040517) and Ethyl benzene (SNAP 040518).

Adipic acid production (2.B.3) and Carbide production (2.B.5) are not in Croatia.

For source category 2.A.10.b Croatia is using notation key "IE", since PM emissions are included in other NFR 2.B codes.

Ammonia production (NFR 2.B.1, SNAP 040403)

One ammonia manufacturer has been in operation in Croatia during the whole time series. Natural gas is used as both feedstock and fuel in the production process. Ammonia is produced by catalytic steam reforming of natural gas, in which hydrogen is chemically separated from natural gas and combined with nitrogen to produce ammonia. Ammonia production process results in emissions of NOx, NMVOC, CO and NH_3.

Installation of the unit for separation of ammonia and hydrogen from a portion of synthesis gas that is incinerated in the primary reformer (installed in April 2009), made it possible to return these two components to production process (instead of incinerating them). The ammonia is extracted in a high pressure scrubber in contact with water, and the resulting ammonia water is stripped. This technology has led to an evident reduction in total NOx emissions (as NO_2) in 2009.

The same manufacturer also produces nitric acid, sulphuric acid and mineral fertilizers. Also, the same manufacturer was producing carbon black until 2009.

Nitric acid production (NFR 2.B.2, SNAP 040402)

There is one manufacturer of nitric acid in Croatia, with two units-plants, one of which has two production lines. In the production process, ammonia, which is used as feedstock, is vaporized, mixed with air and burned over a platinum/rhodium alloy catalyst. Both plants utilize dual-pressure production processes. Nitric acid is used in the manufacture of fertilizers by the same facility.

Nitric acid production results in NOx emission.

In July 2010, abatement technologies (Selective Catalytic Reduction - SCR) for removing NOx (as NO_2) were installed at Plant 1. This has resulted in evident reduction in NOx emissions in 2011. The causes of the fluctuation in emissions were technical problems associated with the operation of the installed SCR (loss of catalyser and system reconstruction, as well as frequent shutdowns and start-ups of the plants). At Plant 2, this technology was put into trial operation in December 2017.

Other chemical industry (NFR 2.B.10.a, SNAP 0404 and 0405)

Other chemical industry includes production of various chemical products such as sulphuric acid, ammonium phosphate, NPK fertilizers, urea, carbon black, ethylene, propylene, vinyl chloride, polyethylene LD, 1,2 dichloroethane, polyvinylchloride, styrene, polystyrene, formaldehyde and ethyl benzene, which results in emission of various pollutants, as described below. Production of the following chemical products was shut down: ammonium phosphate and carbon black in 2009; ethylene, propylene, polyethylene LD and polystyrene in 2011; 1,2 dichloroethane in 2001; vinyl chloride in 2002; polyvinylchloride in 2000, styrene and ethyl benzene in 1991 (with a short reactivation of ethyl benzene production during 1995 and 1996). Production of polyethylene LD was reactivated in 2014 and 2015 and was stopped again in 2016. Production of sulphuric acid was stopped for two years, in 2010 and 2011.

Methodology, emission factors and activity data

Ammonia production (NFR 2.B.1, SNAP 040403)

Emission calculation is based on the Tier 2 EMEP/EEA methodology. Tier 2 EFs from GB2023 were used for all emissions except for NOx, for which the facility specific annual emission factors were used since 1998 (direct emissions measurements divided by quantities of ammonia produced, for each year). For the period 1990-1997, an average NOx emission factor was calculated and used, based on available direct emissions measurements.

It is assumed that annual changes in the composition of natural gas (feedstock) and technical problems related to the operation of the installed emission reduction technology are the reason for occasional fluctuations in NOx emission factors. Other official explanations were not obtained.

Data on ammonia production and natural gas composition were collected from the survey of the manufacturer and verified by comparison with Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS). Data of direct emissions measurements are taken from the EPR database.

Nitric acid production (NFR 2.B.2, SNAP 040402)

Since 1998, facility specific emission factors were calculated from periodically measured NOx emissions and annual production capacity. For the period 1990-1997, an average NOx emission factor was calculated and used, based on available direct emissions measurements. Data on the production of nitric acid (100 percent HNO_3 from both plants) were collected from the survey of the manufacturer and verified by comparison with Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS). Data are presented in Table 5.2-1.

Other chemical industry (NFR 2.B.10.a, SNAP 0404 and 0405)

Emission factors are expressed as the quantity of pollutants emission per unit of production. For Polyethylene Low Density, PVC (suspension PVC and emulsion PVC), Styrene, Polystyrene (expandable - EPS) and Ethyl benzene, Ethylene, Propylene, 1,2 dichloroethane, Vinyl chloride, Formaldehyde and Ammonium phosphate production, Tier 2 methodology with Tier 2 emission factors from GB2023 were used.

For NPK fertilizers production, since 1998 (for TSP since 2007), facility specific NOx, NH_3 and TSP emission factors were calculated from direct measurements of emissions and annual production capacity. For the period 1990-1997 (for TSP 1990-2006), an average NOx, NH_3 and TSP emission factors were calculated and used, based on available measurements.

For Sulphuric acid production, SO_2 emissions were reported. Direct SO_2 emissions are facility specific emission since 1998. For the period 1990-1997, an average SO_2 emission factor was calculated and used, based on available direct SO_2 emissions measurements and annual production capacity.

For Urea production, NH_3, TSP, $PM_{2.5}$, PM_{10} and BC emissions were reported. For TSP, $PM_{2.5}$, PM_{10} and BC emission calculation, Tier 2 emission factors from GB2023 were used. Regarding NH_3, direct facility specific emissions measurements since 1998, were used. For the period 1990 to 1997, an average NH_3 emission factor was calculated and used, based on available direct NH_3 emissions measurements and annual production capacity.

For Carbon black production, Tier 2 EMEP/EEA GB2023 methodology and Tier 2 emission factors were used for SO_2, NOx, NMVOC, CO and TSP emission calculation. Those emissions were reported for the period 1990 – 2009. For the period 2000-2009, facility specific direct CO emissions were reported.

For Ammonium phosphate production, Tier 2 emission factors from GB2023 were used for TSP, PMs and BC emission estimation.

Data on the production of ammonia, nitric acid, sulfuric acid, NPK fertilizer and urea were collected from the survey of the manufacturers of these inorganic chemicals in Croatia and verified by comparison with Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS). For all other chemicals in the scope of this source category, activity data are taken from national statistic (Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS)). Activity data for this category are presented in Tables 4.2-1 and 4.2-2.

Table 4.2-1 Activity data for NFR 2.B.1, 2.B.2 and 2.B.10.a, represented by the relevant SNAP codes

NFR	2.B.1	2.B.2	2.B.10.a				
Name	Ammonia	Nitric acid	Carbon black	Sulphuric acid	Ammonium phosphate	NPK fertilisers	Urea
SNAP	040403	040402	040409	040401	040406	040407	040408
Unit	t	t	t	t	t	t	t
1990	344947	332459	30624	241759	66711	556522	280354
1991	347524	291997	18783	187009	42365	532082	328029
1992	425719	381797	13479	278434	53635	716537	356995
1993	344812	287805	17123	178269	43719	482845	273226
1994	350184	311236	21468	265550	48193	554370	278981
1995	377589	299297	27185	233122	65332	548305	314137
1996	373728	278683	26735	223201	52067	516058	383822
1997	402407	292892	24214	202191	47760	536732	361730
1998	301758	220508	24087	164011	40661	457556	279110
1999	387159	260198	20627	192587	47557	523246	360427
2000	395024	306201	20029	199585	32112	583243	352553
2001	315388	257534	21180	126284	19080	407087	279682
2002	285937	249992	19416	135224	24496	468376	265811
2003	321598	235583	21295	123248	22131	499870	336593
2004	404157	375926	20272	186318	52782	554096	396655
2005	398547	280746	18498	220625	65840	582543	372627
2006	388821	277590	26264	259014	78936	365118	370549
2007	430154	306619	23724	243149	75040	862263	407863
2008	444925	312928	16904	256988	76418	526041	405950
2009	375284	261478	3976	91486	32203	230963	389071
2010	438662	336795	NO	NO	NO	440289	439310
2011	447499	332713	NO	NO	NO	447284	445160
2012	416358	288207	NO	4465	NO	373566	428931
2013	417505	297545	NO	4584	NO	223515	439062
2014	458049	307296	NO	7687	NO	208530	465373
2015	455235	344638	NO	35333	NO	344827	447934
2016	420372	293260	NO	63792	NO	238178	393544
2017	468795	322185	NO	55352	NO	276863	464367
2018	396690	289498	NO	57469	NO	267410	361142
2019	480665	302067	NO	75170	NO	194610	452480
2020	453715	293765	NO	89436	NO	185359	437155
2021	287866	160149	NO	66894	NO	127206	282630
2022	55228	45302	NO	26254	NO	91232	34725

Source: CBS, EPR, survey request: fertilizers producers; Processing: Ekonerg Ltd

Table 4.2-2 Activity data for NFR 2.B.10.a, represented by the relevant SNAP codes

NFR	2.B.10.a									
Name	Styrene	Ethylene	Propylene	1,2 dichloro-ethane	Vinyl-chloride	Poly-ethylene LD	PVC	Polystyrene	Ethyl-benzene	Form-aldehyde
SNAP	040510	040501	040502	040503	040504	040506	040508	040511	040518	040517
Unit	t	t	t	t	t	t	t	t	t	t
1990	8923	72631	17586	72653	98976	171800	104602	46913	2725	22.0
1991	NO	66871	15272	68325	88135	136039	67934	33719	288	22.0
1992	NO	68318	13349	92089	118570	141614	70969	44389	NO	22.0
1993	NO	68634	9026	79608	103851	144415	44259	64269	NO	22.0
1994	NO	65285	7127	97528	128257	130805	79038	67498	NO	22.0
1995	NO	67547	8221	84374	112560	145235	93897	55805	4162	25.0
1996	NO	64782	7796	48631	63124	144100	45456	64121	2922	22.0
1997	NO	63554	7631	26264	35488	145439	47805	78580	NO	22.0
1998	NO	60148	6535	31308	41115	184493	73647	99960	NO	30.0

NFR	2.B.10.a									
Name	Styrene	Ethylene	Propylene	1,2 dichloro-ethane	Vinyl-chloride	Poly-ethylene LD	PVC	Polystyrene	Ethyl-benzene	Form-aldehyde
SNAP	040510	040501	040502	040503	040504	040506	040508	040511	040518	040517
Unit	t	t	t	t	t	t	t	t	t	t
1999	NO	60295	6981	47686	62236	179745	31304	84928	NO	21.0
2000	NO	38918	6443	71364	64875	83983	2953	20172	NO	19.0
2001	NO	46632	5542	64442	14432	113146	NO	33168	NO	20.0
2002	NO	43554	5074	NO	6950	112771	NO	45439	NO	19.0
2003	NO	41252	4622	NO	NO	160944	NO	46361	NO	14.2
2004	NO	49886	5135	NO	NO	193430	NO	35331	NO	16.3
2005	NO	50263	4860	NO	NO	191958	NO	54617	NO	15.6
2006	NO	48824	4740	NO	NO	123217	NO	58721	NO	11.5
2007	NO	45438	4498	NO	NO	119015	NO	69841	NO	10.2
2008	NO	43045	4053	NO	NO	119838	NO	60471	NO	5.4
2009	NO	38797	3174	NO	NO	115646	NO	56359	NO	6.9
2010	NO	36271	2909	NO	NO	139032	NO	54194	NO	6.3
2011	NO	23323	2068	NO	NO	83920	NO	12849	NO	5.9
2012	NO	NO	NO	NO	NO	NO	NO	NO	NO	5.5
2013	NO	NO	NO	NO	NO	NO	NO	NO	NO	4.2
2014	NO	NO	NO	NO	NO	577	NO	NO	NO	3.9
2015	NO	NO	NO	NO	NO	610	NO	NO	NO	2.0
2016	NO	NO	NO	NO	NO	NO	NO	NO	NO	2.0
2017	NO	NO	NO	NO	NO	NO	NO	NO	NO	3.0
2018	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.0
2019	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2020	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.4
2021	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.0
2022	NO	NO	NO	NO	NO	NO	NO	NO	NO	1,5

Source: CBS, Processing: Ekonerg Ltd

Recalculations and improvements

There was no recalculation or other improvement.

4.3. Metal production (NFR 2.C)

Source category description

This sub-chapter gives an overview of the production of various metals in the Republic of Croatia. The following primary metal production processes are present in Croatia: Iron and steel production (NFR 2.C.1, SNAP 0402), Ferroalloys production (NFR 2.C.2, SNAP 0403) and Aluminium production (NFR 2.C.3, SNAP 0401). There is no primary production of other metals such as magnesium, lead, zinc, copper, nickel etc. in Croatia.

Iron and steel production (NFR 2.C.1, SNAP 0402)

In the scope of iron and steel production, the following activities were present in Croatia during the time series: Steel production (NFR 2.C.1.1, SNAP 040205 - Open hearth furnace steel plant and SNAP 040207 - Electric furnace steel plant), Iron production (NFR 2.C.1.2 SNAP 040202 - Blast furnace charging) and Other (Rolling mills) (NFR 2.C.1.5 SNAP 040208 – Rolling mills).

Production of pig iron in one plant was carried out until the end of 1991, when it was shut down due to the inability of iron ore delivery during the war, as well as reduction and subsequently a cessation of the production of steel in open hearth furnaces (OHF) in the same year. It should be noted that sinter and pellets required for the production of iron were being imported and their production was not present in Croatia.

Emissions from lime produced for the needs of pig iron production are included in sub-sector 2.A.2.

Production of steel in electric arc furnaces (EAF), in two plants, was present during the whole time series. One plant was producing steel during the entire reporting period, with the exception of 2016. The second plant was active in the period 1990-2008 and in 2013 and 2014. Both plants used EAFs during the entire period, in which liquid steel was produced and then processed to finished products by casting and rolling. All production of steel in Croatia was stopped during 2016.

Since 1990, there were two rolling mills processes present in Croatia, hot and cold. In 2009, cold rolling mill process was stopped.

Pig iron production results in process emission of PM, heavy metals, PCBs, PAH and PCDD/PCDF. In OHF, process emissions consist mainly of PM, heavy metals and NMVOC, as well as PCBs, PAH, and PCDD/PCDF, while in EAF, process NOx and CO emissions are also generated. In the rolling mills, PM emissions are generated (also with NMVOC present in hot process).

Ferroalloys production (NFR 2.C.2, SNAP 0403)

Ferroalloys are alloys of iron and metals such as silicon, manganese and chromium. Ferroalloys production typically involves the use of electric arc furnaces and raw materials with relatively variable physical properties.

There were two factories producing ferroalloys in Croatia. One factory ceased its production in 1994, while the second factory stayed in operation until 2003. Only nationally aggregated statistical data on production quantities are available. The production fluctuated over the years, mainly as a result of discontinuous operations caused by the war in Croatia.

Ferroalloys production results in process emission of particulate matter.

Aluminium production (NFR 2.C.3, SNAP 0401)

Primary aluminium is produced in two steps. First, bauxite ore is ground, purified and calcined to produce alumina (Al_2O_3). The alumina is then electrically reduced to aluminium by smelting in large pots.

Primary aluminium production in Croatia was halted in 1991, mainly due to war activities.

Two types of technologies were applied in Croatia: prebaked anodes with side feed and prebake anodes with central feed.

One plant in Croatia manufactures aluminium castings by the pressure injection process. It does not deal with primary or secondary aluminium production, nor with production of aluminium from bauxite or recycled aluminium. Therefore, there are no relevant emissions from this plant.

Primary aluminium production results in emission of NOx, CO, SO_2, TSP, PM, BC, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno[1,2,3-cd]pyrene.

Methodology, emission factors and activity data

Iron and steel production (NFR 2.C.1, SNAP 0402)

Emission calculation is based on the Tier 2 of the EMEP/EEA methodology (GB2023) and implies multiplication of annual amount of products by the appropriate emission factor for a specific production process of metal.

Emission factors are expressed as the quantity of emissions of pollutants per unit of production.

Activity data on iron production in blast furnaces, as well as steel production, were from the NIR.

Activity data for rolling mills for the period 1990-2008 were taken from the scientific article „Sofilić et all, Archives of Metallurgy and Materials; Vol. 53, 2009, Issue 2“, and for the period after 2008, data were taken from the Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS).

Ferroalloys production (NFR 2.C.2, SNAP 0403)

Emission calculation is based on the Tier 1 EMEP/EEA methodology and implies multiplication of annual amount of products by the proposed emission factor.

Emission factors are expressed as the quantity of emissions of pollutants per unit of production. All emission factors are taken from GB2023.

Annual production of ferroalloys was extracted from statistical reports published by Central Bureau of Statistics.

Aluminium production (NFR 2.C.3, SNAP 0401)

Emission calculation is based on the Tier 2 EMEP/EEA methodology and implies multiplication of annual amount of products by the corresponding emission factor.

Emission factors are expressed as the quantity of emissions of pollutants per unit of production. All emission factors are taken from GB2023 (primary aluminium production, pre-baked cell).

Data on primary aluminium production were collected by a survey of aluminium manufacturer.

Activity data for the production of iron, steel, ferroalloys and primary aluminium are shown in Table 4.3-1.

Table 4.3-1 Activity data for NFR 2.C.1, 2.C.2 and 2.C.3, represented by the relevant SNAP codes

NFR	2.C.1				2.C.2	2.C.3
Name	Electric furnace steel plant	Open hearth furnace steel plant	Blast furnace charging	Rolling mills	Ferroalloys production	Aluminium production
SNAP	040207	040205	040202	040208	040302	040301
Unit	t	t	t	t	t	t
1990	171138	253161	209308	575928	129955	74248
1991	119734	94165	25713	310104	124263	50931
1992	101944	NO	NO	226086	81630	NO
1993	74082	NO	NO	190097	36605	NO
1994	63355	NO	NO	159068	54337	NO
1995	45370	NO	NO	108862	26081	NO
1996	45754	NO	NO	101965	10559	NO
1997	69895	NO	NO	110997	24694	NO
1998	103204	NO	NO	163059	12615	NO
1999	75877	NO	NO	128562	14142	NO
2000	69641	NO	NO	110266	16112	NO

NFR	2.C.1				2.C.2	2.C.3
Name	Electric furnace steel plant	Open hearth furnace steel plant	Blast furnace charging	Rolling mills	Ferroalloys production	Aluminium production
SNAP	040207	040205	040202	040208	040302	040301
Unit	t	t	t	t	t	t
2001	56169	NO	NO	98372	701	NO
2002	32789	NO	NO	55252	220	NO
2003	40942	NO	NO	111530	724	NO
2004	86105	NO	NO	115471	NO	NO
2005	73640	NO	NO	116393	NO	NO
2006	80516	NO	NO	147189	NO	NO
2007	76252	NO	NO	144409	NO	NO
2008	138865	NO	NO	188307	NO	NO
2009	46264	NO	NO	79187	NO	NO
2010	103427	NO	NO	78472	NO	NO
2011	95907	NO	NO	82310	NO	NO
2012	1037	NO	NO	28060	NO	NO
2013	111009	NO	NO	42248	NO	NO
2014	146465	NO	NO	35851	NO	NO
2015	121533	NO	NO	24886	NO	NO
2016	NO	NO	NO	13084	NO	NO
2017	3856	NO	NO	13151	NO	NO
2018	135775	NO	NO	11157	NO	NO
2019	69126	NO	NO	9894	NO	NO
2020	45273	NO	NO	7868	NO	NO
2021	185143	NO	NO	7971	NO	NO
2022	169135	NO	NO	8338	NO	NO

Source: NIR 2020 (original source: CBS and survey requests to producers), scientific article "Sofilić et all"; Processing: Ekonerg Ltd

Recalculations and improvements

There was no recalculation or other improvements for this category.

4.4. Other solvent and product use (NFR 2.D – 2.L)

Source category description

This chapter gives an overview of the following source categories under NFR 2.D - 2L Other solvent and product use: Domestic solvent use including fungicides (NFR 2.D.3.a), Road paving with asphalt (NFR 2.D.3.b), Asphalt roofing (NFR 2.D.3.c), Coating applications (NFR 2.D.3.d), Degreasing (NFR 2.D.3.e), Dry cleaning (NFR 2.D.3.f), Chemical products (NFR 2.D.3.g), Printing (NFR 2.D.3.h), Other solvent and product use (NFR 2.D.3.i, 2.G), Pulp and paper industry (NFR 2.H.1), Food and beverages industry (NFR 2.H.2), Other industrial processes (NFR 2.H.3), Wood processing (NFR 2.I), Production of POPs (NFR 2.J) and Consumption of POPs and heavy metals (NFR 2.K). Emissions from source category 2.L Other industrial processes including production, consumption, storage etc. of bulk products are included in other NFR 2.D-2.K.

Domestic solvent use including fungicides (NFR 2.D.3.a)

Domestic solvent use including fungicides covers emissions of NMVOCs arising from the domestic use of solvent-containing products. Many of these products are also used in industry and commerce. Croatian inventory stratified the following products/activities: Cosmetics and toiletries products, Car care products, DIY/buildings, Paint/varnish removers and solvents, DIY/buildings, Sealants, filling agents, Pesticides, and Domestic use of pharmaceutical products. Source of activity data are Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS), except for the activity Domestic use of pharmaceutical products, for which annual national population statistics are used. Further distinction between aerosol and non-aerosol products is not available in national statistics.

Road paving with asphalt (NFR 2.D.3.b)

Asphalt for road paving is commonly referred to as bitumen, asphalt cement, asphalt concrete or road oil and is produced in petroleum refineries. The annual weight of asphalt produced for road paving is used to calculate emissions of NMVOCs and PM from this source category. Data on the amount of asphalt produced were obtained from the Croatian Asphalt Society, which collects data from all asphalt plants in the Republic of Croatia.

Asphalt roofing (NFR 2.D.3.c)

The asphalt roofing industry manufactures saturated felt, roofing and siding shingles, and roll roofing and sidings. Most of these products are used in roofing and other building applications. This source category covers emissions of NMVOC, CO and PM from all related facilities. National production of shingles is used as activity data (Annual Statistical Reports, Industrial production, Annual PRODCOM Results).

Coating applications (NFR 2.D.3.d)

Paints are used within the industrial and domestic sectors. Traditionally, the term paint has often been used to describe pigmented coating materials only, thus excluding clear coatings such as lacquers and varnishes. However, here the term paint is taken to include all materials applied as a continuous layer to a surface with the exception of glues and adhesives.

Application of coatings during the manufacture of a number of other industrial products is covered by NFR source category 2.D.3.g Chemical products: adhesive, magnetic tapes, films and photographs manufacturing (SNAP 060311); textile finishing (SNAP 060312); leather tanning (SNAP 060313).

Use of paints is a major source of NMVOC emissions. It is generally not considered relevant for emissions of particulate matter, heavy metals or persistent organic pollutants.

Degreasing (NFR 2.D.3.e)

Degreasing is a process of cleaning products from water-insoluble substances, such as grease, fats, oils, waxes, carbon deposits, fluxes and tars. In most cases, the process is applied to metal products, but also plastic, fiberglass, printed circuit boards and other products are treated by the same process. The metal-working industries are the major users of solvent degreasing. Industrial metal degreasing with organic solvents takes place in specially designed cleaning equipment. Emission limits required by the Solvents Emissions Directive 1999/13/EC can only be achieved by using hermetically sealed cleaning equipment. This leads to a significant reduction of emissions and increased workplace safety. Metal degreasing takes place in either open-top or closed tanks. The open-top tanks, however, have been phased out in the European Union due to the Solvents Emissions Directive 1999/13/EC. Only small facilities, using not more than 1 or 2 tonnes of solvent per year (depending on the risk profile of the solvent) are still allowed to use open-top tanks. The most common organic solvents for vapour cleaning are:

methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL). Degreasing results in NMVOC emission.

Dry cleaning (NFR 2.D.3.f)

Dry cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres, using organic solvents. In general, dry cleaning process can be divided into following steps: cleaning in a solvent bath, drying with hot air and recovery of solvent, deodorisation (final drying) and regeneration of used solvent. Dry cleaning results in NMVOC emission.

Chemical products (NFR 2.D.3.g)

Source category Chemical products covers the emissions from the use of various chemical products in manufacturing or processing of chemical products. In Croatia, in the period since 1990, this source category includes many activities, such as: Polyester processing (SNAP 060301), Polyvinylchloride processing (SNAP 060302), Polyurethane processing (SNAP 060303), Polystyrene foam processing (SNAP 060304), Rubber processing (SNAP 060305), Pharmaceutical products manufacturing (SNAP 060306), Paints manufacturing (SNAP 060307), Inks manufacturing (SNAP 060308), Glues manufacturing (SNAP 060309), Bitumen blowing (SNAP 060310) and Adhesive, magnetic tapes, films and photographs manufacturing (SNAP 060311). Almost all of these activities still exist in Croatia with the exception of rubber processing, which was stopped during 2006, polystyrene foam processing which was stopped during 2011, and Bitumen blowing, which was present from 2003 to 2014. Leather tanning (SNAP 060313) is present in Croatia, but ammonium salts are not used in any phase of this activity, thus there are no NH_3 emissions. Tyre production does not occur in Croatia.

All activities in this category result in NMVOC emissions except for bitumen blowing, for which NMVOC, TSP, Cd, As, Cr, Ni, Se and PAH emissions are calculated.

Printing (NFR 2.D.3.h)

Printing includes NMVOC emissions arising from solvents used in printing industry. Printing involves the use of inks which may contain organic solvents. These inks can be diluted before use. Different inks have different portions of organic solvents and require dilution to different extents. Printing can also require the use of cleaning solvents and organic dampeners. Ink solvents, diluents, cleaners and dampeners may all make a significant contribution to emissions from industrial printing. Printing processes convert original text and pictures into an image on a carrier and the main process types are named according to how this image is carried.

Other solvent and product use (NFR 2.D.3.i, 2.G)

Other solvent and product use includes emissions of NMVOCs arising from the following activities that are present in Croatia: Oil extraction (SNAP 060404), Application of glues and adhesives (SNAP 060405), Wood preservation - Creosote preservation type (SNAP 060406), Wood preservation - Organic solvent-borne preservative (SNAP 060406), Car dewaxing (SNAP 060409), Use of shoes (SNAP 060603), Concrete additive (SNAP 060412-2), Cooling lubricant (SNAP 060412-3), Lubricant (SNAP 060412-4), Tobacco combustion (SNAP 060602) and Use of fireworks (SNAP 060601).

Glass wool and Mineral wool enduction (SNAP 060401 and 060402) as well as Underseal treatment and conservation of vehicles (SNAP 060407) are not present in Croatia, according to available information.

Official clarifications about activity data that show time series inconsistency cannot be obtained. Based on publicly available information, it can be assumed why some of dips and jumps occurred within time series. For example, from 2002, there was an increase in use of adhesives in construction due to massive increase in construction sector in Croatia, which ended in sudden drop due to the recession in 2009. In wood preservation with creosote, there is a sudden drop in 2014 due to replacement of widely-used wooden power poles with concrete poles and replacement of wooden railway ties with concrete ones. Data for vehicle dewaxing were influenced by increased use of foil wrapping of vehicles. An increasing trend of use of fireworks (mainly use of prepared explosives, other than propellant powders) was noted from 2002 to 2005 with a peak in 2003. Reasons for other inconsistencies in time series are unknown.

Pulp and paper industry (NFR 2.H.1)

There are three types of processes for pulp and paper production that existed and still exist in Croatia: Kraft (sulphate), acid sulphite and neutral sulphite semi-chemical process. Sulphate pulping was used until 1990 and acid sulphite pulping was used until 1994, while the neutral sulphite semi-chemical process still exists. Sulphate and neutral sulphite semi-chemical processes result in emissions of NOx, CO, NMVOC, SO_2 and PM, while acid sulphite process results in emissions of NOx, NMVOC, SO_2 and PM.

Food and beverages industry (NFR 2.H.2)

Croatian Informative inventory reports are considering following activities in scope of NFR 2.H.2 Food and drink: production of wine (white and unspecific colour wine), spirits, beer, bread, coffee roasting, meat, fish etc. frying / curing, sugar production, animal feed, margarine and solid fats and final cakes, biscuits and breakfast cereals production. Emissions from food and beverages industry include NMVOC emissions from various processes in production chain.

Wood processing (NFR 2.I)

Wood processing activity includes the manufacture of plywood, reconstituted wood products and engineered wood products. This source category is only important for particulate matter emissions. The relevant activity statistic is the mass of wood products processed in Croatia.

Production of POPs (NFR 2.J)

According to GB2023, the production of POPs is not a key source category since the production processes are mostly highly controlled in order to manage health and environmental effects. In addition, no emission factors are available for the production of POPs.

Consumption of POPs and heavy metals (NFR 2.K)

According to Directive 96/59/EC and the Ordinance on the management of polychlorinated biphenyls and polychlorinated terphenyls (Official Gazette, No. 105/08), equipment with a volume of PCBs greater than 5 dm^3 had to be decontaminated by December 31, 2010. Other equipment, after devices of which it was an integral part have been withdrawn from use, must be collected separately and handed over to an authorized person for decontamination and/or disposal as soon as possible in accordance with the provisions of the mentioned Ordinance and the Law on Waste Management (Official Gazette, No. 84/21), at the latest within the period determined by the Act on Ratification of the Stockholm Convention on Persistent Organic Pollutants.

Furthermore, Croatia has an established system for managing waste batteries and accumulators, regardless of their size and shape. Also, Croatia has transposed the provisions of EU regulations on limiting/banning the use of mercury in products into its regulations and is also a signatory to the Minamata Convention.

Therefore, for emissions from category 2.K, notation key "NE" was used.

Methodology, emission factors and activity data

Domestic solvent use including fungicides (NFR 2.D.3.a)

Emission estimation is based on the Tier 2a and 2b GB2023 methodology.

Tier 2a, with technology-specific emission factors based on solvent consumption is used for the activity DIY/buildings, Paint/varnish removers and solvents, as GB 2023 does not provide an emission factor based on product use for this activity.

For the activity Domestic use of pharmaceutical products, approach 2b is used, with emission factors based on the number of inhabitants, which is allowed to be used in cases where statistics on product use are incomplete. For this submission, the number of inhabitants was updated in accordance with CBS estimates, and emissions for the years 1997 and 2000-2010 were recalculated.

Tier 2b, with technology-specific emission factors based on product use, is used for all other activities within this category.

Emission factors are expressed as the emission per unit of solvent-containing products (product consumption) or per capita. Activity data for NFR 2.D.3.a, represented by the relevant SNAP code are given in Table 4.4-1.

A significant increase in activity data in the Car care products category occurred in the last several years which is a result of a new business entity appearing on the market, which affected the increase in production and sales of this product.

In the Pesticides category, a significant increase in activity data in 2020 was observed compared to the rest of the time series. In this category, the inventory includes PRODCOM data on sold quantities of products belonging the group ‘pesticides and other agrochemical products’. To clarify the cause of this increase, the CBS was contacted. The answer was that this group includes all disinfectants (hand sanitisers, surface disinfectants and disinfectants used in agriculture), which is in line with Eurostat and the Customs Tariff. For this reason, due to increased consumption attributable to the pandemic, there was an increase in 2020.

Table 4.4-1 Activity data for NFR code 2.D.3.a, represented by the relevant SNAP code

NFR 2.D.3.a	Cosmetics and toiletries	House-hold products	Car care products	DIY/ buildings, Paint/ varnish removers & solvents	DIY/ buildings, Sealants, filling agents	Pharmace-utical products	Various products: pesticides
SNAP	060408-1	060408-2	060408-3	060408-4	060408-5	060411	060408-7
Unit	kg prod.	kg prod.	kg prod.	kg solvent	kg products	population	t products
1990	749437	11009000	7277000	7106000	9431000	4778000	13937
1991	810098	8458000	5003000	4072000	5471000	4513000	11578
1992	755473	6974000	5574000	2525000	3285000	4470000	4982

NFR 2.D.3.a	Cosmetics and toiletries	House-hold products	Car care products	DIY/ buildings, Paint/ varnish removers & solvents	DIY/ buildings, Sealants, filling agents	Pharmace-utical products	Various products: pesticides
SNAP	060408-1	060408-2	060408-3	060408-4	060408-5	060411	060408-7
Unit	kg prod.	kg prod.	kg prod.	kg solvent	kg products	population	t products
1993	771290	6917000	4701000	2259000	2959000	4641000	6647
1994	840915	4953149	4536000	2409000	4786000	4649000	10047
1995	668622	5378897	3609000	1815000	5821000	4669000	10901
1996	380755	4190651	4764000	1909000	6608000	4494000	9994
1997	380919	7007809	3692000	1716000	7912000	4572000	9194
1998	382291	6481108	2876000	1674000	9980000	4501000	7674
1999	426322	6045846	3044000	1544000	8409000	4554000	6081
2000	508522	5813441	2275000	1528000	7300000	4426000	7182
2001	497411	5956084	2505000	1474000	7383000	4299642	8570
2002	571345	7219129	3475000	1663000	9146000	4302174	7164
2003	625157	8590884	3009101	1661000	6225000	4303399	4799
2004	723313	8560240	2629826	1712000	8696000	4304600	6675
2005	483679	9004148	2764705	1693000	15084000	4310145	4423
2006	460002	9405593	1503195	1591000	12429000	4311159	4297
2007	578606	9957008	1324135	1430000	9255000	4310217	3993
2008	694125	8955890	2111528	1656000	13272000	4309705	3188
2009	581419	7663580	2136197	1405000	6968000	4305181	2372
2010	1281127	7584616	2961162	1182000	6804000	4295427	2445
2011	1544609	9098104	2616124	1112000	6686000	4280622	1923
2012	1370629	8984782	2977454	847000	5350000	4267558	1547
2013	696184	8713631	2557159	812000	4260000	4255689	939
2014	927176	8269223	2517049	711000	3529000	4238389	581
2015	498006	10871273	3850747	759000	3624000	4203604	528
2016	263372	8314330	4241600	764000	4033000	4174349	535
2017	194776	7689441	12017481	584000	4792000	4124531	462
2018	317124	7361617	16950005	739000	5102000	4087843	327
2019	334492	7039742	36322094	778000	4819000	4065253	480
2020	282581	6804953	40439963	789000	4229000	4047680	2538
2021	268206	6150580	46016156	1499000	4239000	3878981	1817
2022	351717	5930034	11047467	1762000	4247000	3855641	738

Source: CBS, Processing: Ekonerg Ltd

Road paving with asphalt (NFR 2.D.3.b)

Only drum mix asphalt plants are used in Croatia. Since activity data are only available from 2008 onwards, an estimate of asphalt production data was carried out for the period before 2008 using the available bitumen production data from the period 1990-2007 and mean value of the asphalt/bitumen ratio for the known years.

Methodology used is based on GB2023. Recommended Tier 2 emission factors are used for NMVOC and BC, while abatement technologies are included for TSP, PM_{10} and $PM_{2,5}$. Technologies included in calculations were determined based on data from each individual plant. Data were collected through a questionnaire sent to operators (68 plants, whose register is maintained by the Croatian Asphalt Association) and all data gaps were rechecked in EPR database. Data collected in this way are presented in Table 4.4-2.

Tablica 4.4-2 Use of abatement technologies

Year	Share of plants using technology in the total number of plants	
	Fabric filter	Wet scrubber
1990	29%	-
1991	44%	-
1992	44%	-
1993	44%	-
1994	44%	-
1995	40%	-
1996	40%	-
1997	45%	-
1998	54%	-
1999	53%	-
2000	56%	-
2001	65%	-
2002	68%	-
2003	67%	-
2004	78%	-
2005	79%	4%
2006	74%	3%
2007	78%	3%
2008	83%	2%
2009	80%	2%
2010	83%	2%
2011	83%	2%
2012	82%	2%
2013	85%	2%
2014	86%	2%
2015	88%	2%
2016	92%	2%
2017	91%	2%
2018	93%	2%
2019	98%	-
2020	98%	-
2021	98%	-
2022	98%	-

Source: asphalt plants, EPR

Total emissions are the sum of emissions from plants that use and from plants that do not use abatement technologies.

There was a very significant reduction in emissions, especially in recent years. This is due to the fact that after 2015, over 90% of plants use high-efficiency emission reduction technologies.

Activity data for NFR 2.D.3.b are presented in Table 4.4-3.

Asphalt roofing (NFR 2.D.3.c)

Emission estimation is based on the Tier 1 EMEP/EEA 2023 methodology. The recommended Tier 1 emission factors from the GB2023 are used. Emission factors are expressed as the amount of emission per annual production unit.

Activity data for NFR 2.D.3.c are presented in Table 4.4-2.

Coating applications (NFR 2.D.3.d)

Emission estimation is based on the Tier 1 EMEP/EEA 2023 methodology. It is assumed that all paint was used in diffuse sources. For the calculation, data from the Eurostat database (from the year 2001 onward) were used, together with annual statistical reports on industrial production (annual PRODCOM results) (1990-2000) and expert estimates for the amounts of paint based on GDP (Source: Eurostat: June 2017, Market Survey / Feb 2016, CHP survey / June 2017, SHARES2015 from Feb 2017, ECFIN: AMECO GDP June 2017, EEA / UNFCCC June 2017). The Eurostat data on the amounts of solvent-based paint (import, export and sold production) and amounts of water-based paint (import, export and sold production) were used. Total amount of paint used is presumed to be equal to imported amounts reduced by the exported amounts and increased by the produced amounts (i.e. sales, product realization). In the calculation, it is assumed that the total applied paint in Croatia is equal to consumption in decorative, industrial and other applications.

Croatia currently does not have sufficient data that would enable transition to the Tier 2. It is planned to further investigate this category and possibly available substitute data. After determining the most accurate approach, an improvement of emissions estimate will be implemented, which is planned for one of the next submissions.

Emission factor is expressed as the amount of NMVOC emissions per total paint consumption. Activity data for NFR 2.D.3.d are presented in Table 4.4-2.

Degreasing (NFR 2.D.3.e)

For the calculation of NMVOC emissions, the consumption of the most common organic solvents for degreasing was used (according to GB2023). Data on quantities of the most common organic solvents (import / export / production) for the years 2001 – onward, were taken from the Eurostat database. The calculation does not include the organic solvent trichlorethylene because it is assumed that this solvent is completely consumed within the activity NFR 2.D.3.f Dry cleaning. In addition to data from the Eurostat database (2001-onward), for the NMVOC emission calculation from this source for the period 1990-2000, the annual statistical reports on industrial production (annual PRODCOM results) and expert estimates for the quantities of degreasing products based on GDP were used.

NMVOC emission factor is the GB2023 Tier 2 EF (open-top degreaser), and it is expressed as the amount of NMVOC per annual unit of degreasing product. Activity data for NFR 2.D.3.e are given in Table 4.4-2.

Dry cleaning (NFR 2.D.3.f)

Emission calculation for this activity includes methodology based on the amount of solvent used (import/export/production) for dry cleaning.

The EMEP/EEA GB2023 assumes that the most widespread solvent used in dry cleaning, accounting for about 90 % of the total consumption, is tetrachloroethene (also called tetrachloroethylene or perchloroethylene (PER)). Data for import / export / production are available from the Eurostat database. PER production data are available only in PRODCOM codes, where PER is linked to trichlorethylene, which is mostly used in metal degreasing processes (NFR 2.D.3.e). Given the above mentioned, the assumption that all PER (including the amount of trichlorethylene) is used only in dry cleaning sector is included in the calculation, thus minimizing the possibility of double counting. Since NMVOC EF for dry cleaning is shown in GB2023 as grams per kilogram of cleaned textiles, TERT has proposed using the following NMVOC emission calculation method: the second paragraph of Section 3.2.1. Dry

Cleaning in GB explains that solvent emissions directly from the cleaning machine into the air represent little more than 40 % for a closed-circuit machine, which is most likely the main type of machines currently used for dry cleaning. Open-circuit equipment may be in use somewhere in small quantities, but it was basically removed from the use around the 1990s. According to the previous explanation, TERT has recommended that it should be assumed that the EF for dry cleaning can be 400 g of NMVOC/kg solvent (for all years). The same method is applied in the Estonian Inventory. In addition to data from the Eurostat database (2001-onward), for the NMVOC emission calculation from this source for the period 1990-2000, the annual statistical reports on industrial production (annual PRODCOM results) and expert estimates for the quantities of dry cleaning products based on GDP were used.

Emission factor is expressed as the amount of NMVOC emissions per annual amount of solvent used for dry cleaning. Activity data for NFR 2.D.3.f are presented in Table 4.4-3.

Table 4.4-3 Activity data for NFR codes 2.D.3.b, 2.D.3.c, 2.D.3.d, 2.D.3.e and 2.D.3.f, represented by the relevant SNAP code

NFR	2.D.3.b	2.D.3.c	2.D.3.d	2.D.3.d	2.D.3.d	2.D.3.e	2.D.3.f
Name	Road paving with asphalt	Asphalt roofing	Decorative coating application	Industrial coating application	Other coating application	Degreasing	Dry cleaning
SNAP	040611	040610	060100	060100	060100	060201	060202
Unit	kt	kt	t	t	t	t	t
1990	594.1	24.5	28819.1	28819.1	28819.1	14792.6	428.4
1991	425.8	14.5	20840.0	20840.0	20840.0	6108.5	338.1
1992	105.5	14.3	14493.3	14493.3	14493.3	1839.8	298.4
1993	83.0	13.0	13355.3	13355.3	13355.3	1692.2	274.6
1994	754.0	13.6	13014.2	13014.2	13014.2	2782.4	295.5
1995	801.0	14.8	13863.7	13863.7	13863.7	27874.4	315.2
1996	1004.4	19.7	15231.3	15231.3	15231.3	19951.5	335.5
1997	1515.4	6.0	16263.9	16263.9	16263.9	2439.2	352.4
1998	1484.5	9.9	16483.2	16483.2	16483.2	2436.2	358.8
1999	1623.0	13.6	15941.8	15941.8	15941.8	2186.8	356.5
2000	1456.5	23.4	15472.0	15472.0	15472.0	2614.7	368.9
2001	1141.5	11.6	15480.4	15480.4	15480.4	2344.5	380.4
2002	2197.5	9.5	16434.6	16434.6	16434.6	2488.0	390.8
2003	3377.9	24.7	17151.8	17151.8	17151.8	2506.8	403.3
2004	4002.8	24.9	18860.1	18860.1	18860.1	3269.9	288.5
2005	3593.3	43.8	19481.9	19481.9	19481.9	2944.0	261.0
2006	3314.6	72.7	21080.1	21080.1	21080.1	3423.1	230.8
2007	3285.4	46.8	18429.3	18429.3	18429.3	3911.5	224.2
2008	4290.0	25.3	21103.1	21103.1	21103.1	3778.9	176.7
2009	3230.0	23.5	16636.1	16636.1	16636.1	3370.3	143.6
2010	2170.0	18.0	16047.4	16047.4	16047.4	3627.8	132.8
2011	2550.0	16.6	16160.3	16160.3	16160.3	3097.3	132.1
2012	2500.0	10.0	15173.5	15173.5	15173.5	2985.8	112.7
2013	2760.0	16.5	14051.8	14051.8	14051.8	155.5	65.8
2014	2300.0	13.1	14170.2	14170.2	14170.2	84.4	144.1
2015	2150.0	38.5	13911.9	13911.9	13911.9	142.7	98.9
2016	2200.0	17.3	16368.7	16368.7	16368.7	85.4	122.6
2017	2160.0	27.6	12207.3	12207.3	12207.3	145.5	86.7
2018	2540.0	15.9	16000.7	16000.7	16000.7	136.6	86.5
2019	2620.0	18.9	18686.0	18686.0	18686.0	113.0	82.7
2020	2340.0	19.0	16728.2	16728.2	16728.2	84.7	60.4
2021	2710	22.0	11583.3	11583.3	11583.3	142.4	29.3
2022	2570.0	21.5	14312.3	14312.3	14312.3	80.7	58.0

Source: CBS, EUROSTAT, Croatian Asphalt Society; Processing: Ekonerg Ltd

Chemical products (NFR 2.D.3.g)

Methodology for emissions estimate from the source category Chemical products is based on Tier 2 approach of the EMEP/EEA methodology (GB2023) for all activities except polyester and PVC processing.

For PVC processing, only Tier 1 emission factor is available in GB, thus it was used in calculations. For polyester processing, activity data needed for Tier 2 approach were not available, thus Tier 1 NMVOC emission factor was used as well. The inquiries for requesting data were sent to the Croatian Chamber of Commerce and the companies engaged, which all stated that they do not have the required data.

Activity data used in calculations are taken from annual statistical reports on industrial production (annual PRODCOM results) for all activities except for bitumen blowing (for which data obtained from refineries were used), and for pharmaceutical products manufacturing (for which data obtained from manufacturers were used).

For bitumen blowing, the following technologies were used during the operations:

- steam from the top of the reactor is quenched by injecting a small amount of water, after which bitumen droplets are separated from liquefied hydrocarbons through a demister,
- vapours are incinerated on the incinerator after leaving the demister.

Therefore, for NMVOC emission estimate, abated EF was used, according to Table 3-17 of GB2023, Part B, Chapter 2.D.3.g Chemical products. For other substances, recommended Tier 2 values according to GB2023 were used.

For pharmaceutical products manufacturing, recommended Tier 2 emission factors were used (GB2023), with taking into account abatement technologies for NMVOC.

Total annual amount of solvents used in the production of pharmaceutical products in each plant is used as activity data. Data were collected from 16 plants and also include the amount of solvent used for disinfection of equipment and for analytical purposes in the laboratory. Since the data provided by the operators were incomplete, the EPR database was also reviewed to complete the missing data, i.e., to collect replacement data on annual product quantities, which were then used to estimate the missing solvent consumption data, as described below.

As expected, more recent data are available, and for older historical data an expert assessment was performed, using known parameters such as plant start-up year, annual production (where data was available), and average solvent consumption per production in years closest to the year being estimated. For plants and years for which production data were not available, the GDP of the sector Manufacturing industry/Manufacture of basic pharmaceuticals and pharmaceutical products was used as a substitute (Source: www.dzs.hr - gross domestic product - annual calculation). For the years for which GDP data is not available as well (1990-1994), data on total annual production of pharmaceutical products in Croatia were used.

The abatement technologies included in estimates were determined based on data for each individual plant, collected through a questionnaire sent to operators. It was found that during the time series abatement technologies related to Primary measure program 2, with high use of secondary measures, i.e., incineration, adsorption and/or condensation (according to GB2023), were used in five plants. These measures have been applied in one plant since 2000, in one plant since 2008, in two plants since 2013 and in one plant since 2016. In the remaining nine plants, the use of abatement technologies has not been determined, and for these plants, the application of conventional primary measures (good housekeeping, process optimization) is assumed, without the use of secondary measures. Total emissions are the sum of emissions from plants that use abatement technologies and the plants that do not use them.

Regarding the emission trend, it should be noted that in 2012, the largest consumer of solvents has a significant increase in production, which affects the increase in raw material use, and consequently the increase in emissions compared to previous years. Also, since 2013, this operator uses abatement technologies, which is when the biggest drop in emissions occurs. In 2022, there is a significant reduction in emissions due to reduced activities in this sector.

Activity data for various activities in the scope of NFR 2.D.3.g are presented in Table 4.4-4.

Table 4.4-4 Activity data for NFR code 2.D.3.g, represented by the relevant SNAP codes

NFR 2.D.3.g	Polyester processing	PVC processing	Polyurethane processing	Polystyrene foam processing	Rubber processing	Pharmaceutical products manufac.
SNAP	060301	060302	060303	060304	060305	060306
Unit	kt	kt	kt	kt	kt	t solvents
1990	6.0	49.7	3.8	7.8	5.7	3163.7
1991	4.2	30.7	2.8	7.3	5.4	2036.4
1992	3.5	20.0	1.7	6.7	2.4	1796.4
1993	2.6	15.1	2.0	6.6	2.5	1856.5
1994	2.5	5.5	2.5	9.3	2.3	1921.3
1995	2.2	5.3	2.9	6.4	2.3	1882.3
1996	3.4	5.3	1.8	7.6	1.3	1344.8
1997	7.0	5.2	1.8	10.4	0.03	2188.4
1998	8.3	4.2	1.8	9.9	0.02	2418.6
1999	5.6	2.9	1.8	5.3	0.02	2758.3
2000	12.8	1.5	1.9	3.6	0.02	2950.0
2001	9.7	1.0	2.8	1.4	0.02	3151.5
2002	14.7	8.4	5.6	NO	0.02	2617.5
2003	9.7	8.4	2.9	NO	0.01	2461.8
2004	10.9	10.1	2.5	1.0	0.01	2499.8
2005	10.9	9.4	2.9	1.7	0.004	2331.4
2006	14.1	8.0	2.4	11.0	0.004	1756.6
2007	16.5	8.6	1.9	15.8	NO	2349.2
2008	16.5	9.3	1.9	16.2	NO	3150.6
2009	14.0	6.8	1.0	11.1	NO	2572.9
2010	7.3	4.7	0.8	10.1	NO	2783.5
2011	7.1	3.8	0.6	0.6	NO	3162.5
2012	7.7	3.8	0.6	NO	NO	3969.1
2013	7.9	3.2	0.5	NO	NO	2852.1
2014	7.3	0.7	0.6	NO	NO	3729.3
2015	8.5	0.9	0.4	NO	NO	4549.5
2016	8.1	1.0	0.6	NO	NO	5659.8
2017	8.8	0.9	0.5	NO	NO	5788.2
2018	8.6	1.3	0.6	NO	NO	5768.0
2019	8.9	1.4	0.5	NO	NO	5287.7
2020	9.0	1.4	0.5	NO	NO	5063.5
2021	10.9	1.6	0.4	NO	NO	4740.8
2022	10.0	1.5	0.4	NO	NO	2499.3

Source: CBS (annual PRODCOM results), INA d.d., pharmaceuticals manufacturers, Processing: Ekonerg Ltd.

Table 4.4-4, cont.

NFR 2.D.3.g	Paints manufacturing	Inks manufacturing	Glues manufacturing	Adhesive, magnetic tapes, films and photographs manufac.	Bitumen blowing
SNAP	060307	060308	060309	060311	060310
Unit	kt	kt	kt	m^2	kt
1990	22.0	4.7	21.6	1009.0	NO
1991	13.8	3.6	13.4	776.0	NO
1992	9.5	1.4	7.1	469.0	NO
1993	9.1	1.0	10.9	299.0	NO
1994	10.8	1.5	11.2	239.0	NO
1995	10.78	1.4	10.1	320.0	NO
1996	13.9	1.5	17.2	592.0	NO
1997	15.0	1.4	10.9	404.0	NO
1998	15.5	1.1	10.4	419.0	NO
1999	15.2	0.8	8.2	257.0	NO
2000	15.1	0.9	10.4	344.0	NO
2001	16.8	0.8	12.4	339.0	NO
2002	15.2	0.9	25.8	323.0	NO
2003	15.3	0.8	30.9	138.0	11.1
2004	15.0	0.9	46.1	27.0	90.0
2005	16.4	0.7	56.6	109.0	53.5
2006	17.3	0.7	71.3	108.0	91.1
2007	20.1	0.9	81.8	75.3	82.2
2008	19.7	0.9	77.7	93.3	94.4
2009	15.2	0.6	33.8	95.4	95.8
2010	16.4	0.3	35.5	95.2	57.6
2011	16.6	0.4	28.7	74.0	48.0
2012	14.3	0.3	28.8	41.0	29.3
2013	12.6	0.3	31.6	NO	39.2
2014	14.2	0.3	21.6	NO	2.9
2015	14.6	0.3	18.8	NO	NO
2016	17.4	0.3	19.0	NO	NO
2017	17.3	0.3	16.5	NO	NO
2018	16.0	0.4	23.3	NO	NO
2019	16--.3	0.3	22.8	NO	NO
2020	12.5	0.3	20.1	NO	NO
2021	14.0	0.3	18.3	NO	NO
2022	13.3	0.2	19.8	NO	NO

Source: CBS (annual PRODCOM results), INA d.d., pharmaceuticals manufacturers, Processing: Ekonerg Ltd

Printing (NFR 2.D.3.h)

Emission calculation is based on ink used in the printing industry, using Tier 2 EMEP/EEA 2023 methodology.

Data on the amounts of ink (import/export/production) were taken from the Eurostat database (from the year 2001 onward). In addition to Eurostat database, for the NMVOC emission calculation from this source for the period 1990-2000, the annual statistical reports on industrial production (annual PRODCOM results), together with expert estimates for quantities of ink consumed in printing industry based on GDP, were used.

In this submission, a recalculation of the entire time series was performed for this category using substitute data that enabled transition to the Tier 2, since the specific data required for the calculation according to the EMEP/EEA methodology are not available. French methodology was used for the improvement (source: EMEP/EEA Guidebook, Additional Guidance: 2D3

Solvent and Product Use), and it is a transitional solution until national data is collected, which is expected in one of the next submissions.

The aforementioned methodology proposes emission factors expressed as the amount of NMVOC emissions per annual unit of applied ink for the years 1990, 2000, 2010 and 2019, as follows:

	g NMVOC/Mg ink
1990	872,447
2000	709,526
2010	508,191
2019	355,647

For other years, emission factors are interpolated and they are extrapolated for the period after 2019.

Activity data for NFR code 2.D.3.h are represented in Table 4.4-4.

Other solvent and product use (NFR 2.D.3.i, 2.G)

The methodology for emission estimation is based on the Tier 2 of EMEP/EEA 2023 approach. Tier 2 emission factors used for all activities, except Application of glues and adhesives, are expressed as the amount of NMVOC emissions per annual consumption unit.

For the activity Application of glues and adhesives, abatement technologies for NMVOC emissions are included, for which rates of penetration were modelled on IIASA data taken from the GAINS model for the Republic of Croatia. This was done for 1990, 2005, 2010 and 2030. For other years, data were estimated by linear interpolation. Abatement technologies included in calculations (taken from the GAINS model, in accordance with GB2023), include: activated carbon adsorption (ACA), emulsions (EMU), hot melts-100% solid (HOTM), incineration (INC) and no control (NOC). The shares of the use of each abatement technology/measure in the observed period are defined as follows:

	1990	***2005***	***2010***	***2030***
- *ACA*	0%	0%	2%	10%
- *EMU*	0%	50%	50%	55%
- *HOTM*	0%	7%	15%	20%
- *INC*	0%	10%	8%	5%
- *NOC*	100%	33%	25%	10%

In accordance with the above, abated emission factors were calculated for each year based on the Tier 2 approach of the EMEP/EEA methodology, with the inclusion of abatement technologies/measures (in accordance with GB2023, ch. 2.D.3.i, 2.G Other solvent and product use, tab. 3-11, 3-22), with the established rates of penetration over the time series. The calculated emission factors for the whole time series are presented in Appendix 2, Table P2-3.

For the source category NFR 2.D.3.i, 2.G, basic activity statistics are stratified by activities and are separated to sub-categories 2.D.3.i Other solvent use and 2.G Other product use.

For activity under SNAP code 060404 Oil extractions, relevant activity statistics are the quantities of seed used in units of tonnes per year.

For activity under SNAP 060405 Application of glues and adhesives, relevant activity statistic are quantity of glues produced in units of tonnes per year for industry, DIY/buildings (construction) and domestic uses.

For activities under SNAP 060406 Wood preservation (Creosote preservation type and Organic solvent-borne preservative), the preservative consumption data is not available and the "quantity of wood preserved" (volume of wood impregnated with creosote (m^3/yr.) and volume of wood impregnated with solvent borne preservative (m^3/yr.) is combined with proposed assumptions in EMEP/EEA 2023.

For Car dewaxing (SNAP 060409), relevant activity data is annual number of motor vehicles (passenger and light cargo) imported by sea on Croatian territory. Data are available for the period 2000 - 2012, and for other years expert assessment was applied. Data are the result of processing the Uniform Customs declaration for the customs procedure of release goods into free circulation (import) by Croatian Ministry of Finance, Customs Administration.

For activity under SNAP 060601 Use of fireworks, relevant activity statistics are amounts of prepared explosives, other than propellant powders, and signalling flares.

For activity under SNAP 060602 Tobacco combustion, relevant activity statistics are the quantities of cigarettes and cigars used in units of tonnes per year combined with assumptions that one cigarette contains 1g of tobacco and one cigar contains 5g of tobacco.

For Use of shoes (SNAP 060603), relevant activity statistics is annual number of sold pairs of shoes.

For Concrete additive (SNAP 060604-1), relevant activity statistics is annual quantity of sold additives for construction activities.

Basic activity statistics data are taken from Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS).

As source of activity data for Cooling lubricant (SNAP 060604-2) and Lubricant (SNAP 060604-3), national energy balance was used. Relevant activity data is non-energy use of various lubricants in energy sector, petrochemical industry, other industry, construction, transport and agriculture. Lubricants consumption in two-stroke engines is included in the Energy sector.

Activity data for NFR 2.D.3.i and NFR 2.G are shown in Tables 4.4-5 and 4.4-6.

Table 4.4-5 Activity data for NFR codes 2.D.3.h, 2.D.3.i, 2G, represented by the relevant SNAP codes

NFR	2.D.3.h	2.D.3.i		2.G	
Name	Printing	Wood preservation with solvent borne preservative	Wood preservation with creosote	Tobacco combustion	Use of fireworks
SNAP	060403	060406b	060406a	060602	060601
Unit	kt	t	t	t	t
1990	6.53	31.69	334.83	12091	709
1991	5.09	11.77	124.32	11232	709
1992	2.63	25.50	269.43	12428	709
1993	2.17	21.40	226.08	11271	709
1994	2.67	51.41	508.73	4856	709
1995	2.71	50.68	362.50	11845	1214
1996	2.84	50.05	473.00	11327	1787
1997	2.95	43.21	409.63	11185	1766
1998	2.62	47.91	402.58	11965	1197
1999	2.33	33.54	434.43	13839	973
2000	2.50	34.33	243.73	13531	707
2001	2.47	37.54	234.65	17674	1659
2002	2.59	53.54	334.65	18350	8292
2003	2.95	60.63	1145.83	19070	11487
2004	3.33	53.11	1761.98	14256	6201
2005	3.61	32.86	1361.48	14634	2773

NFR	2.D.3.h	2.D.3.i		2.G	
Name	Printing	Wood preservation with solvent borne preservative	Wood preservation with creosote	Tobacco combustion	Use of fireworks
SNAP	060403	060406b	060406a	060602	060601
Unit	kt	t	t	t	t
2006	4.09	18.54	971.35	14422	2088
2007	4.47	96.01	1451.90	14595	1471
2008	4.46	422.14	1337.15	15405	1024
2009	4.03	2058.15	1750.10	11335	456
2010	4.06	401.83	1819.20	13279	181
2011	4.20	448.51	1319.18	11665	156
2012	4.14	421.02	1712.98	11144	11
2013	4.79	572.80	2600.20	9598	1455
2014	4.71	518.98	364.18	8377	1036
2015	4.69	675.70	617.23	8157	1000
2016	4.70	507.70	290.00	8162	1278
2017	4.71	1240.47	622.78	9097	1349
2018	4.65	1054.08	584.18	12042	1629
2019	4.67	1366.62	427.33	11823	1728
2020	4.39	638.64	584.10	10904	2341
2021	4.77	437.41	317.45	8777	2660
2023	4.37	534.03	125.60	8493	2192

Source: CBS, EUROSTAT; Processing: Ekonerg Ltd

Table 4.4-6 Activity data for NFR code 2.D.3.i, 2.G, represented by the relevant SNAP code

NFR	2.D.3.i			2.G			
Name	Fat, edible and non-edible oil extraction	Use of adhesives	Vehicles dewaxing	Use of Shoes	Concrete additive	Cooling lubricant	Lubricant
SNAP	060404	060405	060409	060412-1	060412-2	060412-3	060412-4
Unit	t	t of glue	number of vehicles	1000 pairs of shoes	t	t	t
1990	121158	21591	751	26384	3109	63535	53001
1991	28401	13209	704	11977	1152	51834	43584
1992	72700	7079	657	8751	757	30733	30600
1993	42622	7479	438	13865	778	30232	29200
1994	72922	6280	503	8407	1081	30831	25285
1995	73551	7180	548	9408	934	31431	15000
1996	69991	8972	588	5766	964	32030	15300
1997	132847	10874	648	6715	1124	32728	17500
1998	157060	10379	687	5192	1102	33527	15800
1999	100509	8206	729	5159	1123	33325	15500
2000	25260	10355	768	2381	603	29823	14600
2001	24256	12385	673	2279	539	30921	20600
2002	155631	25851	58	3891	912	33419	17300
2003	151524	30873	7	4935	1583	28817	25100
2004	95505	46119	36	7130	1983	39214	19400
2005	123783	56573	152	5477	4724	35212	21700
2006	129269	71330	45	5776	6319	37898	19400
2007	98045	81768	70	5803	3872	44882	16400
2008	96740	77701	48	5443	2023	38660	17200
2009	76898	33849	25	5069	1722	37060	14800
2010	83669	35507	26	5276	2449	32960	11200
2011	86646	28722	10	4966	1668	33025	10300
2012	26214	28801	16	4486	1989	29323	10200
2013	34087	31622	5	4533	1394	28321	10500
2014	44358	21616	5	5148	522	29429	12000

NFR	2.D.3.i			2.G			
Name	Fat, edible and non-edible oil extraction	Use of adhesives	Vehicles dewaxing	Use of Shoes	Concrete additive	Cooling lubricant	Lubricant
SNAP	060404	060405	060409	060412-1	060412-2	060412-3	060412-4
Unit	t	t of glue	number of vehicles	1000 pairs of shoes	t	t	t
2015	51005	18810	5	5010	500	31834	10600
2016	47170	18955	5	4989	827	34137	18400
2017	61879	16530	5	6086	1660	33540	16900
2018	66927	23291	5	6276	2165	33944	15600
2019	45742	22251	5	5901	1174	35147	16900
2020	48337	19692	5	4524	1205	34551	13100
2021	57381	17357	5	4642	1354	35054	14200
2022	56253	18291	5	4832	1688	37661	9200

Source: CBS, Croatian Ministry of Finance, Customs Administration, Energy balance; Processing: Ekonerg Ltd

Pulp and paper industry (NFR 2.H.1)

Methodology for emission estimation is based on the Tier 2 of EMEP/EEA 2023 methodology. For all activities in the source category 2.H.1, recommended Tier 2 emission factors are used according to the EMEP/EEA 2023. All emissions from fuel combustion in these processes are reported under NFR 1.A.2.d, using Tier 1 approach.

Emission factors are expressed as emission per annual production unit.

Activity data for different SNAP codes within the NFR code 2.H.1 are presented in Table 4.4-7.

Table 4.4-7 Activity data for NFR codes 2.H.1 and 2.I, represented by the relevant SNAP codes

NFR	2.H.1			2.I
Name	Paper pulp (Neutral Sulphite Semi-Chemical process)	Paper pulp (Acid sulphite process)	Paper pulp (Kraft process)	Wood processing
SNAP	040604	040603	040602	040620
Unit	t	t	t	t
1990	94703	1623	14609	91422
1991	68778	1074	NO	60789
1992	62985	703	NO	74862
1993	74304	476	NO	69093
1994	92838	71	NO	63325
1995	78246	NO	NO	52779
1996	62933	NO	NO	53954
1997	69885	NO	NO	50541
1998	57552	NO	NO	52254
1999	71158	NO	NO	47461
2000	88607	NO	NO	50308
2001	77232	NO	NO	51038
2002	78247	NO	NO	54988
2003	52526	NO	NO	62789
2004	66065	NO	NO	68151
2005	55489	NO	NO	89565
2006	63331	NO	NO	110134
2007	49554	NO	NO	121040
2008	52122	NO	NO	123953
2009	36946	NO	NO	94985
2010	53340	NO	NO	93545
2011	61192	NO	NO	97483

NFR	2.H.1			2.I
Name	Paper pulp (Neutral Sulphite Semi-Chemical process)	Paper pulp (Acid sulphite process)	Paper pulp (Kraft process)	Wood processing
SNAP	040604	040603	040602	040620
Unit	t	t	t	t
2012	42966	NO	NO	102444
2013	40366	NO	NO	143088
2014	32648	NO	NO	134822
2015	31957	NO	NO	134552
2016	33596	NO	NO	87228
2017	38912	NO	NO	117871
2018	38767	NO	NO	113729
2019	46852	NO	NO	100264
2020	45108	NO	NO	150940
2021	47566	NO	NO	183130
2022	43808	NO	NO	140940

Source: CBS, Processing: Ekonerg Ltd

Food and beverages industry (NFR 2.H.2)

Emission estimation is based on the Tier 2 of EMEP/EEA 2023 methodology. For all activities in this category, Tier 2 default emission factors are used, and they are based on various food and beverages products.

In GB 2023, Ch. 2.H.2, section 3.3.2, it is stated that background emission factors presented (tab. 3-2 to 3-10) are used to derive default emission factors and that the recommendation is to use the given default emission factors (tab. 3-11 to 3-32). In accordance with this instruction and in order to avoid double counting of emissions from individual activities in this category, background factors were not taken into account and only default emission factors were used.

Activity data for different SNAP codes within the NFR code 2.H.2 are given in Table 4.4-8.

Table 4.4-8 Activity data for NFR code 2.H.2, represented by the relevant SNAP codes

NFR 2.H.2	Bread	Wine	Beer	Spirit	Cakes, biscuits cereals	Marga-rine & solid fats	Animal feed	Sugar	Meat frying/ curing	Coffee roast-ing
SNAP	040605	040606	040607	040608	040615	040616	040617	040625	040626	040630
Unit	t	hl	hl	hl	t	t	t	t	t	t
1990	250489	1299550	2800220	1222918	40848	24507	970853	200645	135315	12905
1991	205425	1114993	2247510	1125981	32337	21000	755750	100162	104501	12591
1992	202327	1099244	2720037	611939	23525	17723	653431	94666	90577	8248
1993	185419	851302	2481344	551763	21307	14687	650745	78847	86103	7296
1994	201668	858680	3156610	323896	22371	13094	530053	115440	86112	8420
1995	172510	829480	3170134	310632	23505	24507	519900	175340	86795	8003
1996	154330	793676	3291972	418724	24146	16637	477753	195316	89773	8144
1997	154443	548426	3662853	358295	26151	16170	476549	141380	84603	8643
1998	139070	626098	3759435	315762	26507	15755	537653	139207	82321	8429
1999	124364	483515	3606546	326754	25666	16124	496339	113966	79562	7639
2000	122585	612812	3993439	320831	26320	20261	694835	56729	134297	7768
2001	123620	548667	3779271	253721	26943	16414	530348	130693	84992	7955
2002	138063	600463	3638502	265219	29454	22232	559542	173896	101742	11056
2003	136241	638412	3701131	247523	36822	27378	583495	146561	101212	11181
2004	140597	631784	3606304	218749	34988	30635	758976	214934	101972	10545
2005	136930	504248	3495910	281664	36322	25427	534785	245387	106546	9697
2006	144683	534735	3688972	203974	36313	31814	590284	320345	116218	13040
2007	202890	652852	3810230	49582	39349	29600	643886	328322	115739	13549

NFR 2.H.2	Bread	Wine	Beer	Spirit	Cakes, biscuits cereals	Marga-rine & solid fats	Animal feed	Sugar	Meat frying/ curing	Coffee roast-ing
SNAP	040605	040606	040607	040608	040615	040616	040617	040625	040626	040630
Unit	t	hl	hl	hl	t	t	t	t	t	t
2008	194473	508689	3879887	52652	46395	4688	637284	315764	223998	12832
2009	191204	556945	3674323	48824	47396	17284	602422	255956	133945	13934
2010	193074	463463	3438947	55617	49494	16136	599633	261568	131874	13010
2011	192282	488750	3738332	51300	49221	17542	654202	329322	141720	14203
2012	193307	441905	3625144	41924	47762	16200	656880	296728	137243	12129
2013	157647	487803	3443429	53504	47365	15010	654983	273843	130385	11667
2014	194812	452727	3416678	49926	50662	13574	736066	335388	130027	11620
2015	190523	472699	3396272	44607	49691	12839	517659	248827	125013	11927
2016	183009	484895	3365899	41339	47555	12039	696173	333866	135622	14513
2017	185677	460889	3343055	43872	48755	11615	675234	331949	143199	13497
2018	176738	500608	3468984	46587	47806	11478	724469	126464	143043	13354
2019	170650	514891	3266374	44008	47036	10931	727980	192437	150486	11725
2020	156689	528500	2325427	36893	45195	10414	783238	125897	157631	11680
2021	157835	547818	2425093	48958	45625	10398	779555	96630	165158	11145
2022	157720	560326	3387815	57143	46117	9075	777113	118472	169170	10370

Source: CBS; Processing: Ekonerg Ltd

Wood processing (NFR 2.I)

Methodology for emission estimation is based on Tier 1 EMEP/EEA approach. Proposed Tier 1 emission factors are used according to GB2023. Activity data are taken from the Annual Statistical Reports, Industrial production, Annual PRODCOM Results (CBS). Activity data for NFR code 2.I is presented in Table 4.4-6.

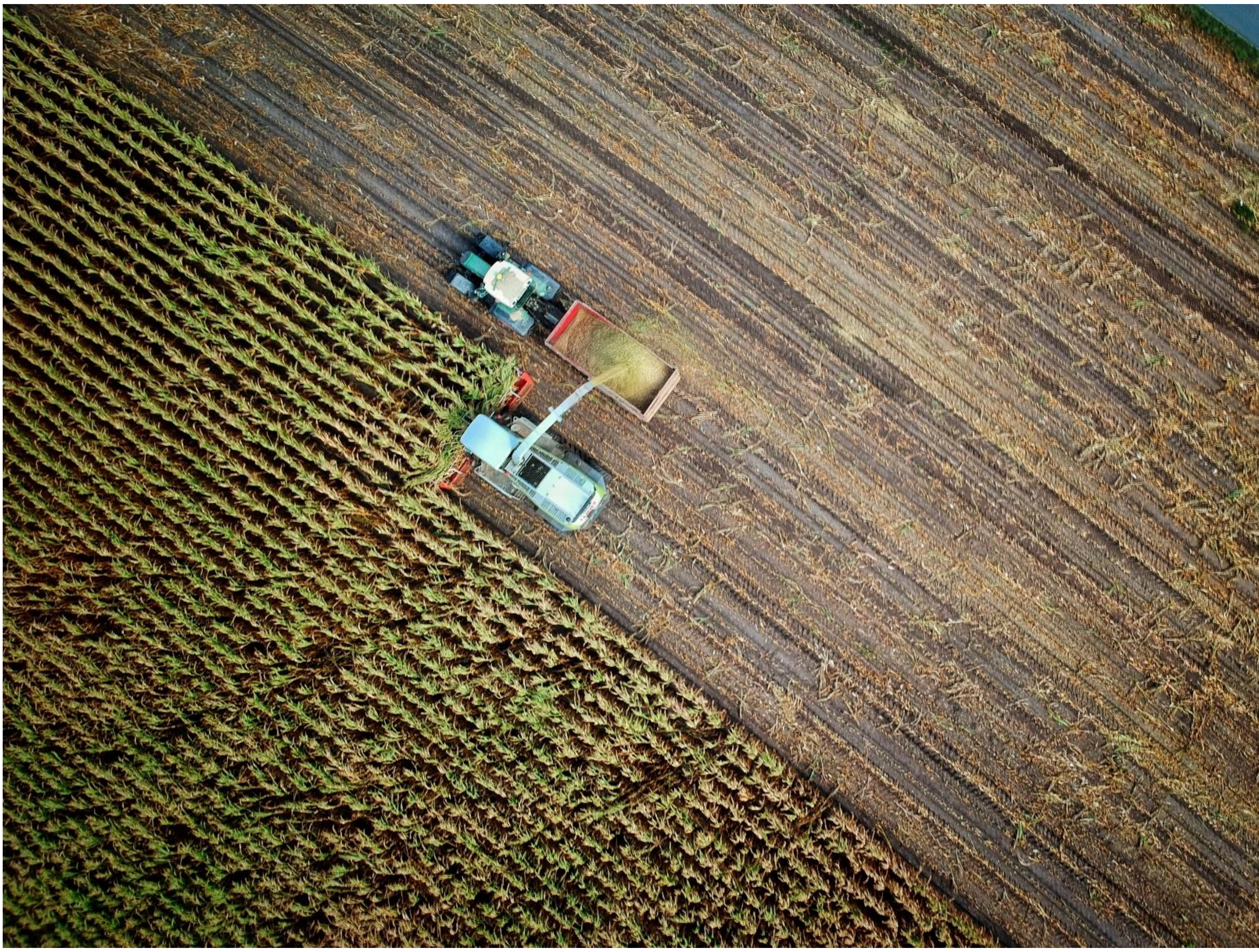
Recalculations and improvements

Printing (NFR 2.D.3.h)

Recalculations of NMVOC emissions were made for the whole time series 1990-2021, due to the implementation of the Tier 2.

Pulp and paper industry (NFR 2.H.1)

Recalculations were made for the whole time series, due to the implementation of GB2023 and new EFs for SO_2, NOx, CO and TSP for neutral sulphite semi-chemical process (1990-2022), which were not previously included, and updated SO_2 EF for acid sulphite process (1990-1994).



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5. Agriculture (NFR 3)

This chapter gives an overview of the sector NFR 3 Agriculture and contains information on methodologies, activity data, emission factors, recalculations used for the calculation of emission estimates and planned improvements. Under NFR sector 3, emissions of ammonia, particles (TSP, $PM_{2.5}$ and PM_{10}) HCB, NMVOC and NOx are reported.

This sector includes the following sub-sectors from which certain pollutant emissions in the Republic of Croatia are reported:

- 3.B Manure Management
  - 3.B.1.a Dairy cattle
  - 3.B.1.b Non-dairy cattle
  - 3.B.2 Sheep
  - 3.B.3 Swine
  - 3.B.4.d Goats
  - 3.B.4.e Horses
  - 3.B.4.f Mules and asses
  - 3.B.4.g.i Poultry
  - 3.B.4.g.i Laying hens
  - 3.B.4.g.ii Broilers
  - 3.B.4.g.iii Turkeys
  - 3.B.4.g.iv Other poultry
- 3.D Crop production and agricultural soils
  - 3.D.1.a Mineral N-fertilizers
  - 3.D.a.2.a Animal manure applied to soils
  - 3.D.a.2.b Sewage sludge applied to soils
  - 3.D.a.2.c Other Organic Fertilisers Applied to Soils
  - 3.D.a.3 Urine and dung deposited by grazing animals
  - 3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products
  - 3.D.e Cultivated crops
  - 3.D.f Use of pesticides
- 3.F Field burning of agricultural residues

Information on the inclusion / exclusion of the condensing component in the PM_{10} and $PM_{2.5}$ emission factors according to the NFR emission categories is found in Appendices 2 and 6.

There are 5 main sources of activity data for emission calculation: the Central Bureau of Statistics (CBS), Croatian Agricultural Agency (CAA), Ministry of Economy and Sustainable Development, FAOSTAT and fertilizer companies.

The key categories for the agriculture sector are shown in Table 5-1. Key Category Analysis (KCA) is presented in Section 1.5 and Appendix 1.

Table 5-1 Key sources of the Agriculture sector

NFR Category	NFR Category Name	Key Categories	
		Pollutant	KCA
3B1a	Dairy cattle	NMVOC	L1
		NH3	L1, T1
3B1b	Non-dairy cattle	NMVOC	L1, T1
		NH3	L1, T1
3B3	Swine	NH3	L1
3B4gi	Laying Hens	NH3	T1
3B4giv	Other Poultry	PM10	T1
		TSP	T1
3Da1	Inorganic N-fertilizers	NOX	L1, T1
		NH3	L1, T1
3Da2a	Animal manure	NH3	L1, T1
3Dc	On-farm storage, handling and transport of agricultural products	PM10	L1, T1
		TSP	T1
3De	Cultivated crops	NMVOC	L1
3Df	Use of pesticides	HCB	T1
3F	Field burning of agricultural residues	PM2.5	T1
		PM10	T1
		Cd	T1
		DIOX	T1

L1 = level assessment, tier 1, 2022

T1 = trend assessment, tier 1, 1990–2022

5.1. Manure management (NFR 3.B)

Source category description

The manure management is source of emissions of NH_3, NO, NMVOC and PM. The NH_3, NO, NMVOC arise from the excreta of agricultural livestock deposited in and around buildings and collected as liquid slurry, solid manure or litter-based farmyard manure (FYM) and the last two are observed together as solid. Those emissions take place from buildings housing livestock and outdoor yard areas, from manure stores, following land spreading of manures and during grazing. The PM emissions arise mainly from feed, and also from bedding, animal skin or feathers, and take place from buildings housing livestock. There are five main sources of emissions from animal husbandry and manure management: livestock feeding (PM), livestock housing and holding areas (NH_3, PM, NMVOC), manure storage (NH_3, NO, NMVOC), field-applied manure (NH_3, NO, NMVOC) and manure deposited during grazing (NH_3, NO, NMVOC). Croatia is reported ammonia, NOx and PM emissions for animal husbandry, while NMVOC emission is not reported for now.

The national specifics for manure management regarding key categories are presented in Appendix 2.

Methodology, emission factors and activity data

The methodology used is in line with GB2023, which includes the use of the "Manure Management N-flow tool" model. For the calculation of NH_3 and NOx emissions from the NFR sector 3.B Animal husbandry and manure management, Tier 2 “mass-flow” methodology was used for all animal categories other than Swine and Poultry, for which Tier 3 method was used. A Tier 3 method was used to utilise the calculation procedure outlined under Tier 2, but with the inclusion of abatement measures.

National specifics described in the previous chapter were implemented within the Tier 2 methodology. Emission factor for a certain part of the poultry sub-category “Other poultry” (pheasants, quails, guinea fowls, ostriches, chickens other than laying hens) correspond to the emission factor for ducks, in accordance with the ERT recommendation.

National implemented proportions of livestock category housed on slurry and solid based systems and national specifics in manure management (nitrogen excretion rate (Nex)) were developed by the experts from the Faculty of Agriculture, University of Zagreb and are presented in Table 5.1-9 for the year 2022. The Nex values for animal categories with variable values for selected years are presented in Table 5.1-10.

Tier 3 methodology for swine and poultry: To implement possible abatement measures, additional data on livestock building / management and methods of storage and application of manure was collected as part of an estimate calculation improvement project. This was done by analysing information in Environmental permits[28] for animal farms (fattening pigs, sows, laying hens, broilers and turkey). For the farms of laying hens, fattening pigs and sows, for the period from 2020 onwards, data obtained from the CBS database, Census of Agriculture 2020, which includes a larger number of the listed animals, was analyzed. Environmental permits for 71 farms were additionally analyzed. Animals were sorted by applicable abatement measures. Abatement measures were taken from „Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources“, ECE/EB.AIR/120. Where the emission reduction potential of a measure was given in a form of a range, average value was selected. Reduction potentials are presented in Table 5.1-2 and 5.1-3.

Table 5.1-1 Percentage of animals with applicable abatement measures within the total animal number in 2022

Animal category		Percentage of animals on processed farms of the total number in Republic of Croatia	Percentage of animals from processed farms with applicable abatement measures of the total number
Swine	Fattening pigs	28%	28%
	Sows	45%	45%
Poultry	Laying hens	43%	33%
	Broilers	30%	30%
	Turkeys	92%	36%

Source: MESD; Processing: Ekonerg Ltd

In the calculation of NH_3 emissions, for certain categories of animals (swine, poultry), reduction measures are included according to installed reduction techniques on farms based on their environmental permits. For sows and fattening pigs emission reductions were calculated in accordance with the reduction potentials for animal housing systems, manure storage

[28] An environmental permit is issued for facilities carrying out the activities that may cause pollutant emissions into the soil, air, water and sea and the facilities that will carry out such activities after construction, or reconstruction and commissioning. Regulation on environmental permit Official Gazette 8/14, 5/18

techniques and manure application techniques, while for laying hens, broilers and turkeys, emission reduction is applicable only for animal housing systems (see Table 5.1-2). The final reduction of default NH_3 emission factor was obtained as a percentage of animals under applied reduction measures / technologies in relation to the total number of animals in Croatia.

The assessment of NH_3 emission reductions is applied on a farm-by-farm basis. From the farm's environmental permits, it is analysed which NH_3 emission abatement techniques each farm uses. Once this has been determined, the annual number of animals is collected for each year and for each farm with the reduction technique applied, and it is assumed that all animals on a particular farm are under the same NH_3 emission reduction techniques. The abatement ratio is developed by using number of animals under each specific abatement measure and using % mitigation of emissions for that measure to get a calculated mitigation in emissions. The annual number of animals in the calculations is not modified and the total AD is always used (Tables from 5.1-4 to 5.1-8). The reduction is instead of AD, applied to default NH_3 emission factor for each state (housing, storage, application). Mitigation is applied to the emission factors for NH_3 for each form of management (housing, storage, application). Depending on the measure, the corresponding reduction potential is applied to default emission factor for each form of management. The same approach was used to calculate the abatement ratios and apply them to the default NH_3 emission factor for housing, storage and application of slurry for sows and fattening pigs and housing only for poultry categories (there are no abatement measures in place for other forms of management). The same approach was used to calculate the mitigation ratios and apply them to the given NH_3 EF's for housing of sows and fattening pigs and housing for the poultry categories only (there are no mitigation measures for other forms of management). Mitigation ratios and their application to a given NH_3 EF's for storage and application of slurry from sows and fattening pigs was also calculated according to the methodology described above. Final emission abatement was obtained as a percentage of animals with applicable abatement methods / technologies in relation to the total number of animals in Croatia. The abatement measures to reduce NH_3 emissions and associated potentials are taken from the „*Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources*“, ECE/EB.AIR/120 and listed in the tables 5.1-2 and 5.1-3.

For better understanding, a detailed example was provided for market pigs, year 2021, for abatement related to housing: From the farm's environmental permits, it was determined that two abatement techniques are implemented: for 46,888 fattening pigs (A), the housing technique "Partially slatted floor" with the NH_3 emission abatement potential of 17.50% per head (A_m) from the Table 5.1-2, and for 74,298 fattening pigs (B) the housing technique "Frequent manure removal " with the NH_3 emission abatement potential of 25% per head (B_m). The total number of fattening pigs in Croatia in 2021 is 864,446 (C). To calculate the percentage reduction of NH_3 emissions for these two housing techniques for fattening pigs, the following equation is used:

$$((A \times A_m) + (B \times B_m)) \, / \, C$$

Inserting the above figures into the equation gives the following:

$$((46{,}888 \times 0.175) + (74{,}298 \times 0.25)) \, / \, 864{,}446 = 0.031$$

The calculated emission reduction of 3.1% is then applied to the default NH_3 emission factor for fattening pigs, whereby the default emission factor for slurry of 0.28 (kg/animal) is reduced to 0.27132581 (kg/animal) for 2021. The same approach was used for other ways of animal housing (fattening pigs, sows, poultry) as well as for the storage and application of slurry for fattening pigs and sows. For poultry, except for the housing, there are no abatement techniques for storage and application of slurry.

Table 5.1-2 The NH_3 emission abatement potential used for determination of abated emission factors for animal housing systems

Housing system	NH_3 emission abatement potential (%)
Fattening pigs	
Partially slatted floor with reduced pit	17.5%
Frequent manure removal	25%
Sows	
Water and manure channel	50%
Frequent manure removal	25%
Laying hens	
Enriched cages, ventilated belts, 2 removals a week	35%
Enriched cages, ventilated belts, removals more than 2 times a week	40%
Broilers	
Fan-ventilated house with fully littered floor with non-leaking drinking system	25%
Turkeys	
Fan ventilated house with fully littered floor and non-leaking drinking system	12.5%

Source: Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources“, ECE/EB.AIR/120.

Table 5.1-3 Reduction potentials used for determination of reduction factors for manure storage and manure application techniques

Manure storage technique	NH_3 emission abatement potential (%)
Tight lid, roof or tent structure	80%
Plastic sheeting (floating cover)	60%
Natural crust (floating cover)	40%
Plastic sheeting (floating cover)	40%
Manure application technique	**NH_3 emission abatement potential (%)**
Incorporation of surface applied slurry (within 4 h)	55%
Injecting slurry (closed slot) - deep injection (> 15cm)	85%
Incorporation of surface applied slurry (within 24 h)	30%

Source: Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources“, ECE/EB.AIR/120.

Data for cattle farms are not currently available, therefore reduction techniques were not applicable to cattle.

Reduction potentials for NO_x were not estimated or applied due to missing default values or ranges of emissions reduction, so it is likely that NO_x emission have remained overestimated.

Analysis was conducted for each year from 1990 to 2021 and for each animal category separately, and are reported as a percentage reduction of emissions (Tables 5.1-4 – 5.1-8).

Table 5.1-4 Number of fattening pigs with reduction measures and percentage reduction of default EF

Year	Number of animals (total)	Animal housing system		Manure storage techniques		Manure application techniques	
		Number of animals in reduction	Reduction of default EF (%)	Number of animals in reduction	Reduction of default EF (%)	Number of animals in reduction	Reduction of default EF (%)
1990	1341000	16148	1.2%	24926	1.9%	35849	2.7%
1991	1387000	16148	1.2%	24926	1.8%	35849	2.6%
1992	1002000	16148	1.6%	24926	2.5%	35849	3.6%
1993	1069000	16148	1.5%	24926	2.3%	35849	3.4%
1994	1149000	16148	1.4%	24926	2.2%	35849	3.1%
1995	993000	16148	1.6%	24926	2.5%	35849	3.6%
1996	1016000	16148	1.6%	24926	2.5%	35849	3.5%
1997	991000	16148	1.6%	24926	2.5%	35849	3.6%
1998	980000	16148	1.6%	24926	2.5%	35849	3.7%
1999	1157000	16148	1.4%	24926	2.2%	35849	3.1%
2000	1048296	16148	1.5%	24926	2.4%	35849	3.4%
2001	1046721	16148	1.5%	24926	2.4%	35849	3.4%
2002	1096308	16148	1.5%	24926	2.3%	35849	3.3%
2003	1145756	16148	1.4%	24926	2.2%	35849	3.1%
2004	1259889	16148	1.3%	24926	2.0%	35849	2.8%
2005	1005609	16148	1.6%	24926	2.5%	35849	3.6%
2006	1289820	16148	1.3%	24926	1.9%	35849	2.8%
2007	1165708	16148	1.4%	24926	2.1%	35849	3.1%
2008	941819	22220	2.4%	51126	5.4%	43699	4.6%
2009	1082225	25095	2.3%	60326	5.6%	63631	5.9%
2010	1066618	29605	2.8%	86666	8.1%	63631	6.0%
2011	1104031	32856	3.0%	96485	8.7%	84497	7.7%
2012	1056381	32856	3.1%	96485	9.1%	84497	8.0%
2013	983007	32856	3.3%	96485	9.8%	84497	8.6%
2014	1036943	32856	3.2%	96485	9.3%	84497	8.1%
2015	1044762	32856	3.1%	96485	9.2%	84497	8.1%
2016	1040696	32856	3.2%	96485	9.3%	84497	8.1%
2017	992668	32856	3.3%	96485	9.7%	84497	8.5%
2018	924956	33748	3.6%	100010	10.8%	86027	9.3%
2019	894828	19651	2.2%	50845	5.7%	64259	7.2%
2020	920348	42157	4.6%	46013	5.0%	11572	1.3%
2021	864446	42157	4.9%	50091	5.8%	11572	1.3%
2022	857433	42157	4.9%	50091	5.8%	11572	1.4%

Processing: Ekonerg Ltd

Table 5.1-5 Number of sows with reduction measures and percentage reduction of default EF

Year	Number of animals (total)	Animal housing system		Manure storage techniques		Manure application techniques	
		Number of animals in reduction	Reduction of default EF (%)	Number of animals in reduction	Reduction of default EF (%)	Number of animals in reduction	Reduction of default EF (%)
1990	232000	3668	1.6%	2934	1.3%	6236	2.7%
1991	234000	3668	1.6%	2934	1.3%	6236	2.7%
1992	180000	3668	2.0%	2934	1.6%	6236	3.5%
1993	193000	3668	1.9%	2934	1.5%	6236	3.2%
1994	198000	3668	1.9%	2934	1.5%	6236	3.1%
1995	182000	3668	2.0%	2934	1.6%	6236	3.4%
1996	181000	3668	2.0%	2934	1.6%	6236	3.4%
1997	185000	3668	2.0%	2934	1.6%	6236	3.4%
1998	186000	3668	2.0%	2934	1.6%	6236	3.4%
1999	205000	3668	1.8%	2934	1.4%	6236	3.0%
2000	185249	3668	2.0%	2934	1.6%	6236	3.4%
2001	187102	3668	2.0%	2934	1.6%	6236	3.3%

Year	Number of animals (total)	Animal housing system		Manure storage techniques		Manure application techniques	
		Number of animals in reduction	Reduction of default EF (%)	Number of animals in reduction	Reduction of default EF (%)	Number of animals in reduction	Reduction of default EF (%)
2002	190189	3668	1.9%	2934	1.5%	6236	3.3%
2003	200907	3668	1.8%	2934	1.5%	6236	3.1%
2004	229446	3668	1.6%	2934	1.3%	6236	2.7%
2005	199351	3668	1.8%	2934	1.5%	6236	3.1%
2006	198668	3668	1.8%	2934	1.5%	6236	3.1%
2007	182635	4868	2.7%	3854	2.1%	8276	4.5%
2008	162063	8943	5.5%	10034	6.2%	12761	7.9%
2009	167649	8943	5.3%	10034	6.0%	12761	7.6%
2010	163956	11643	7.1%	15474	9.4%	16331	10.0%
2011	129375	12643	9.8%	15474	12.0%	16331	12.6%
2012	125966	12643	10.0%	15474	12.3%	16331	13.0%
2013	127643	12643	9.9%	15474	12.1%	16331	12.8%
2014	119277	12643	10.6%	15474	13.0%	16331	13.7%
2015	150377	12643	8.4%	15474	10.3%	16331	10.9%
2016	152593	12643	8.3%	15474	10.1%	16331	10.7%
2017	159761	12643	7.9%	15474	9.7%	16331	10.2%
2018	155506	12643	8.1%	15474	10.0%	16331	10.5%
2019	160019	7991	5.0%	9196	5.8%	9978	6.2%
2020	112700	19375	17.2%	9015	8.0%	5886	5.2%
2021	106861	19375	18.1%	8637	8.1%	5886	5.5%
2022	87062	19375	22.3%	8637	9.9%	5886	6.8%

Processing: Ekonerg Ltd

Table 5.1-6 Number of laying hens with reduction measures and percentage reduction of default EF

Year.	Number of animals (total)	Animal housing system	
		Number of animals in reduction	Reduction of default EF (%)
1990	7756000	454983	5.9%
1991	7671000	454983	5.9%
1992	6648000	454983	6.8%
1993	6321000	454983	7.2%
1994	6253000	454983	7.3%
1995	6503000	454983	7.0%
1996	6260000	454983	7.3%
1997	6089000	454983	7.5%
1998	5853000	454983	7.8%
1999	5851000	454983	7.8%
2000	5988000	454983	7.6%
2001	5709000	454983	8.0%
2002	5775000	454983	7.9%
2003	5610000	454983	8.1%
2004	6447000	454983	7.1%
2005	6056000	454983	7.5%
2006	5758000	454983	7.9%
2007	5529907	454983	8.2%
2008	5486401	454983	8.3%
2009	5673000	454983	8.0%
2010	4357905	454983	10.4%
2011	4078789	454983	11.2%
2012	3696170	509863	13.8%
2013	3979081	570036	14.3%
2014	3722447	590623	15.9%
2015	3017389	590623	19.6%

Year.	Number of animals (total)	Animal housing system	
		Number of animals in reduction	Reduction of default EF (%)
2016	3496860	624223	17.9%
2017	3843140	624223	16.2%
2018	2777952	624223	22.5%
2019	2786363	282816	10.1%
2020	2865082	893685	31.2%
2021	3257811	893685	27.4%
2022	2681561	893685	33.3%

Processing: Ekonerg Ltd

Table 5.1-7 Number of broilers with reduction measures and percentage reduction of default EF

Year	Number of animals (total)	Animal housing system	
		Number of animals in reduction	Reduction of default EF (%)
1990	4416916	43750	1.0%
1991	4264538	43750	1.0%
1992	3394171	43750	1.3%
1993	3279241	58750	1.8%
1994	3229137	58750	1.8%
1995	3105426	263000	8.5%
1996	2839151	263000	9.3%
1997	2826754	263000	9.3%
1998	2572101	360000	14.0%
1999	2673000	360000	13.5%
2000	3235000	417000	12.9%
2001	3352000	417000	12.4%
2002	3686000	586000	15.9%
2003	3936000	645000	16.4%
2004	2634000	645000	24.5%
2005	2520000	645000	25.6%
2006	2068000	645000	31.2%
2007	2097961	645000	30.7%
2008	2281879	645000	28.3%
2009	3111000	645000	20.7%
2010	3377605	645000	19.1%
2011	4420993	645000	14.6%
2012	4980156	645000	13.0%
2013	4524637	645000	14.3%
2014	5556971	645000	11.6%
2015	5974694	645000	10.8%
2016	5362104	654975	12.2%
2017	5838080	654975	11.2%
2018	7525121	654975	8.7%
2019	8895498	581611	6.5%
2020	9213219	751501	8.2%
2021	8012409	552231	6.9%
2022	7302326	546647	7.5%

Table 5.1-8 Number of turkeys with reduction measures and percentage reduction of default EF

Year	Number of animals (total)	Animal housing system	
		Number of animals in reduction	Reduction of default EF (%)
1990	854870	0	0
1991	825378	0	0

Year	Number of animals (total)	Animal housing system	
		Number of animals in reduction	Reduction of default EF (%)
1992	656923	0	0
1993	634679	0	0
1994	624982	0	0
1995	601038	0	0
1996	549502	0	0
1997	547103	0	0
1998	497816	0	0
1999	545000	0	0
2000	516000	0	0
2001	497000	0	0
2002	528000	0	0
2003	477000	16796	3.5%
2004	599000	16796	2.8%
2005	431000	16796	3.9%
2006	573000	16796	2.9%
2007	677474	16796	2.5%
2008	577486	16796	2.9%
2009	584000	16796	2.9%
2010	726301	16796	2.3%
2011	608666	16796	2.8%
2012	470701	16796	3.6%
2013	444116	16796	3.8%
2014	369446	18553	5.0%
2015	495034	18553	3.7%
2016	511844	18553	3.6%
2017	493072	18553	3.8%
2018	442028	18553	4.2%
2019	511289	9982	2.0%
2020	480973	37105	7.7%
2021	417424	18532	4.4%
2022	419007	18722	4.4%

Table 5.1-9 Nex* and the share of animals by manure management systems for each animal category for 2022

Animal category	Nex*	Manure management system		
		Liquid (Slurry)	Solid	Pasture
Dairy cattle	96.44	66.07%	32.00%	1.90%
Other cattle	39.36	50.87%	44.13%	5.00%
Sheep	15.05	0.00%	18.13%	81.73%
Goats	17.99	0.00%	5.33%	94.67%
Horses	35.78	0.00%	29.67%	70.33%
Mules/Asses	35.78	0.00%	10.00%	90.00%
Fattening pigs	9.31	92.84%	7.10%	0.00%
Sows	30.35	84.10%	14.90%	1.00%
Laying hense	0.63	7.80%	91.27%	0.93%
Broillers	0.36	0.93%	98.07%	1.00%
Turkeys	1.84	0.00%	98.07%	1.93%
Ducks	0.82	1.93%	93.07%	5.00%
Geese	0.82	15.00%	80.00%	5.00%

Source: Croatian NIR2024

*Nex – Nitrogen excretion rate

Table 5.1-10 Nex* and the share of animals by manure management systems for each animal category for 2022

Year	Nex*			
	Dairy cattle	Other cattle	Fattening pigs	Sows
1990	96.36	39.76	12.10	29.89
2000	96.36	40.82	12.10	29.89
2005	96.38	40.83	12.12	29.90
2010	96.36	39.04	12.10	29.89
2015	96.36	41.31	12.10	29.89
2020	96.36	41.23	12.10	29.89
2021	96.41	39.35	12.11	29.90
2022	96.44	39.36	12.11	29.90

Source: Croatian NIR2024

NMVOC methodology and EF used for emissions calculation was Tier 2 methodology (GB2023), using the default Tier 2 EFs for NMVOCs (Table 3.9, Table 3.10, Table 3.11, Table 3.12, GB2023) for the whole time period.

Proportion of animals on silage feed was estimated by the experts from the Faculty of Agriculture, University of Zagreb, and are presented in Table 5.1-11.

Table 5.1-11 Percentage (%) of animal categories on silage feeding for selected years and year 2022

Year	Dairy cows (SNAP 100901)	Other cattle (SNAP 100902)	Sheep & goats (SNAP 100905)
1990	20	10	0
2000	50	50	0.5
2005	60	58	0.5
2010	70	65	0.5
2022	84	73	1

For PM, GB2023 Tier 1 methodology and default EF (Table 3.5, GB2023) were used for emissions calculation.

Relevant activity data are the number of certain livestock categories in Croatia which were attained in more detail. The categories were defined according to typical examples provided in the Guidebook; thus including goats and mules/asses in the emission calculation. Camels, buffalo and fur animals were not included because the first two animal categories do not exist in Croatia while data on fur animals’ number are not available. Since the total poultry number in Croatia includes some other animals such as pheasants, quails, guinea fowls, ostriches and chickens other than laying hens, in order to ensure the completeness of the calculation and the comparability with statistical data, they were attributed to the reported sub-category Other poultry. Therefore sub-category Other poultry includes ducks, geese, pheasants, quails, guinea fowls, ostriches and chickens other than laying hens.

The main data source is the Central Bureau of Statistics, Croatian Agricultural Agency (dairy cattle) and for some categories the FAOSTAT database. Data sources for each year and livestock category are presented in Table 5.1-12. Trend of animal number for each livestock category is presented in Tables 5.1-13 and 5.1-14.

Table 5.1-12 Sources for activity data for NFR code 4.B Animal husbandry and manure management

Livestock categories	CBS	FAO	CAA	Minstry of Agricutlure
Dairy cattle	1990-2022			
Other cattle	1990-2022			
Sheep	1990-2022			
Goats	1990-1991; 1999-2022	1992-1998		
Horses	1990-1994; 2000-2009		1995-1999	2010 – 2022
Mules/assess	1990-1991; 2000-2009	1992-1994	1995-1999	2010 – 2022
Swine	1990-2022			
Poultry	1990-2022			

Table 5.1-13 Activity data for NFR codes 3.B.1.a, 3.B.1.b, 3.B.2, 3.B.3, 3.B.4.d, 3.B.4.e and 3.B.4.f

NFR	3.B.1.a	3.B.1.b		3.B.2	3.B.4.d	3.B.4.e	3.B.4.f	3.B.3	
SNAP	100501	100502	100502	100505	100511	100506	100512	100503	100504
Name	Dairy cows	Other cows (mature)	Other cows (young)	Sheep	Goats	Horses	Mules/asses	Breeding pigs	Market pigs
Unit	animal	animal	animal	animal	animal	animal	animal	animal	animal
1990	462718	47405	315804	751000	172000	39000	17000	232000	1341000
1991	443566	65873	268586	753000	133000	36000	13000	234000	1387000
1992	359863	29830	195326	539000	113809	26000	13440	180000	1002000
1993	347245	47269	209368	525000	105000	22000	12430	193000	1069000
1994	325809	28338	162736	444000	107685	21000	6640	198000	1149000
1995	316943	35873	149209	453000	107292	4685	1549	182000	993000
1996	293893	36373	141822	427000	105271	5274	1750	181000	1016000
1997	283652	33965	137815	453000	99544	5886	1902	185000	991000
1998	273516	38451	134112	427000	84403	6540	2077	186000	980000
1999	268438	29339	140920	488000	78000	7309	2255	205000	1157000
2000	262209	26933	137428	528675	79393	9611	2518	185249	1048296
2001	254096	28104	156223	539498	92943	10871	2780	187102	1046721
2002	247026	32285	137802	580016	96534	13570	3097	190189	1096308
2003	252211	29424	162685	586641	86087	15217	3033	200907	1145756
2004	226289	48078	191568	721578	126060	17057	3195	229446	1259889
2005	234966	38787	197272	796480	134483	17883	3146	199351	1005609
2006	232923	37300	212682	679839	102877	18885	3299	198668	1289820
2007	225407	32052	209618	645992	91902	18075	3415	182635	1165708
2008	212625	37799	203131	643384	83877	19687	3591	162063	941819
2009	212220	28284	206647	619044	76119	19958	3617	167649	1082225
2010	206537	23534	214243	629437	75215	19306	2490	163956	1066618
2011	184745	25683	236127	638608	70030	20041	2833	129375	1104031
2012	180555	26415	244547	679313	71978	20335	3100	125966	1056381
2013	168025	37467	236940	620000	69000	21467	2967	127643	983007
2014	159394	62289	218954	604866	60697	21144	2162	119277	1036943
2015	151502	52433	236157	607711	62057	21868	2471	150377	1044762
2016	146510	54357	243746	618896	75530	22775	2880	152593	1040696
2017	139443	55523	255791	636808	76771	23209	3273	159761	992668
2018	135851	28302	249972	636294	80064	23649	3711	155506	924956
2019	130025	31941	258273	657197	81540	24737	4143	160019	894828
2020	109807	56022	257052	661992	86258	25795	4677	112700	920348
2021	102333	62260	262994	654339	85783	28970	5306	106861	864446
2022	79042	82324	260478	642808	81581	31413	6120	87062	857062

Source: CBS, FAO, CAA; Processing: Ekonerg Ltd

Table 5.1-14 Activity data for NFR codes 3.B.4.g.i, 3.B.4.g.ii, 3.B.4.g.iii, and 3.B.4.g.iv

NFR	3.B.4.g.i	3.B.4.g.ii	3.B.4.g.iii	3.B.4.g.iv		
SNAP	100507	100508	100509a	100509z		
Name	Laying hens	Broilers	Turkeys	Ducks	Gees	Other poultry
Unit	animal	animal	animal	animal	animal	animal
1990	7756000	4416916	854870	345557	113147	3615510
1991	7671000	4264538	825378	333635	109243	3308206
1992	6648000	3394171	656923	265542	86948	2090416
1993	6321000	3279241	634679	256551	84003	2121525
1994	6253000	3229137	624982	252631	82720	2060530
1995	6503000	3105426	601038	242953	79551	1492032
1996	6260000	2839151	549502	222121	72730	1049497
1997	6089000	2826754	547103	221151	72412	1188581
1998	5853000	2572101	497816	201228	65889	768967
1999	5851000	2673000	545000	219655	71923	1510422
2000	5988000	3235000	516000	227435	74470	1215096
2001	5709000	3352000	497000	237356	77718	1873926
2002	5775000	3686000	528000	235699	77176	1363126
2003	5610000	3936000	477000	237982	77923	1439095
2004	6447000	2634000	599000	226000	74000	1205000
2005	6056000	2520000	431000	175000	68000	1390000
2006	5758000	2068000	573000	219000	76000	1394000
2007	5529907	2097961	677474	191000	70000	1487000
2008	5486401	2281879	577486	184000	57000	1429000
2009	5673000	3111000	584000	186976	62203	1170187
2010	4357905	3377605	726301	200785	45972	760873
2011	4078789	4420993	608666	172387	39176	203421
2012	3696170	4980156	470701	210080	45994	757258
2013	3979081	4524637	444116	120215	26213	212428
2014	3722447	5556971	369446	96024	49011	523209
2015	3017389	5974694	495034	74476	21675	606517
2016	3496860	5362104	511844	91514	21009	373016
2017	3843140	5838080	493072	50848	13284	160976
2018	2777952	7525121	442028	55603	16089	596011
2019	2786363	8895498	511289	52114	16533	484894
2020	2865082	9213219	480973	52638	11938	432868
2021	3257811	8012409	417424	35476	12388	360660
2022	2681561	7302326	419007	48545	12567	452564

Source: CBS; Processing: Ekonerg Ltd

Recalculations and improvements

NH_3 emissions for 2020 and 2021 have been recalculated due to the transition to DZS data for farms of laying hens, fattening pigs and sows.

5.2. Crop production and agricultural soils (NFR 3.D)

Source category description

Crop production and agricultural soils sector is a source of NH_3, NO, NMVOC and PM emission. There are four main sources of emissions from crop production and agricultural soils: fertiliser application (NH_3), soil microbial processes (NO), crop processes (NH_3 and NMVOC) and soil cultivation and crop harvesting (PM).

This chapter gives information for sub-sector Mineral N-fertilizers (NFR 3.D.1.a), Livestock manure applied to soils (NFR 3.D.a.2.a), Sewage sludge applied to soils (NFR 3.D.a.2.b), Livestock manure applied to soils category (NFR 3.D.a.3), Farm-level agricultural operations including storage, handling and transport of agricultural products (NFR 3.D.c), Cultivated crops (NFR 3.D.e).

Emissions for the source categories which are not estimated: NFR 3.D.a.2.c Other organic fertilizers (no activity data available), NFR 3.D.a.4 Crop residues applied to soils (there are no emission factors in the methodology), NFR 3.D.b Indirect emissions from managed soils (there are no methodologies or emission factors), NFR 3.D.d Off-farm storage, handling and transport of bulk agricultural products (EF are not available in EMEP/EEA guidebook).

Emissions of NMVOC regarding source category NFR 3.D.f Use of pesticides are presented in the scope of source category NFR 2.D.3.a Domestic solvent use including fungicides.

Mineral N-fertilizers (NFR 3.D.1.a)

Emissions of NH_3 and NOx resulting from the application of N fertilizers, including urea.

Livestock manure applied to soils (NFR 3.D.a.2.a)

Emissions of NH_3 and NOx due to manure applied to agricultural land. This source is presented separately starting with this report which is an improvement – in previous reports it was reported within the category 3.B. The emissions are calculated within the 3.B calculation, using mass-flow approach (see Chapter 6.1).

Sewage sludge applied to soils (NFR 3.D.a.2.b)

Emissions of NH_3 and NOx from usage of sewage sludge is - according to Croatian legislation -permitted only when it does not contain more heavy metals or organic matter than is allowed within the articles 5 and 6 of the „Guidance on sludge from waste water purification when that sludge is used in agriculture“ (*Pravilnik o gospodarenju muljem iz uređaja za pročišćavanje otpadnih voda kada se mulj koristi u poljoprivredi*, OG 38/08) and only when all potential pathogens are removed/destroyed. According to the aforementioned Guidance, the sludge is to be used in accordance with the crop needs and, in such manner, to keep the quality of water bodies at the required level.

Up to the year 2010 only the sludge from the wastewater of food industry was used in agriculture, while from the year 2012 onwards the sludge from communal wastewater purifiers was also used. For the year 2022, 6 sludge producers and 4 sludge users are reported.

Other Organic Fertilisers Applied to Soils (NFR 3.D.a.2.c)

Source of NH_3 and NOx emissions from organic fertilisers, other than livestock manure and sewage sludge, applied to soils (including digestate and compost). Activity data for this source category will be available and processed in the next year submission.

Livestock manure applied to soils category (NFR 3.D.a.3)

Emissions of NH_3 and NOx due to manure applied to grazing land. The emissions are calculated within the 3.B calculation, using mass-flow approach (see Chapter 6.1). Emissions of NMVOC from this source category are included and calculated within 3.B source category.

Farm-level agricultural operations including storage, handling and transport of agricultural products (NFR 3.D.c)

Relates to the particle emissions from agricultural operations, using the data on utilized agricultural area (UAA).

Cultivated crops (NFR 3.D.e)

Relates to the NMVOC emissions from agricultural operations, using the data on cropland and grassland.

Use of pesticides (NFR 3.D.f)

Pesticide emissions originate mainly from their use in the agricultural and forest sectors. Other emission sources (e.g. the manufacturing of pesticides or emission of imported products) are not included in this source category.

In the EMEP/EEA Guidebook 2013, the following pesticides were included: Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene (HCB), Mirex, Toxaphene, pentachlorophenol and Lindane. The use of these pesticides as pure substances listed in the Aarhus Protocol on Persistent Organic Pollutants (POPs) and the Stockholm Convention has already been prohibited by most of the parties who have ratified the Protocol. In accordance with the POP Protocol art. 3, para 8, and art. 9, para. 1 (b) only substances (PAHs, Dioxins/furans, HCB and PCBs) listed in Annex III shall be reported.

Since the early 1990s, HCB has no longer been used as a pure substance. However, it can be present as an impurity or as a by-product in certain pesticides or chemicals. Some of these pesticides, e.g. Chlorthalonil (fungicide) and Picloram (herbicide) are still in use and their application is approved until 2017 or longer (see the EU database on pesticides). In 2014, more than 75% of the total pesticide sales (396 kt) in the EU 28 were fungicides and herbicides (see Eurostat database, pesticide sales). More than 24 million tonnes of fungicides and herbicides have been used worldwide. For this reason, pesticide applications are still a source of HCB emissions.

Emissions arise following the application of pesticides either from volatilization of pesticides deposited to leaf or soil prior to uptake by the crop or soil, or from ‘spray drift’ – the movement of fine droplets of pesticide spray away from the target application zone to areas downwind. For the calculation of emissions, only primary emissions of active input (e.g. evaporation during application, evaporation from the plant and soil surface after application) have to be taken into account. Further emission paths are neglected, due to the persistence and the high sorption behaviour of the respective pesticide or HCB on the organic soil substance.

In general, pesticides are characterized by their chemical structure and property of semi-volatility. The latter determines the emission behaviour. A Dutch study (MJPG, 1995) estimates that on average, 25% of all pesticide used is emitted to the air. However, the use of the most dangerous pesticides has been prohibited by international agreement (see Table 5.3.1). The only emissions associated with pesticide use that are currently reported are emissions of HCB, which is present as a contaminant. According to the Pesticide Leaching Model (PELMO 3.31; Ferrari et al, 2005), all the HCB present as a contaminant will be volatilised.

Methodology, emission factors and activity data

Mineral N-fertilizers (NFR 3.D.1.a)

For NH_3 emission calculation from the source category 3.D.1.a Mineral N fertilizers, Tier 2 GB2019 methodology was used and for NOx emission calculations Tier 1 GB2019 methodology was used. Emission factors used for NH_3 emission calculation from source category NFR 3.D.1.a Mineral N fertilizers are default Tier 2 factors attained from GB2019, Table 3.2. Entire agricultural land area in Croatia is in "Cool" climate zone, with a median temperature of 10-11°C according to the literature (Z*aninović, M. et al*). As for the normal/high pH ratios - 32% of the land is estimated to have pH below 7 (*Mesić, M. et al*).

Methodology also includes preparation of activity data that includes the calculation of the amount of nitrogen (N) in each of mineral fertilizers produced (accounting also for mineral fertilizers exported from and mineral fertilizers imported in Croatia). This calculation is performing on the basis of data obtained from all fertilizers producer in Croatia and amounts of a particular mineral fertilizer formulation and N content in each formulation. An assumption is made that all mineral fertilizers sold and imported in Croatia are actually applied to soil is used for emissions calculation.

This estimate is based on the amount of N in mineral fertiliser that is annually consumed in the Republic of Croatia and on the "Mineral fertiliser consumption, in tonnes of nitrogen" dataset obtained from the CBS.

- Data on the consumption of mineral fertilisers that are produced and applied in Croatia were obtained from companies that produces synthetic fertilizers for the time period 1992-1999, since CBS has no data on N applied from mineral fertilizers before the time period before 2000 (Table 5.5-1). Data on mineral fertilizers produced and applied in Croatia in 1990 and 1991 have been estimated by extrapolation method using the pattern from 1992 to 1999.
- "Mineral fertiliser consumption, NUTS 0, in tonnes of nutrient" CBS dataset is available starting from the year 2000, with peak consumption in 2008.

Relevant activity data for ammonia emission calculation is the mineral N-fertilizer consumed (applied). The consumed amount refers to the amount produced and sold for domestic use and also to the imported amounts. The activity data providers are producers of mineral fertilizers in Croatia. There are three mineral fertilizer producers in Croatia, among whom one produces a dominant share. The other two have started with production in the year 2006 and 2010, respectively. Preparation of activity data relates to calculation of the amount of nitrogen (N) in each of the mineral fertilizer type produced, excluding mineral fertilizers exported and including mineral fertilizers imported in Croatia. This calculation is performed using information on particular mineral fertilizer formulation and N content in each formulation obtained from fertilizers producer in Croatia. Regarding activity data received from the main fertilizer company, due to lack of data, the consumed amount was estimated by extrapolation method for the years 1990 and 1991 using the trend from the 1992 to 2006 time period.

Since official CBS data on N consumption (with no segregation for each fertilizer type) is available for the period from 2000 (and is also used as AD set for CRF tables), mineral fertilizer production dana on each fertilizer type was used as vector to distribute the CBS data. It is expected that CBS data will be available soon for the entire 1990-2000 time period.

Activity data for nitrogen (N) applied for each type of mineral fertilizer is shown in Table 5.2-1.

Table 5.2-1 Activity data for NFR code 3.D.1.a

3.D.1.a	N (nitrogen) applied							
Name	Urea	Calcium ammonium nitrate	NPK	Ammonium nitrate	Urea ammonium nitrate	Ammonium sulphate	Ammonium sulfonitrate	Total
Unit	kg N	kg N	kg N	kg N	kg N	kg N	kg N	kg N
1990	31376015	39030122	36285992	0	721273	0	0	0
1991	31957265	38643459	37441717	0	672217	0	0	0
1992	41093640	43521030	39921424	0	282405	0	0	0
1993	32705540	27743580	29856295	0	1053575	0	0	0
1994	29839280	36707850	29814546	0	549065	0	0	0
1995	29038880	35701020	28395908	0	279725	0	0	0
1996	32894140	34644780	30768659	0	81740	0	0	0
1997	42897760	43609050	35924213	0	920915	0	0	0
1998	27755940	38790630	28358872	0	341030	0	0	0
1999	31669160	34221420	39495688	0	235170	0	0	0
2000	38179584	39921706	39861836	0	41875	0	0	0
2001	57768696	37933147	32340662	0	300495	0	0	0
2002	50655639	38065664	31650881	0	96815	0	0	0
2003	42176472	31017324	33360685	0	5203219	1863300	0	0
2004	45109237	32069375	33625948	0	5126147	1647293	0	0
2005	41939650	36264840	36438674	0	4983133	1682703	0	0
2006	41555040	40021849	37732772	0	3024324	1540316	0	0
2007	46486607	39451328	40122830	0	3574246	813389	0	0
2008	65532821	55416207	47907534	0	467684	827953	0	0
2009	33343767	30669628	26144086	0	15769	619850	0	0
2010	45043935	38246014	25485034	0	23187	547131	0	0
2011	56381522	38898515	29057189	0	19372	658501	0	0
2012	52977787	31041560	22209100	0	0	655953	0	0
2013	32923601	28558977	16160081	0	0	276940	0	0
2014	27880685	28878928	16627034	0	0	293602	0	0
2015	35233951	32046047	19745358	0	8341	345630	41252	7121
2016	31518361	26429010	12965009	0	542053	328108	189915	347543
2017	40251540	31397799	25147230	0	248205	350025	234633	782570
2018	49232412	32678534	15837330	0	0	635677	594076	441971
2019	43956766	35984500	16236897	0	195	559099	419647	362495
2020	49043506	32853186	15953639	0	0	647718	241032	224418
2021	47593569	36215483	16451053	0	1330	820613	1045767	62186
2022	46857061	30141967	9843675	0	0	827214	703023	58061

Source: CBS; Processing: Ekonerg Ltd

Livestock manure applied to soils (NFR 3.D.a.2.a)

Methodology used for NH_3 emissions is GB2023, Tier 2 – NH_3 emissions were calculated within the NFR 3.B category (“mass-flow” approach) using the same AD set.

For NOx emissions, Tier 1 methodology was used (no Tier 2 methodology is available in GB2023). Applied N was calculated in the 3.B „mass-flow“ approach (sum of $m_{applic\_slurry\_N}$ and $m_{applic\_solid\_N}$).

NH_3 emissions were calculated for all animal categories. NOx emissions for swine and poultry (3.B.3, 3.B.4.g.i, 3.B.4.g.ii, 3.B.4.g.iii and .3B.4.g.iv) were calculated and reported here, while NOx emissions for other (predominantly pasture animals) are reported in 3.D.a.3. Livestock manure applied to soils category in accordance with the GB2023 methodology.

Sewage sludge applied to soils (NFR 3.D.a.2.b)

NH_3 and NOx emissions from source 3.D.a.2.b Sewage sludge applied to soil were reported for the first time 2018 submission, IIR 1990 – 2016. Following the revision, TERT recommended (HR-3Da2b-2018-0001) to modify the default Tier1 methodology and change the used AD from population numbers to readily available "applied N from sewage sludge" (CRF data), and to change EF to 0.04 kg NO_2 (GB2023, Annex 2) and 0.13 kg NH_3 GB2023, Annex 1). These changes were implemented in this report. AD on this source was provided from the Croatian Agency for Environment and Nature and is available from 2005 onwards while for the period 1990-2004 currently there is no data available.

Table 5.2-2 Activity data for NFR code 3.D.a.2.b

NFR 3Da2b	Applied N (kg/y)
1990	NE
1991	NE
1992	NE
1993	NE
1994	NE
1995	NE
1996	NE
1997	NE
1998	NE
1999	NE
2000	NE
2001	NE
2002	NE
2003	NE
2004	NE
2005	117
2006	233
2007	272
2008	623
2009	17859
2010	16886
2011	26574
2012	37196
2013	60968
2014	35756
2015	51397
2016	60501
2017	50191
2018	66571
2019	24285
2020	24473
2021	27158
2022	33943

Source: Ministry of Environment and Energy; Processing: Ekonerg Ltd.

Other Organic Fertilisers Applied to Soils (NFR 3.D.a.2.c)

For emissions from other organic fertilisers, Tier 1 methodology should be used. For the emission of NH_3 from N applied in digestates derived from material other than manure, values should be obtained from Chapter 6.3. Biological treatment of waste - Anaerobic digestion at biogas facilities (NFR 5.B.2). Activity data are still not available, and collecting these data is a long-term goal. It is assumed that emissions from this subsector are negligibly small. Further details are given in Croatia's NIR2024, Chapter 5.5.1.2

Urine and dung deposited by grazing animals (NFR 3.D.a.3)

Methodology used for NH_3 emissions is GB2023, Tier 2 – NH_3 emissions were calculated within the 3.B category ("mass-flow" approach).

For NOx emissions, GB2023 Tier 1 methodology was used (no Tier 2 methodology is available in GB2023). Applied N was calculated in the 3.B „mass-flow" approach (m_{graz_N}).

NH_3 and NOx emissions were calculated and reported for 3.B.1.a, 3.b.1.b, 3.B.2, 3.B.4.d, 3.B.4.e, 3.B.4.f animal categories, while NOx emissions for swine and poultry are reported within the NFR 3.D.a.2.a source, in accordance with GB2023 methodology.

Due to the harmonization of the Nex (nitrogen excretion rate) values in the IIR with the CRF values of Nex, emissions of NH_3 and NOx were recalculated for entire period 1990 – 2018.

Farm-level agricultural operations including storage, handling and transport of agricultural products (NFR 3.D.c)

Currently the calculation for PM is performed using Tier 1 methodology, where $E_{pollutant} = AR_{area} \times EF_{pollutant}$, using default EF for PMs (0.06 for PM_{10} and $PM_{2.5}$ and 1.56 kg/ha for TSP, GB2023, Table 3.1).

Activity data (AR_{area}) used for PM emission calculations is the total utilized agricultural area (UAA), data provided by Croatian Bureau of Statistics. AD for the whole historic period is presented in table 5.2-3.

Table 5.2-3 Activity data for NFR 3.D.c

NFR 3.D.c	Total utilized agricultural area (UAA)
Unit	ha
1990	3059733
1991	3048915
1992	2120536
1993	2153750
1994	2179271
1995	2178453
1996	2576871
1997	2658509
1998	2791681
1999	2754371
2000	1168705
2001	1177999
2002	1181138
2003	1195734
2004	1176161
2005	1210790
2006	1230183
2007	1201756
2008	1289091
2009	1299582
2010	1333835
2011	1326083
2012	1330973

NFR 3.D.c	Total utilized agricultural area (UAA)
Unit	ha
2013	1568881
2014	1508885
2015	1537629
2016	1546019
2017	1496663
2018	1485645
2019	1504445
2020	1506205
2021	1476351
2022	1447919

Source: CBS

Cultivated crops (NFR 3.D.e)

The calculation for NMVOC estimates was performed using Tier 2 methodology according to the GB 2023. Emissions were estimated for all of the relevant crop types for which EFs are available in the GB2023 (wheat, rye and rape, Table 3.3). For the remaining cropland area an average of the highest and lowest EF (wheat and rape) was applied (0.83 kg NMVOC/ha)[29].

Croatia has cold climate condition (Z*aninović, M. et al*). Therefore, the emission factor for pasture (grass 15°C) of 0.41 kg NMVOC/ha/yr following the GB2023, Table 3.3, has been taken. Emissions are currently calculated with the following formula:

$$E_{NMVOC\_cl\_gl} = \Sigma A_{cl,gl} * EF_{cl,gl}$$

where:

$E_{NMVOC\_cl,gl}$ = annual NMVOC emission flux from cropland and grassland areas (kg NMVOC)

$A_{cl,gl}$ = annual cropland area, annual grassland area (ha)

$EF_{cl,gl}$=EF of wheat, rye, rape and average EF (wheat and rape) for cropland and grass (15°C) for grassland (kg NMVOC/ha

Table 5.2-4 Activity data for NFR code 3.D.e

NFR 3.D.e	grassland - CLC	cropland - CBS (wheat + rye + rape)	wheat	rye	rape
Unit	ha	ha	ha	ha	ha
1990	1201059	1625377	318955	3053	12647
1991	1200671	1625009	324460	2974	9004
1992	1200284	1624962	168865	2252	11743
1993	1199896	1624240	211845	2453	13010
1994	1199509	1623886	198381	2963	13889
1995	1199121	1623503	227044	1930	10982
1996	1198733	1623062	200852	2043	7651
1997	1198346	1622790	208377	1959	5356
1998	1197958	1622480	241734	2146	8949
1999	1197571	1622026	169280	2446	16234
2000	1197183	1621796	182333	2738	12886
2001	1196795	1616080	184274	2981	10319
2002	1196408	1610192	179153	3244	13041

[29] Recommended approach as preseneted in the NEC Review 2017 (EC 2017) for Austria

NFR 3.D.e	grassland - CLC	cropland - CBS (wheat + rye + rape)	wheat	rye	rape
Unit	ha	ha	ha	ha	ha
2003	1196020	1604186	157175	2960	15524
2004	1195633	1598060	162634	2869	14282
2005	1195245	1589563	146253	1848	20149
2006	1194857	1581227	175551	2008	8413
2007	1188825	1577321	175045	1731	13069
2008	1182792	1575729	156536	1367	22372
2009	1176759	1571716	180376	998	28723
2010	1170727	1567090	168507	1035	16339
2011	1164694	1561068	149797	871	17536
2012	1158662	1556118	186949	846	9893
2013	1157755	1549053	204506	1019	17972
2014	1156848	1540669	156139	1373	23122
2015	1156848	1540670	140986	1093	21977
2016	1155942	1534442	168029	1285	36778
2017	1155035	1532960	116151	774	48616
2018	1154128	1528949	135708	1292	55032
2019	1153222	1527135	141602	1292	41361
2020	1153222	1525637	145053	1058	41661
2021	1153222	1522938	143535	511	30281
2022	1153222	1522092	157864	820	22402

Sources: CBS, NIR

Activity data used for NMVOC emission calculations is the agricultural area under wheat, rye and rape, data provided by Croatian Bureau of Statistics. For the grassland, data was taken from the land use area calculation in the Land use, Land Use Change and Forestry (LULUCF) sector. Further details are given in Croatia's NIR2024, Chapter 5.3.3.

Use of pesticides (NFR 3.D.f)

HCB emission was calculated by using Tier 1 methodology (GB2023) by summing the amount of each pesticide applied and the concentration of HCB in that pesticide (i.e. its impurity factor):

Impurities derived from the manufacturing process and/or product storage are present in all pesticide active ingredients. Impurities can have an adverse impact on human health, the environment or both. Maximum impurity standards (here used as an impurity factor, IF) are listed for specific active constituents. One of the listed substances is HCB. Before pesticide regulations were implemented, HCB impurity levels in many active substances were quite high but producers were obliged to reduce the impurity levels dramatically. Today, the amounts of impurities are clearly below the legally defined impurity levels but national standards for HCB impurity can differ between countries and depend on the year of implementation. Emission factors for emission calculation are given in the Table 5.2-5.

Table 5.2-5 Tier 1 emission factors for source category 3.D.f Use of pesticides

Active substances	1990 mg/kg	1995 mg/kg	2000 mg/kg	2005 mg/kg	2010 mg/kg	2015 mg/kg	Banned in EU since	EU Directives or Regulations
Atrazine	2,50	1	1	Use stopped	Use stopped	Use stopped	End 2003	No 2004/248/EC
Clopyralid	not used in EU	not used in EU	not used in EU	not used in EU	2.50	2.50		Reg. (EU) No 2019/168, 06/64/EC, No 540/2011, No 678/2014

Active substances	1990 mg/kg	1995 mg/kg	2000 mg/kg	2005 mg/kg	2010 mg/kg	2015 mg/kg	Banned in EU since	EU Directives or Regulations
Chlorothalonil	300	300	40	10	40	40		2005/53/EC, Reg. (EU) 2018/1262, Reg. (EU) No 540/2011, Reg.(EU) 2017/1511, Reg. (EU) No 533/2013
Chlorthal-dimethyl	1000	1000	40	40	Use stopped	Use stopped	End 2010	2009/715/EC ******
Endosulfan	0.1	0.1	0.1	0.1	Use stopped	Use stopped	End 2005	05/864/EC, No 1107/2009
Lindane	100	50	50	50	Use stopped	Use stopped	End 2007	1107/2009, 850/2004, 2000/801/EG
Quintozene	500	500	500	Use stopped	Use stopped	Use stopped	End 2000	No 2000/816/EC
Picloram	50	50	50	50	50	50		No 540/2011, 2010/39/EU, Reg. (EU) No 2018/1796
Propazine	1	1	1	Use stopped	Use stopped	Use stopped		No 2002/2076
Simazine	1	1	1	Use stopped	Use stopped	Use stopped	End 2004	No 2004/247/EC
Penta-chlorophenol (PCP)	50	50	50	Use stopped	Use stopped	Use stopped	End 2002	No 2002/2076

Source: GB2023

Sources of activity data are Central Bureau of Statistics (CBS) and Ministry of Agriculture. The annual sales of relevant active substance (in kilograms) is used to conclude the quantity that is applied, using the assumption that during the year, all the pesticides sold to farmers, ranchers, foresters, etc. are applied.

As a result of the study it was concluded that the following pesticides: Propazine, Pentchlorophenol, Quintozene, Chlorthaldimethyl and Endosulfan were not / are not in use in the Republic of Croatia and will be marked with notation key „NO“ in the Inventory. Annual quantities of pesticide active substance sold in the Republic of Croatia are shown in Table 5.2-6.

Only the quantities produced were available for Lindane, and it was assumed in the HCB emission calculation that the amount of Lindane produced was equal to the amount of active substance produced, and that it was equal to the amount of active substance sold. Use of Lindane in Croatia was banned in 2002.

Only the quantities of sold Atrazine were available for the period 1990 – 1993. Consequently, quantities of the active substance of atrazine sold for the period 1990 – 1993 were estimated using a mean value of 88% for the proportions of the active substance of atrazine sold in the sold quantity of atrazine in the period 1994 – 2003. Share of active substance of atrazine sold in sold amount of atrazine in the period 1994 – 2003 ranged from 76 - 97%. Use of Atrazine in Croatia was banned in 2004.

There was no production or sales of Simazine in the period 1990 – 1991. Only the quantities of sold Simazine were available for the period 1992 – 1993. Consequently, the quantities of the active substance of simazine sold for the 1992 – 1993 period were estimated using a mean value of 55% for the proportions of sold active substance of other triazine-based herbicides and sold active substance in the sold quantity of other triazine-based herbicides in the period 1994 – 2007. Share of sold active substance of other triazine-based herbicides in the sold amount of other triazine-based herbicides in the 1994 – 2007 period ranged from 45 – 71%. Use of Simazine in Croatia was banned in 1994.

For Picloram and Chlorthalonil, only available data were the data on annual sales of active substance since the year 2013. For the historical trend from 1990 to 2012, the quantity of active substance sold in 2013 was taken into calculation and it was applied for all years in 1990 – 2012 period.

Data on annual sales of active substance since 2013 were available for Propazine. Propazine has only been in use in the EU since 2010. For the period 2010 – 2012 the quantity of active substance sold in 2013 was taken into calculation and applied for all years in the period 2010 – 2012.

Table 5.2-6 Annual sales of active substance in kilograms for the pesticides in Croatia

Annual sales of active substance (kg)						
Year	Lindane	Atrazine	Simazine	Picloram	Chlorthalonil	Clopyralid
1990	11700	635752	NO	82.7	13,515.22	NO
1991	12663	356727	NO	82.7	13,515.22	NO
1992	13625	935968	21984	82.7	13,515.22	NO
1993	16243	912127	13740	82.7	13,515.22	NO
1994	14633	1253000	use stopped	82.7	13,515.22	NO
1995	15488	1334000		82.7	13,515.22	NO
1996	12800	818000		82.7	13,515.22	NO
1997	4300	606000		82.7	13,515.22	NO
1998	7000	732000		82.7	13,515.22	NO
1999	6500	168000		82.7	13,515.22	NO
2000	9800	695000		82.7	13,515.22	NO
2001	4200	1024000		82.7	13,515.22	NO
2002	use stopped	544000		82.7	13,515.22	NO
2003		138245		82.7	13,515.22	NO
2004		use stopped		82.7	13,515.22	NO
2005				82.7	13,515.22	NO
2006				82.7	13,515.22	NO
2007				82.7	13,515.22	NO
2008				82.7	13,515.22	NO
2009				82.7	13,515.22	NO
2010				82.7	13,515.22	2,784.54
2011				82.7	13,515.22	2,784.54
2012				82.7	13,515.22	2,784.54
2013				82.7	13,515.22	2,784.54
2014				101.1	8,603.01	3,086.57
2015				101.9	3,066.80	2,174.11
2016				84.2	4,078.80	2,597.73
2017				87.7	4,187.62	3,096.47
2018				105.8	6,406.20	2,085.05
2019				89.14	7,552.40	1,736.55

Annual sales of active substance (kg)						
Year	Lindane	Atrazine	Simazine	Picloram	Chlorthalonil	Clopyralid
2020				143.65	1,341.40	1,498.20
2021				145.45	0	1,512.31
2022				86.55	0	2,244.41

Sources: CBS, Ministry of Agriculture

Recalculations and improvements

Livestock manure applied to soils (NFR 3.D.a.2.a)

NH_3 and NOx emissions for the period 2019-2021 have been recalculated due to FE corrections for fattening pigs and sows, which resulted in a reduction in emissions.

Cultivated crops (NFR 3.D.e)

Emissions were recalculated for the period 2015 – 2021 due to the corrections of AD for cropland area.

5.3. Field burning of agricultural residues (NFR 3.F)

Source category description

Field burning of agricultural residues is a minor source of several pollutants. The practice of burning crop residues is used as a quick and favourable method for clearing the land from crop residues that enables further and undisturbed land tillage. Field burning can also improve the fight against diseases and pests of certain crops. This activity is prohibited by the EU legislation and by the Croatian legislation (Ordinance on good agricultural and environmental conditions (OG 89/11)).

This category does not include activities of burning crop residues after their use for another purpose, for example, straw used for protection of agricultural products during storage at the farms. These activities should be included in the sector NFR 5.C.2 Waste.

Field burning of agricultural residues results in emission of a number of pollutants into the atmosphere including ammonia (NH_3), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), sulphur dioxide (SO_2), carbon monoxide (CO) and particles (PM), including black carbon (BC). Burning of agricultural residues also results in emission of heavy metals and dioxins.

Methodology, emission factors and activity data

For the calculation of emissions, the EMEP/EEA Tier 1 methodology according to GB2023 is used, which is based on estimates for amounts of agricultural residues and the application of a default emission factors for each pollutant, and this level of calculation is used for emission calculation in the Republic of Croatia.

For the emission calculation according to the GB2023 Teir 1 methodology, required activity data should include the actual harvested area of the most important crops (wheat, barley, maize, oats, rye, peas, beans, soybeans) that are burned and data on average yields of the most important crops (wheat, barley, maize, oats, peas, beans, soybeans) for each year of the entire time series.

The improvement of the calculation included the collection and processing of the necessary AD that include the actual harvested area of the most important crops that is burned. An expert judgement of the area under the most important crops that is burned for the entire historic period was obtained from the Ministry of Agriculture, and these data are given in table 5.3-2.

Default values of the ratio of residue mass to crop yield (s) are given in Table 5.3-1. To ensure consistency with the IPCC Guidelines 2006 (Chapter 2.4), and with the assumption that the dry matter content in yield (d) is 0.85, for crops other than wheat, maize and rice, values for wheat should be used.

Data on yield (Table 5.3-3) of the most important crops were obtained from the Central Bureau of Statistics for all historic years.

Table 5.3-1 Default values for estimating the amount of residues burned

CROP	Ratio of residue mass to crop yield (s)	Average crop yield (Y), kg ha^{-1} fresh weight	Combustion factor (C_f)
Wheat	1.3	3.6	0.9
Barley	1.2		
Maize	1.0	11.8	0.8
Oats	1.3		
Rye	1.6		
Rice	1.4	4.6	0.8
Peas	1.5		
Beans	2.1		
Soybeans	2.1		

Source: IPCC, 2000, GB2023

Table 5.3-2 Data on the area under the most important crops that is burned (Expert judgement)

Harvested area (ha)	Wheat	Barley	Maize	Oats	Rye	Peas	Beans	Soybeans
1990	63.79	5.16	30200.52	1.55	0.00	0.00	0.00	0.90
1991	64.89	5.16	29290.68	2.34	0.00	0.00	0.00	0.70
1992	32.34	3.29	22212.30	1.76	0.00	0.00	0.00	0.50
1993	46.10	3.66	22389.96	1.72	0.00	0.00	0.00	0.30
1994	39.70	3.62	22231.02	1.85	0.00	20200.00	0.00	0.20
1995	45.20	3.25	21243.54	1.58	0.00	0.00	0.00	0.10
1996	41.00	3.10	21649.44	1.63	0.00	0.00	0.00	0.15
1997	43.10	3.38	22259.16	1.81	0.00	0.00	0.00	0.15
1998	48.30	4.27	22652.16	2.17	0.00	0.00	0.00	0.20
1999	34.10	4.45	34553.25	2.41	0.00	0.00	0.00	0.30
2000	42.10	5.55	26318.79	2.60	0.00	0.00	0.00	0.35
2001	37.50	6.13	27528.03	2.61	0.00	0.00	0.00	0.35
2002	36.10	6.12	27612.45	2.45	0.00	0.00	0.00	0.40
2003	32.20	6.50	27424.98	2.53	0.00	0.00	0.00	0.40
2004	33.50	6.75	27571.23	2.35	0.00	0.00	0.00	1.20
2005	30.80	5.03	28707.57	2.12	0.00	0.00	0.00	1.30
2006	39.20	5.92	26657.55	2.49	0.00	0.00	0.00	2.00
2007	40.15	5.90	23083.92	2.80	0.00	0.00	0.00	1.40
2008	30.80	6.55	21984.34	1.99	0.00	0.00	0.00	1.10
2009	36.70	5.96	17814.60	2.09	0.00	0.00	0.00	0.90
2010	38.80	5.25	17806.08	1.93	0.00	0.00	0.00	1.20
2011	30.30	4.83	15256.50	2.53	0.00	0.00	0.00	1.85
2012	19.10	5.69	11966.44	2.85	0.00	0.00	0.00	1.80
2013	20.20	5.38	8650.95	2.17	0.00	0.00	0.00	1.60
2014	16.30	4.62	5051.34	2.11	0.00	0.00	0.00	1.50
2015	15.60	4.37	2639.70	2.35	0.00	0.00	0.00	9.69
2016	16.80	5.65	126.04	2.66	0.00	0.00	0.00	8.65

Harvested area (ha)	Wheat	Barley	Maize	Oats	Rye	Peas	Beans	Soybeans
2017	16.65	5.40	98.85	9.81	0.00	0.00	0.00	2.55
2018	14.93	5.10	91.79	1.59	0.00	0.00	0.00	1.05
2019	14.16	5.37	38.38	1.85	0.00	0.00	0.00	1.05
2020	10.94	1.50	15.86	0.78	0.00	0.00	0.00	1.32
2021	7.13	1.35	14.20	0.00	0.00	0.00	0.00	0.00
2022	0.35	3.79	0.30	0.00	0.00	0.00	0.00	0.00

Source: Ministry of Agriculture

Table 5.3-3 Data on yield of the most important crops

Yield (tonnes / ha)	Wheat	Barley	Maize	Oats	Rye	Peas	Beans	Soybeans
1990	5.02	3.81	3.88	2.44	5.19	0.29	2.27	2.03
1991	4.61	3.60	4.89	2.30	4.73	0.31	2.46	2.47
1992	3.90	3.25	3.67	2.57	2.69	0.31	2.67	1.76
1993	4.19	3.43	4.48	2.39	2.56	0.12	2.70	2.31
1994	3.78	2.98	4.55	2.29	2.41	0.14	2.96	2.16
1995	3.86	3.18	4.90	2.43	2.62	0.29	3.24	2.29
1996	3.69	2.84	5.23	2.43	2.70	0.22	2.90	2.19
1997	4.00	3.21	5.88	2.58	2.56	0.19	2.73	2.46
1998	4.22	3.36	5.25	2.59	2.58	1.33	3.53	2.28
1999	3.30	2.81	5.56	2.36	2.55	1.25	3.39	2.50
2000	4.75	3.24	4.07	2.37	2.64	1.65	0.36	1.38
2001	4.40	3.13	5.67	2.74	3.62	2.48	0.62	2.21
2002	4.59	3.38	6.38	3.03	2.84	2.39	0.73	2.70
2003	3.22	2.46	4.20	2.10	2.02	1.30	0.73	1.66
2004	4.93	3.52	6.31	3.13	3.13	2.29	0.73	2.65
2005	4.11	3.23	6.92	2.34	2.56	2.00	0.93	2.48
2006	4.58	3.64	6.53	2.67	2.73	2.19	0.64	2.77
2007	4.64	3.82	4.94	2.01	2.52	1.79	0.56	1.95
2008	5.48	4.26	7.98	3.29	2.98	2.48	1.52	3.01
2009	5.19	4.09	7.35	2.98	2.87	2.57	1.26	2.60
2010	4.04	3.28	6.97	2.50	2.42	1.54	1.29	2.72
2011	5.22	4.01	5.68	3.05	3.39	2.76	0.86	2.50
2012	5.35	4.14	4.34	3.32	2.87	2.91	0.60	1.79
2013	4.88	3.74	6.50	2.78	2.90	1.23	1.35	2.36
2014	4.16	3.80	8.10	2.67	2.04	2.64	0.90	2.79
2015	5.38	4.43	6.47	3.06	3.07	2.06	0.78	2.21
2016	5.71	4.66	8.55	3.03	3.62	3.46	0.93	3.10
2017	5.87	4.83	6.31	2.95	3.32	2.00	0.87	2.44
2018	5.44	4.46	9.12	2.82	3.32	2.14	1.24	3.18
2019	5.58	5.13	8.98	3.11	3.17	3.49	1.24	3.12
2020	5.86	4.85	8.43	3.37	4.13	1.31	1.35	3.09
2021	6.70	5.42	7.78	3.45	4.07	4.69	0.89	2.61
2022	6.00	5.05	6.13	3.01	3.49	3.67	0.88	2.15

Source: CBS

Recalculations and improvements

There was no recalculations or other improvements.

Photo by Ivan Bandura (@unstable_affliction) - Unsplash

6. Waste (NFR 5)

Croatia reports for the following source categories of the sector NFR 5 Waste:

- 5.A Biological treatment of waste - solid waste disposal on land
- 5.B.1 Biological treatment of waste - composting
- 5.B.2 Biological treatment of waste - anaerobic digestion at biogas facilities
- 5.C Waste Incineration
    - 5.C.1.b.i Industrial waste incineration
    - 5.C.1.b.iii Clinical waste incineration
    - 5.C.1.b.v Cremation
- 5.C.2 Open burning of waste
- 5.D Wastewater Handling
    - 5.D.1 Domestic wastewater handling
    - 5.D.2 Industrial wastewater handling
- 5.E Other Waste
    - SNAP code 091009 Car fire
    - SNAP code 091010 Detached house fire
    - SNAP code 091011 Undetached house fire
    - SNAP code 091012 Apartment building fire
    - SNAP code 091013 Industrial building fire

Information on the inclusion / exclusion of the condensing component in the PM_{10} and $PM_{2.5}$ emission factors according to the NFR discharge categories is found in appendices 2 and 6.

Source category description

The source category NFR 5.A includes emissions of NMVOC and PMs; 5.B.1 and 5.B.2 include emission of NH_3; 5.C.1 and 5.C.2 include emissions of NO_x, NMVOC, SO_2, PMs, CO, heavy metals, PCDD/PCDF, PAHs, HCB and PCBs; 5.D includes emissions of NMVOC and NH_3; 5.E includes emissions of PMs, heavy metals and PCDD/PCDF.

Implementation and establishment of the integral waste management system in Croatia are ensured by applying and fulfilling the objectives defined by the Waste Management Act[30] and Waste Management Plan[31]. The main act regulating waste management issues in the Republic of Croatia is the Waste Management Act. There are a number of ordinances that have been adopted according to Waste Management Act, some of them regulating certain waste management operations, some regulating management of specific waste types.

The Waste Management Act defines goals and deadlines for reducing the total mass of disposed waste and quantitative goals and deadlines for amount of separately collected and recycled

[30] Waste Management Act (OG 84/21, 142/23)
[31] Decision on the adoption of theWaste Management Plan of the Republic of Croatia for the period 2023 - 2028 (OG 84/23)

waste, in accordance with EU directives[32,33]. The Republic of Croatia submitted a request to postpone the fulfilment of the goals and deadlines, because it is among the member states that disposed of more than 60% of municipal waste at landfills in 2013 and recycled less than 20% of municipal waste. The European Commission has not yet approved the postponement of the goals and deadlines.

The following waste hierarchy shall apply as a priority order in waste prevention and management legislation and policy: (a) prevention; (b) preparing for re-use; (c) recycling; (d) other recovery, e.g. energy recovery; and (e) disposal. Avoiding and reducing of waste generation has the highest priority and results in reduction of quantity and adversity of produced waste which enters into the next phase. Reuse/recovery of produced waste has the purpose to use material and energy potentials of waste, in the framework of technical, ecological and economic possibilities. Disposal of remaining inert waste at the managed controlled landfills has the lowest rank in the waste management hierarchy. According to the Waste Management Plan the backbone of the waste management system consists of waste management centers and the establishment of recycling yards ensures the availability of separate municipal waste collection services.

Key categories for the Waste sector are shown in Table 6-1. Key Category Analysis (KCA) is presented in Section 1.5 and Appendix 1.

Table 6-1 Key sources for the Waste sector

NFR Category	NFR Category Name	Key Categories	
		Pollutant	KCA
5A	Solid waste disposal on land	NMVOC	L1, T1
5C2	Open burning of waste	PM2.5	T1
		Zn	T1
		PAH	T1

L1 = level assessment, tier 1, 2022

T1 = trend assessment, tier 1, 1990–2022

Methodology, emission factors and activity data

In general the EMEP/EEA methodology, multiplying activity data for each sub category with an emission factor, is applied. A Country-specific (CS) methodology was developed to estimate NMVOC emission factor from 5.A, for all years in reporting period.

Emission factors are expressed as the quantity of pollutant emission per unit of waste treated. Used emission factors are from GB2023 and GB2009 (for emission factors not estimated in GB2023, for NFR 5.C.1.b.i) as well CS NMVOC emission factors for 5.A. The source of emission factors used for emission calculation is noted in each of sub-sector under NFR code 5.

Generally several sources of information concerning activity and emission data for the source category waste have been used:

[32] Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste

[33] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste

- Activity data as reported annually by facilities in legally required forms under the Croatian Environmental Emission Register and Waste Management Information System (MESD);
- Project for improving reporting on GHG emissions from the Waste sector, categories 5.A, 5.B and 5.C "System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950"[34];
- National statistical reports at national level from the Croatian CBS (the Annual Statistical Reports and Releases, Census 1981, Census 1991, Census 2001 and Census 2011 and Census 2021);
- Plant specific activity data collected by direct contacts with facility (e.g. composting facilities, biogas facilities, facilities for cremation, industrial combustion facility);
- Ministry of Agriculture (MA);
- Ministry of the Interior (MI).

6.1. Biological treatment of waste – solid waste disposal on land (NFR 5.A)

Source category description

This source is only a minor source of air pollutant emissions, greenhouse gas CH_4 is the major pollutant. Small quantities of NMVOC, PM_{10}, $PM_{2.5}$, TSP, NH_3 and CO may be emitted. Croatia reports emissions of NMVOC and PMs from solid waste disposal.

Following information, which are relevant for IIR, are taken from GHG emissions report (NIR). According to the requirements of the 2006 IPCC Guidelines, Croatia included the CH_4 emissions for category 5.A Solid waste disposal from municipal solid waste (MSW), industrial waste (IW) and sludge disposed at landfills for the entire time series. This improve the accuracy and completeness of the inventory.

Data source for disposed waste amounts is MESD. Data collection system for waste is based on the Waste Management Act and by-laws and enforcement regulations. By the Ordinance on the Environmental Pollution Register[35], adopted according to Environment Protection Act, the MESD is collecting data on the quantities and types of waste produced, collected, recovered or disposed. Data on quantities are available for each waste code (based on European LoW- List of Waste) and NACE activity. Data on waste are entered in: a) Form NO (Generation of waste), b) Form SO (Collection of waste), Form OZO (Recovery/disposal of waste).

All detail regarding data collection is in detail described in Croatian NIR, according to IPCC methodology. The MESD collects data on waste and landfills in accordance with the Waste Management Act and the Ordinance on the Waste Management[36]. The person who manages the landfill is obliged to submit data on the mass of biodegradable municipal waste disposed of at the landfill on the prescribed forms twice a year, within 30 days from the end of the semester. These data are needed to monitor the achievement of objectives in accordance with the obligations according to EU Directives, which is required to report to the European Commission.

[34] "System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950", Client: MESD, Executor: Bidders Association - EKONERG d.o.o., IPZ Uniprojekt TERRA d.o.o., 2022 - 2023 (in Croatian)
[35] Ordinance on the Environmental Pollution Register (OG 3/22)
[36] Ordinance on the Waste Management (OG 106/22)

The MESD is collecting and processing waste data, among other the data reported to the EPR; Register of permits and certificates for waste management and Waste Management Information System. The “Database on Landfills (CSUIO)" contains data on landfills collected by the MESD and the Environment Protection and Energy Efficiency Fund (EPEEF). The database contains comprehensive information on waste management practices, such as information on technical measures (e.g. fence, scale, flares…) or environmental protection measures (e.g. degassing, compacting, aligning, monitoring…). The database also contains data on the status of remediation of landfills (in preparation/ongoing/finished) and status of operation (active/closed). Active MSW landfills are obligated by legislation to deliver this data to the MESD in prescribed form (Form on landfills and landfilling of waste – Form OOO), as for the rest (closed MSW landfills and IW landfills) the data forms are periodically sent to landfill operators by the MESD or the update is done upon receiving the information on individual landfill from other sources. Data on remediation status is requested by the MESD once a year from EPEEF, which co-financed remediation of almost all official landfills to improve technical standards at landfills, in order to comply with requests of the EU Directives.

Main source for activity data on MSW, IW and sludge is the EPR database and Waste Management Information System database, operated by MESD. Historical data that are not available in databases EPR and Waste Management Information System were collected by the project “System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950”. Detailed explanations of the data sources and methods of assessment the data for emission estimates are contained in the NIR 2024.

Emissions from combustion of landfill gas used for electricity generation are allocated in the Energy sector (1.A.1, 1.A.4).

Methodology, emission factors and activity data

The CS methodology was developed to estimate a NMVOC emission factors for all years in reporting period, based on the CH_4 emissions estimated in the framework of the NIR report. CH_4 emission ratio per ton of disposed waste was used, converted into a volume of CH_4 per tonne of disposed waste (using the molecular volume of CH_4) and then into a volume of biogas per tonne of disposed waste (applying the fraction of CH_4 in biogas F = 50%) and then the fraction of NMVOC in biogas (5.65 g/m^3 of landfill gas), presented in the note at the bottom of Table 3-1, Chapter 5.A of the EMEP/EEA GB2023, was applied. National NMVOC emission factors for all years in reporting period are presented in Appendix 2 of this Report.

The Tier 1 EMEP/EEA methodology from GB2023 is used for emissions calculation of $PM_{2,5}$, PM_{10} and TSP. Tier 2 is not available for this source. Recommended Tier 1 emission factors from GB2023 that expressed as the amount of pollutant per amount of landfilled waste are used.

Relevant activity data is an annual amount of landfilled waste. The activity data is presented in Table 6.1-1. Solid waste disposal trend during the reporting period depends on the multiple factors. For the period 1990 - 2008, there was increasing of disposed waste due to increasing of waste generation, mainly caused by increasing of living standard. After 2009 there is a decrease in quantities registered, caused primary by economic crisis but also other factors regarding to effects of measures undertaken to avoid/reduce and recycle waste. In the period up to 2015, there is a fluctuating trend of landfilled waste, which is affected by measures to avoid/reduce and recycle waste and remediation of illegal landfills. Since 2016, the quantities of landfilled waste have been reduced slightly as a result of more intensive implementation of the measures undertaken to avoid/reduce and recycle waste, which are still not sufficiently applied. During 2021 and 2022, there was a slight increase in disposed waste.

As the calculated CH_4 emissions in the NIR report, which are estimated using the kinetic model (IPCC FOD model), are used to calculate NMVOC emissions, the NMVOC emissions have been increased throughout the reporting period, which has only slowed down after 2017 and has started to decline from 2018. Regarding the application of the Tier 1 EMEP/ EEA methodology for $PM_{2,5}$, PM_{10} and TSP, emissions have been decreased since 2009, when the quantities of landfilled waste started to decrease, first with a fluctuating trend until 2015, and then with a declining trend until 2021 and 2022, when it started to grow slightly.

Further, a number of new legislation acts have been adopted with the purpose to increase separate collection, recycling and recovery of different waste types. National schemes based on „extended producer responsibility“ have been introduced for collection and recovery of different waste categories.

Table 6.1-1 Activity data for NFR codes 5.A, 5.B.1, 5.B.2, 5.C.1.b.i, 5.C.1.b.iii, 5.C.1.b.v and 5.C.2, represented by the relevant SNAP codes

NFR	5.A	5.B.1	5.B.2	5.C.1.b.i	5.C.1.b.iii	5.C.1.b.v	5.C.2
SNAP	090401	091005	091006	090202	090207	090901	090700
Name	Solid waste disposal on land	Composting	Anaerobic digestion at biogas facilities	Industrial waste incineration	Clinical waste incineration	Cremation	Open burning of waste
Unit	kt	kt	ktN in feedstock	kt	kt	corps	kt
1990	1026.970	NO	NO	0.250	0.140	1464	105.493
1991	1023.399	NO	NO	0.250	0.140	1786	99.671
1992	1027.266	NO	NO	0.250	0.140	2287	76.444
1993	1055.555	NO	NO	0.250	0.140	2760	73.447
1994	1115.794	3.691	NO	0.250	0.140	3037	69.033
1995	1152.987	3.906	NO	0.250	0.140	3109	65.869
1996	1212.164	4.121	NO	0.250	0.140	3385	65.484
1997	1256.779	4.336	NO	1.031	0.140	3476	63.010
1998	1307.240	4.551	NO	2.168	0.140	3312	62.299
1999	1332.495	4.766	NO	2.580	0.140	3201	57.358
2000	1393.062	5.400	NO	3.652	0.142	3080	51.875
2001	1457.342	4.358	NO	3.967	0.156	2972	50.601
2002	1544.779	5.830	NO	2.206	0.158	3254	49.585
2003	1614.881	4.171	NO	0.400	0.163	3392	48.246
2004	1675.484	4.931	NO	0.120	0.173	3404	48.391
2005	1762.921	8.930	NO	0.005	0.176	3633	48.116
2006	2023.129	6.913	NO	0.350	0.188	3593	49.382
2007	2321.994	15.649	NO	0.285	0.205	3962	51.197
2008	2559.943	18.653	NO	0.316	0.165	3911	52.409
2009	2238.476	21.317	0.004	IE	0.185	4060	52.253
2010	2001.165	20.860	0.010	IE	0.054	4314	53.009
2011	2038.567	24.432	0.014	IE	0.057	4344	50.511
2012	1960.680	39.709	0.028	IE	0.093	4478	48.838
2013	1992.832	41.091	0.014	IE	0.048	4601	46.535
2014	1830.499	39.723	0.200	IE	0.051	4803	46.684
2015	1918.659	74.877	0.320	IE	0.052	5373	45.331
2016	1769.572	37.488	0.547	IE	0.056	5128	41.900
2017	1683.640	42.444	0.354	IE	NO	5496	37.752
2018	1601.602	47.594	0.164	IE	NO	6440	39.267
2019	1593.402	49.610	0.193	IE	NO	6648	36.111
2020	1459.906	71.252	0.269	IE	NO	6747	36.136
2021	1593.429	85.434	0.280	IE	NO	7791	33.301
2022	1829.753	111.094	0.360	IE	NO	7307	32.622

Source: 5.A, 5.C.1 - MESD, 5.B.1, 5.B.2 – MESD, composting/biogas facilities, 5.C.2 - MA, CBS, Processing: Ekonerg Ltd

Recalculation and improvements

In category 5.A, emissions were recalculated due to the use of new activity data collected by the project to improve the GHG emission „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950“.

PM emissions were recalculated for the period 1990 - 2012 due to new activity data on deposited waste.

NMVOC emissions were recalculated for the period 1990 - 2021 due to the use of new country-specific emission factors for NMVOC for all years in the reporting period, based on CH_4 emissions estimated in the NIR report. CH_4 emissions estimated in the NIR report were recalculated for the entire reporting period, due to the use of the newly estimated values of the DOC parameter (degradable organic carbon) for municipal and industrial waste.

6.2. Biological treatment of waste – composting (NFR 5.B.1)

Source category description

Composting is the process of decomposition of organic matter due to the action of microorganisms under aerobic conditions, which produces carbon dioxide, water, heat and compost as the final product. Composting is carried out gradually and under controlled conditions. An important role is played by microorganisms that biologically decompose organic waste into simpler ingredients, which are then converted into humus compounds.

According to GB2023, NH_3 emission resulting from composting are included in this category (Technologies – Compost production, SNAP 091005). Data on mass of feedstock treated by composting were collected and analysed for entire reporting period from 1990 to 2022, as output of the project to improve the GHG emission „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950“. According to the analyses made in the project, for the period 1994 - 2006, the outputs of the pollutant inventory improvement project for the sector composting[37] were used, while for the period 2007 - 2022, verified data from the ROO database were used.

Methodology, emission factors and activity data

The *Tier 2* EMEP/EEA methodology and recommended *Tier 2* emission factor from GB2023 are used for NH_3 emission calculation from composting.

Relevant activity data is the annual quantity of composted waste. The sources of activity data are:

- eleven legal entities that own the composting facilities, with two branches within one legal entity (a total of twelve composting facilities) - data were collected for the period 1999 - 2006;
- EPR database - verified data were collected for the period 2007 - 2022.

The composting process has been applied in the Republic of Croatia since 1994. Data from one composting facility, which first started operating in 1994, are not available for the period from 1994 to 1999, so they were estimated by the method of linear extrapolation. Data for the period from 1994 to 1999 were calculated taking into account the trend of the mass of composted waste

[37] “Report on inventory improvement for sector composting (NFR 5.B.1)” (lit. 37)

for the period from 2000 to 2002, since in that period the data do not differ significantly, so the calculated values show a similar trend.

Data on mass of composted waste (on a wet weight basis, t), dry matter content of feedstock - waste (kg kg^{-1}) and composting and NH_3 abatement technologies were collected. Data on mass of composted waste include data on different categories of waste according to the European List of Waste (LoW) and by-products.

The total annual mass of composted waste (on a wet weight basis) includes the mass of municipal waste, production waste, sludge and other organic waste (slurry and manure):

- municipal solid waste (groups 15 01 and 20) - for the period 1994 - 2006, the outputs of the pollutant inventory improvement project for the sector composting were used, while for the period 2007 - 2022, verified data from the ROO database were used;
- industrial waste (groups 02, 03, 04, 10, 17) - for the period 2013 - 2022, verified data from the ROO database were used;
- sludge (group 19) and other organic waste (slurry and manure) - for the period 2013 - 2022, verified data from the ROO database were used.

The activity data is presented in Table 6.1-1. Data on dry matter content of the feedstock - waste were collected due to the characterization of different categories of waste and by-products used as feedstock in the composting process. For waste according to the European List of Waste (LoW), dry matter content varies depending on the waste category (Table 6.2-1). To estimate dry matter content, the average percentages of dry matter in raw material - composted waste were collected by the Annual Data Collection Plan (groups 15 01, 19 and 20) and by the pollutant inventory improvement project for sector composting (groups 02, 03, 04, 10 and 17).

Table 6.2-1. Dry matter content of the feedstock – composted waste (kg kg^{-1})

LoW	Dry matter content (kg kg^{-1})
02	0.40
03	0.55
04	0.55
10	0.60
15	0.878
17	0.50
19	0.26
20	0.59

In composting facilities, the following composting technologies are used: a) Compost pile - feedstock in the stack and b) Windrow system - shaking and aeration of feedstock. In the period from 1994 to 2022, the composting facilities did not use NH_3 abatement technology - biofilter.

Recalculation and improvements

In category 5.B.1, NH_3 emissions were recalculated due to the use of new activity data collected by the project to improve the GHG emission „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950“.

Recalculation of NH_3 emissions from composting was carried out for the periods 2011 - 2012 and 2021 - 2022 due to the correction of data on the total annual mass of composted waste.

For the period 1990 - 1993, in the official reporting format (NFR) the notation key "NO" (not occurring) has been used.

6.3. Biological treatment of waste – anaerobic digestion at biogas facilities (NFR 5.B.2)

Source category description

Anaerobic digestion of organic substrates (feedstock) is carried out during metabolic interactions of different types of bacteria which action allows complete bioconversion of organic substrate to methane, carbon dioxide and other trace gases, as hydrogen and hydrogen sulfide. The biogas production is the result of a series of related process steps during which the initial substrate decomposes into simpler compounds, all the way to biogas formation. The stability of the anaerobic digestion process and the specific requirements related to the composition of the substrate are some of the limiting factors that affect anaerobic digestion.

In order to improve the digestion process, feedstock pre-treatment, heating of the digester and mixing of feedstock can be used. The general concept of a biogas facility comprises the following stages: 1) pre-storage of feedstock, 2) anaerobic digestion in the digester, 3) storage of the digestate.

In practice, not all feedstock is stored before anaerobic digestion, but may be fed directly into the digester. The digester can consist of more than one gas-tight vessel. The storage of the digestate can be in a gas-tight vessel, an open tank or another storage facility. The storage may be combined with, or preceded by, treatment of the digestate, e.g. the separation of the liquid and solid fractions before storage. The possible treatment of the liquid fraction in a wastewater treatment plant, the combustion of the solid fraction and the utilisation of digestate as organic fertiliser are beyond the scope of category 5.B.2.

Emissions from anaerobic digestion of organic waste at biogas facilities (NFR 5.B.2) are included in the Energy sector (NFR 1.A.1 and 1.A.4), due to energy recovery. This refers on the emissions generated by the combustion of the biogas. Biogas produced by anaerobic digestion at biogas facilities is used for electricity generation.

According to GB2023, potential NH_3 emission from pre- and post-storage as well as possible leakage during solid-liquid separation are included in this category (SNAP 091006 Biogas production). Data on mass of feedstock treated by anaerobic digestion at biogas facilities were collected and analysed for entire reporting period from 1990 to 2022, as output of the project to improve the GHG emission „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950“. According to the analyses made in the project, for the period 2009 - 2012, the outputs of the pollutant inventory improvement project for the sector anaerobic digestion at biogas facilities[38] were used, while for the period 2013 - 2022, verified data from the ROO database were used.

Methodology, emission factors and activity data

The *Tier 2* EMEP/EEA methodology and recommended *Tier 2* emission factors for pre-storage of feedstock and storage of digestate from GB2023 are used for NH_3 emission calculation from anaerobic digestion at biogas facilities for sub-categories pre-storage of feedstock and storage of digestate.

It can be assumed that NH_3 emissions from the digester or digester system are negligible. Emissions from application of digestates originating from livestock manure are calculated in 3.B, together with the emissions from application of untreated animal manures, and be reported under NFR code 3.D.a.2.a. Emissions from spreading digestates resulting from digestion of

[38] “Report on inventory improvement for sector anaerobic digestion at biogas facilities (NFR 5.B.2)” (lit. 37)

other organic wastes and energy crops are calculated in 3.D and reported under NFR code 3.D.a.2.c.

Relevant activity data is the total annual amount of N in feedstock - waste and by-products treated with anaerobic digestion at biogas facilities (table 6.1-1). The total annual amount of N in feedstock is calculated by multiplying the total fresh weight of feedstock (tonnes a^{-1}) by the dry matter content of the feedstock (kg kg^{-1}) and the concentration of N in the feedstock dry matter (kg N per kg DM). The sources of activity data are:

- twenty legal entities that own the biogas facilities, with four legal entities having several branches - a total of twenty-eight biogas facilities[39] - data were collected for the period 2009 - 2012;
- EPR database - verified data were collected for the period 2013 - 2022.

The anaerobic digestion in biogas facilities has been applied in the Republic of Croatia since 2009. Data on mass of waste and by-products treated with anaerobic digestion at biogas facilities (on a wet weight basis, t), dry matter content of feedstock (kg kg^{-1}), concentration of N in feedstock dry matter (kg N kg^{-1} DM) and NH_3 abatement technologies during manure storage were collected. Data on mass of waste and by-products treated by anaerobic digestion at biogas facilities include data on different categories of waste according to the European List of Waste (LoW) and by-products.

The total annual mass of digested waste (on a wet weight basis) includes the mass of municipal waste, production waste, sludge and other organic waste (slurry and manure):

- municipal solid waste (groups 15 01 and 20) - for the period 2009 - 2012, the outputs of the pollutant inventory improvement project for the sector anaerobic digestion at biogas facilities were used, while for the period 2013 - 2022, verified data from the ROO database were used;
- industrial waste (group 02) - for the period 2013 - 2022, verified data from the ROO database were used;
- sludge (groups 02, 03 and 19) and other organic waste (slurry and manure) - for the period 2013 - 2022, verified data from the ROO database were used.

Data on dry matter content of feedstock and concentration of N in feedstock dry matter were taken from pollutant inventory improvement project for the sector anaerobic digestion at biogas facilities. The values of dry matter content and concentration of N in certain types of waste and by-products were estimated using collected data and recommended values from GB2023 (Table 3.4, GB2023, 5.B.2 Biological treatment of waste - anaerobic digestion at biogas facilities 2023). Table 6.3-1 shows dry matter content of feedstock treated by anaerobic digestion at biogas facilities, while Table 6.3-2 shows concentration of N in feedstock dry matter treated by anaerobic digestion at biogas facilities.

Table 6.3-1 Dry matter content of feedstock treated by anaerobic digestion at biogas facilities (kg kg^{-1})

LoW / by-product code		Dry matter content (kg kg^{-1})
02, 03, 15, 19, 20		0.40
K3	food waste	0.40
K3	milk	0.12
K3	whey	0.07

[39] A total of twenty-nine questionnaires were collected, with data from one wastewater treatment plant not included in the inventory because, according to GB2023 the liquid fraction (activated sludge) from such a plant is not included in the calculation of potential NH_3 emissions from category 5.B.2.

LoW / by-product code		Dry matter content (kg kg^{-1})
K2	poultry manure	0.50
K2	pig solid manure	-
K2	pig slurry	0.04
K2	cattle slurry	0.03 - 0.04
K2	cattle solid manure	0.24 - 0.25
	silage	0.32 - 0.35
	beer trope	0.35

Note:
- for groups 02, 03, 15, 19, 20, the recommended value for municipal waste from table 3.4, GB2023, 5.B.2 was estimated
- for K3 food waste and beer trope, the recommended values from table 3.4, GB2023 (estimates for certain types of waste/by-products) were estimated
- for K3 milk, whey and K2 poultry manure, pig and cattle manure, cattle solid manure and silage, the estimated and submitted values from the questionnaire were used

Table 6.3-2 Concentration of N in feedstock dry matter treated by anaerobic digestion at biogas facilities (kg N kg^{-1} DM)

LoW / by-product code		Concentration of N in feedstock dry matter (kg N kg^{-1} DM)
02, 03, 15, 19, 20		0.007
K3	food waste	0.005
K3	milk	0.005
K3	whey	0.005
K2	poultry manure	0.008 - 0.011
K2	pig solid manure	-
K2	pig slurry	0.004
K2	cattle slurry	0.003 - 0.004
K2	cattle solid manure	0.008
	silage	0.003
	beer trope	0.005

Note:
- for groups 02, 03, 15, 19, 20, the recommended value for municipal waste from table 3.4, GB2023, 5.B.2 was estimated
- for K3 food waste, milk, whey and beer trope, the recommended values from table 3.4, GB2023 (estimates for certain types of waste/by-products) were estimated
- for K2 poultry manure, pig and cattle manure, cattle solid manure and silage, the estimated and submitted values from the questionnaire were used

In biogas facilities, the following NH_3 abatement technologies during manure storage are used: a) thin natural layer, b) floating cover - natural (straw) and c) solid cover. In most biogas facilities manure and slurry are not stored and all quantity is immediately used. Of the biogas facilities that use abatement technologies, most of them use thin natural layer as NH_3 abatement technology during manure storage.

Recalculation and improvements

In category 5.B.2, NH_3 emissions were recalculated due to the use of new activity data collected by the project to improve the GHG emission „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950".

Recalculation of NH_3 emissions from anaerobic digestion at biogas facilities was carried out for the period 2013 - 2021 due to the correction of data on the total annual amount of N in feedstock.

For the period 1990 - 2008, in the official reporting format (NFR) the notation key "NO" (not occurring) has been used.

6.4. Waste incineration (NFR 5.C.1)

Source category description

Waste incineration (NFR 5.C.1) includes emission of pollutants from industrial waste incineration (NFR 5.C.1.b.i), clinical waste incineration (NFR 5.C.1.b.iii) and cremation (NFR 5.C.1.b.v), without energy recovery. There is no municipal waste incineration (NFR 5.C.1.a), neither incineration of sludge from wastewater treatment (NFR 5.C.1.b.iv) in Croatia, and notation key "NO" (not occurring) for that source activities are reported. In Croatia, animal carcasses are burned in several small plants. Data have not been collected so far, which will be done in one of the following reports.

Emissions that occur as a result of waste incineration with energy recovery are presented in the Energy Sector 1.A.

Industrial waste incineration (NFR 5.C.1.b.i)

The official source of activity data for industrial waste incineration is MESD that collects data from emission point sources in the EPR database. According to the Ordinance on the Environmental Pollution Register[40], the completed forms should be submitted for the previous calendar year not later than March 1 of the current year. The competent authority (administrative department of the county and the City of Zagreb) ensures the checking of data submitted in terms of their completeness, consistency and credibility. The MESD coordinates activities relating to data quality assurance and control.

In the period from 1997 to 2002, an incineration of hazardous waste was existed in Croatia and those emissions are reported in the scope of source category NFR 5.C.1.b.i Industrial waste incineration. For the source category NFR 5.C.1.b.ii Hazardous waste incineration the notation key "IE" is used. Croatia uses EWC codes for waste classification that is part of the Regulation on categories, types and classification of waste with a Waste Catalogue and List of hazardous waste[41] and Ordinance on Waste Management[42].

Clinical waste incineration (NFR 5.C.1.b.iii)

The official source of activity data for clinical waste incineration is MESD that collects data from emission point sources in the EPR database. According to the Ordinance on the Environmental Pollution Register, the completed forms should be submitted for the previous calendar year not later than March 1 of the current year.

In the period from 1990 to 2016, an incineration of clinical waste was existed in Croatia and those emissions are reported in the scope of source category NFR 5.C.1.b.iii. There was no incineration of clinical waste in the period 2017 - 2022, neither with energy recovery nor without energy recovery. MESD has confirmed that pharmaceutical waste was exported, and potentially infectious waste was disposed of at landfills after autoclaving. Therefore, notation key "NO" is used for the period 2017 - 2022.

Incineration facilities for clinical waste in Croatia were not modern facilities. The longest-running plant had started with the incineration of clinical waste in 1986, using gas furnaces and no information on installed abatement technologies are available for this facility. The other two facilities were within the hospitals. One facility that operated from 1988 to 2011 had only

[40] Ordinance on the Environmental Pollution Register (OG 3/22)
[41] Regulation on categories, types and classification of waste with a Waste Catalogue and List of hazardous waste (OG 50/05, 39/09)
[42] Ordinance on Waste Management (OG 106/22)

installed a system of flue gas purification by a wet process. For the second facility that operated from 2001 to 2012 there are no available information on installed abatement technologies. Batch incineration without agitation was used in all facilities.

Cremation (NFR 5.C.1.b.v)

The official source of activity data for cremation is MESD that collects data from the two crematories in Croatia, located in Zagreb and Osijek.

Methodology, emission factors and activity data

Industrial waste incineration (NFR 5.C.1.b.i)

The Tier 1 EMEP/EEA methodology and recommended Tier 1 emission factors from GB2023 (and GB2009 for emission factors not estimated in GB2023) are used for emissions calculation.

Relevant activity data is the annual quantity of incinerated industrial waste. The activity data is presented in Table 6.1-1.

Data for the period 1990 -2007 were obtained in direct contact with facilities for industrial and hazardous waste incineration. For years 2007 and 2008, plant specific emission factors were used. These are based on direct emission reported in the EPR database. Data for the period 2009 - 2022 on the total amount of incinerated waste by operation D10 (Waste incineration on land) and operation R1 (Waste usage as a fuel or other means to generate energy) have been based on validated OZO forms - Recovery/disposal. As there is no longer a plant operating without energy recovery since 2009, all emissions related to the incineration of industrial waste are reported within the Energy sector. Since 2009, the source category Incineration of Production Waste (NFR 5.C.1.b.i) has been marked “IE” in the report. Cement kilns are included in this source category, emissions are included in NFR 1.A.2.f.

Clinical waste incineration (NFR 5.C.1.b.iii)

The Tier 1 EMEP/EEA methodology and recommended Tier 1 emission factors from GB2023 are used for emissions calculation.

Relevant activity data for clinical waste incineration is the annual quantity of incinerated clinical waste. The activity data is presented in Table 6.1-1.

The trend of incineration of clinical waste during the period 1990 - 1999 is steady, while in the period 2000 - 2009 the quantity of incinerated clinical waste has been increased. From 2010, there is decrease in incinerated quantities of clinical waste, with a fluctuating trend. This is the result of incineration of clinical waste with energy recovery, which is presented in the Energy sector.

Cremation (NFR 5.C.1.b.v)

The Tier 1 EMEP/EEA methodology and recommended Tier 1 emission factors from GB2023 are used for emissions calculation.

Relevant activity data for cremation is the number of incinerated corpses. The activity data is presented in Table 6.1-1.

The trend of cremated bodies is fluctuating and mostly growing throughout the observed period.

Recalculation and improvements

Industrial waste incineration (NFR 5.C.1.b.i)

Recalculation of PCDD/F emissions from industrial waste incineration was carried out for the period 1990 - 2008 due to the use of new emission factor from GB2023.

Clinical waste incineration (NFR 5.C.1.b.iii)

Recalculation of NO_x, CO, SO_2, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, Cr, Cu, Ni, PCDD/F emissions from clinical waste incineration was carried out for the period 1990 - 2016 due to the use of new emission factors from GB2023.

Cremation (NFR 5.C.1.b.v)

There was no recalculation and other improvement in this report.

6.5. Open burning of waste (NFR 5.C.2)

Source category description

This category includes activities of incineration of agricultural waste (excluding chaff, harvest residues) outdoors carried out on land, in incinerators, in pits in the ground, in open barrels, wire mesh, containers/baskets. GB2023 provides examples of agricultural wastes that might be burned: crop residues (e.g. cereal crops, peas, beans, soya, sugar beet, oil seed rape, etc.), wood, prunings, slash, leaves, plastics and other general wastes. Prunings and slash are residues from thinning and pruning of forests, orchards and vineyards. Straw and wood are often used as the fuel for the open burning of agricultural wastes. It is assumed that the open burning of agricultural waste is mainly done in forestry, fruit growing, vineyard and farming, while the rest is negligible.

Calculation of pollutants from source category open burning of waste was carried out in accordance with the EMEP/EEA methodology and GB2023. Data on mass of open burned waste were collected for entire reporting period from 1990 to 2022, where data of the pollutant inventory improvement project for the sector open burning of waste[43] and data collected by the Annual Data Collection Plan were used. These data were also used in the project to improve the GHG emission „System improvement and creation of databases with historical data for calculation and reporting of greenhouse gas emissions from the Waste sector including data for the historical series from 1950".

Emissions from open burning of waste depend on a number of factors. The most important variables are the type of waste burned and the moisture content of the waste. Ambient temperature and wind conditions and the density/compactness of the waste pile also affect combustion conditions and thus emissions.

Methodology, emission factors and activity data

The Tier 2 EMEP/EEA methodology and recommended Tier 1 and Tier 2 emission factors from GB2023 are used for the calculation of pollutant emissions: CO, NO_x, SO_2, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, Cr, Cu, Zn, As, Se, Pb, Cd, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene and PCDD/F.

The recommended Tier 2 emission factors have been used for the calculation of pollutant emissions from the open burning of pruning residues from orchards and olive groves (Table 3-3, GB2023). The recommended Tier 1 emission factors have been used for the calculation of pollutant emissions from the open burning of pruning residues from vineyards (Table 3-1, GB2023). Assuming a dry matter content of the pruning residues of more than 90 %, the emission factors on a wet weight basis are assumed to be the same as the emission factors on a dry weight basis. There is no practice of open burning pruning residues from forests in the Republic of Croatia.

Relevant activity data is the annual amount of open burned waste (table 6.1-1). The sources of activity data are presented in table 6.5-1. Data on the mass of open burned waste (pruning residues from forests, orchards, olive groves and vineyards) and the area of the Republic of Croatia under forests, orchards, olive groves and vineyards have been collected.

[43] "Report on inventory improvement for sector open burning of waste (NFR 5.C.2)" (lit. 37)

Table 6.5-1 Sources of collected data for the calculation of pollutant emissions from the source category 5.C.2 Open burning of waste

Data	Period	Source
Burnt pruning residues from orchards, olive groves and vineyards (t)	1990 - 2022	MA, Directorate for professional support to agricultural development
Data information on the non-existence of the practice of open burning pruning residues from forests in the Republic of Croatia	1990 - 2022	MA, Directorate of forestry, hunting and wood industry
The area of the Republic of Croatia under forests (ha)	1990 - 2022	MA, Directorate of forestry, hunting and wood industry Source: General Forest management plan for the Republic of Croatia (2016 - 2025), data on overgrown forest areas prepared for the preparation of the National Greenhouse Gas Inventory Report (NIR)
The area of the Republic of Croatia under orchards, olive groves and vineyards	1990 - 2022	CBS

Data on the area of the Republic of Croatia under forests, orchards, olive groves and vineyards are shown in Table 6.5-2. Pruning residues from orchards, olive groves and vineyards are shown in Table 6.5-3.

Table 6.5-2. The area of the Republic of Croatia under forests, orchards, olive groves and vineyards (ha)

Year	The area under forests (ha)	The area under orchards (ha)	The area under olive groves (ha)	The area under vineyards (ha)
1990	2356831.70	19474.35	IE	54315.75
1991	2357045.00	19544.88	IE	53667.00
1992	2357207.60	19615.40	IE	42295.50
1993	2357505.60	19685.93	IE	42493.50
1994	2357705.00	19756.45	IE	41661.00
1995	2357933.50	19826.98	IE	41514.00
1996	2358221.00	19897.50	IE	43289.25
1997	2358338.70	19968.03	IE	43527.75
1998	2358494.20	20038.55	IE	45109.50
1999	2358793.50	15880.13	5464.32	44328.00
2000	2358869.10	20179.60	5699.00	21295.50
2001	2358768.50	20596.80	5706.00	20792.25
2002	2358840.50	21119.00	5740.00	20795.25
2003	2359029.20	21632.10	5637.50	20766.00
2004	2359333.00	20594.70	6195.50	21000.00
2005	2362013.80	21196.00	6178.50	22252.50
2006	2364534.00	22264.90	6681.50	23074.50
2007	2368271.40	22904.00	7173.00	24340.50
2008	2369695.90	25153.10	7485.50	25305.75
2009	2373540.20	25661.30	7652.00	25785.00
2010	2377998.50	23022.30	8548.00	24531.75
2011	2383851.80	22792.00	8600.00	24363.75
2012	2388633.70	21592.20	9050.00	21927.75
2013	2395608.60	19874.40	9295.00	19575.00
2014	2403911.80	22206.80	9541.00	19623.00
2015	2410050.40	21078.40	9550.00	19190.25
2016	2411443.70	20633.20	9092.00	17550.00
2017	2415366.50	21443.80	8341.50	16425.00
2018	2417091.40	22705.20	9348.50	15384.00
2019	2417594.70	24173.80	9303.00	14868.00
2020	2417915.80	23220.40	10141.00	16090.50

Year	The area under forests (ha)	The area under orchards (ha)	The area under olive groves (ha)	The area under vineyards (ha)
2021	2418302.40	23534,00	9970,00	15909,75
2022	2418408.20	24460,08	9950,00	15717,75

IE (included elsewhere) - olive grove areas for the period 1990-1998 are included under orchard areas

Table 6.5-3. Pruning residues from orchards, olive groves and vineyards (t)

Year	Pruning residues from forests (t)	Pruning residues from orchards (t)	Pruning residues from olive groves (t)	Pruning residues from vineyards (t)	TOTAL Pruning residues (t)
1990	NO	6426.00	IE	99066.75	105492.75
1991	NO	6449.00	IE	93222.38	99671.38
1992	NO	6473.00	IE	69970.94	76443.94
1993	NO	6496.00	IE	66950.95	73446.95
1994	NO	6519.00	IE	62513.62	69032.62
1995	NO	6542.00	IE	59326.71	65868.71
1996	NO	6566.00	IE	58917.79	65483.79
1997	NO	6589.00	IE	56421.32	63010.32
1998	NO	6612.00	IE	55687.25	62299.25
1999	NO	5240.92	0.00	52116.66	57357.58
2000	NO	6659.00	21371.25	23844.98	51875.23
2001	NO	7031.00	21397.50	22172.84	50601.34
2002	NO	6940.00	21525.00	21120.04	49585.04
2003	NO	7019.00	21140.63	20086.03	48245.66
2004	NO	6123.00	22923.35	19345.11	48391.46
2005	NO	6042.00	22551.53	19522.77	48116.30
2006	NO	6049.00	24053.40	19279.94	49382.34
2007	NO	5891.00	25464.15	19841.71	51196.86
2008	NO	6084.00	26199.25	20125.42	52408.67
2009	NO	5847.00	26399.40	20006.40	52252.80
2010	NO	5376.00	29063.20	18569.77	53008.97
2011	NO	3708.00	28810.00	17992.78	50510.78
2012	NO	3174.00	29865.00	15798.81	48837.81
2013	NO	2567.00	30208.75	13759.67	46535.42
2014	NO	2696.00	30531.20	13456.99	46684.19
2015	NO	2409.00	30082.50	12839.24	45330.74
2016	NO	2259.00	28185.20	11455.44	41899.64
2017	NO	1851.00	25441.58	10459.63	37752.20
2018	NO	1664.00	28045.50	9557.76	39267.26
2019	NO	1516.00	25583.25	9011.89	36111.14
2020	NO	1268.00	25352.50	9515.00	36135.50
2021	NO	1353.00	23840.00	8107.61	33300.61
2022	NO	1166.17	23754.00	7702.05	32622.22

NO (not occurring) - there is no practice of open burning pruning residues from forests in the Republic of Croatia

IE (included elsewhere) - pruning residues from olive groves for the period 1990 - 1998 are included under pruning residues from orchards

Recalculation and improvements

Recalculation of benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene emissions from open burning of waste was carried out for the period 1990 - 2021 due to the use of new emission factors from GB2023.

Additionally, accurate data for 2021 was collected, as the previous report used estimated values due to missing data. Recalculation of CO, NO_x, SO_2, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, Cr, Cu, Zn, As, Se, Pb, Cd and PCDD/F emissions was made for 2021.

6.6. Wastewater handling (NFR 5.D)

Source category description

Activities considered within this source category are Domestic wastewater handling (NFR 5.D.1) and Industrial wastewater handling (NFR 5.D.2).

Domestic wastewater handling (NFR 5.D.1)

In the scope of this source category, Croatia is reporting emissions from wastewater treatment in residential/commercial sectors and latrines.

Processing wastewater in residential/commercial sectors is most commonly used aerobic biological treatment. Biological treatment plants have minor influence on the emissions of pollutants. Disposal of residential/commercial wastewater, particularly in rural areas where systems such as septic tanks are used, are partly anaerobic. NMVOC emissions are reporting in this source category.

A latrine is a simple "dry" toilet built outside the house, usually in a backyard without water flushing. A storage tank under the latrine can be a hole dug in the ground, or a concrete reservoir. Capacity of the tank can vary between 1 m^3 and 2 m^3. The time of storage can vary between a few months and "forever". Latrines are source of NH_3 emissions in Croatia.

Industrial wastewater handling (NFR 5.D.2)

In the scope of this source category, Croatia is reporting emissions from wastewater treatment in industry. Processing wastewater is most commonly used aerobic biological treatment. Biological treatment plants have minor influence on the emissions of pollutants. NMVOC emissions are reporting in this source category.

Methodology, emission factors and activity data

Domestic wastewater handling (NFR 5.D.1)

The Tier 2 EMEP/EEA methodology and recommended Tier 2 emission factor from GB2023 are used for NMVOC emission calculation in wastewater handling from residential/commercial sectors.

The relevant activity data for wastewater from residential/commercial sectors are the annual amounts of total wastewater treated in residential/commercial sectors.

The source of activity data for wastewater from residential/commercial sectors is Croatian Bureau of Statistics – First Release; Public Sewage System; Source, Treatment and Discharge of Waste Waters. Unavailable data for 1997 was estimated with interpolation method. Data for other years in the period 1990 - 2022 are available from statistical reports and releases. The activity data is presented in Table 6.6-1.

During the reporting period (1990 - 2019) there is an increasing trend of the quantity of wastewater treated in residential/commercial sectors, which is the result of construction and improving the public sewerage system. In the period 2020 - 2022, there is stagnation in the amount of treated wastewater, and the values remain at slightly lower values than in 2019.

The Tier 2 EMEP/EEA methodology and recommended Tier 2 emission factor from GB2023 are used for NH_3 emission calculation from latrine.

The pollutant inventory improvement project for the sector domestic wastewater handling - latrines[44] collected more accurate and reliable activity data for the reporting period 1990 - 2020, according to which the data for the period 2021 - 2022 were estimated.

The relevant activity data for latrines is the number of residents who use latrines. The source of activity data is CBS.

The following data for 2001 and 2011 are available:

- total occupied dwellings,
- total number of households - in urban and other settlements,
  - number of households in dwelling with flush toilet,
  - number of households in dwelling with toilet without flusher,
  - number of households in dwelling without toilets,
  - number of households for which it is unknown in what kind dwelling they live,
- total number of persons per household - in urban and other settlements,
  - number of persons per household in dwelling with flush toilet,
  - number of persons per household in dwelling with toilet without flusher,
  - number of persons per household in dwelling without toilets,
  - number of persons per household for which it is unknown in what kind dwelling they live.

Data for 1981 and 1991 were downloaded from the Internet and the CBS website (https://www.dzs.hr/).

It is assumed that the sum of the number of persons per household in dwelling with toilet without flusher, number of persons per household in dwelling without toilets and number of persons per household for which it is unknown in what kind dwelling they live in 2001 and 2011 are activity data, that is the number of residents in dwelling with latrine. Accuracy and completeness of activity data will be further improved by including data on the number of residents who use latrines from the 2021 Census (Census of Population, Households and Dwellings 2021, Dwellings by Occupancy Status), when it will be available. At the time the Report was prepared, the CBS confirmed that the data was not yet available.

The missing data have been estimated by the methods of linear extrapolation and interpolation and estimation of the share of the population who use latrines in the total population of the Republic of Croatia. Activity data are shown in Table 6.6-1.

Throughout the reporting period (from 1990 to 2022) there is a declining trend in the population who use latrines, which is a result of rising living standards and increasing the population connected to the public sewerage system.

Industrial wastewater handling (NFR 5.D.2)

The *Tier 2* EMEP/EEA methodology and recommended *Tier 2* emission factor from GB2023 are used for NMVOC emission calculation from industrial wastewater handling.

The relevant activity data is the annual amount of total wastewater treated in industry.

The source of activity data for wastewater from industry is Croatian Bureau of Statistics – First Release; Utilization of Waters and Protection of Waters from Pollution in Industry; Discharge of Treated Waste Water, according to NKD 2007. Unavailable data for 1997 was estimated

[44] "Report on inventory improvement for sector domestic wastewater handling - latrines (NFR 5.D.1)" (lit. 36)

with interpolation method. Data for other years in the period 1990 - 2022 are available from statistical reports and releases. The activity data is presented in Table 6.6-1.

During the reporting period (from 1990 to 2022) there is a fluctuating trend in the quantity of wastewater treated in industry. The quantities of wastewater treated in industry were higher in the period up to 2010. After 2010 amounts are reduced, while maintaining the fluctuating trend, which is influenced by the volume of industrial production.

Table 6.6-1 Activity data for NFR codes 5.D.1 and 5.D.2, represented by the relevant SNAP codes

NFR	5.D.1	5.D.1	5.D.2
SNAP	091002	091007	091001
Name	Domestic wastewater - residential/commercial wastewater	Domestic wastewater - latrines	Industrial wastewater
Unit	1000 m^3	st.	1000 m^3
1990	NO	777604	104000
1991	NO	744649	94488
1992	NO	711694	46785
1993	NO	678738	87343
1994	NO	645783	34419
1995	54353	612828	33758
1996	58009	579873	93836
1997	61661	546917	41857
1998	87796	513962	30985
1999	88785	481007	28924
2000	86579	448051	22208
2001	83533	415096	21337
2002	81196	382141	21883
2003	84283	349185	28408
2004	160277	316230	22468
2005	132280	283275	15984
2006	140906	250320	19758
2007	140228	217364	14118
2008	192033	184409	16507
2009	206042	151454	17445
2010	205709	118498	26679
2011	209150	85543	7205
2012	259135	85282	11536
2013	295264	85045	12574
2014	268002	84699	13301
2015	256690	84004	12943
2016	275162	83419	11901
2017	264034	82424	15117
2018	281243	81691	17260
2019	301436	81239	16417
2020	298182	80888	15323
2021	296783	77517	12278
2022	297915	77050	12958

Source: CBS, Processing: Ekonerg Ltd

Recalculation and improvements

There was no recalculation and other improvement.

6.7. Other waste (NFR 5.E)

Source category description

The source category Other waste (NFR 5.E) includes pollutant emissions from fires on road vehicles and fires on building structures, which include mostly unwanted fires on passenger cars and various types of building structures. The types of covered buildings are: detached houses, built and semi-built houses, buildings and industrial buildings.

Methodology, emission factors and activity data

The Tier 2 EMEP/EEA methodology and recommended Tier 2 emissions factor from GB2023 are used for emissions calculation.

Both the activity data and the emission factors are stratified according to the different activity. For car and house fires, the relevant activity statistics are the standard statistics on number of fires per year, collected by MI.

The activity data is presented in Table 6.7-1.

Table 6.7-1 Activity data for NFR code 5.E, represented by the relevant SNAP codes

NFR	5.E				
Name	Car fire	Detached house fire	Undetached house fire	Apartment building fire	Industrial building fire
SNAP	091009	091010	091011	091012	091013
Unit	fire	fire	fire	fire	fire
1990	306	1655	185	73	742
1991	278	1119	164	68	554
1992	294	2127	155	86	844
1993	291	1095	154	54	687
1994	383	1406	174	69	708
1995	484	1698	214	69	907
1996	487	1726	211	57	860
1997	474	1552	219	55	1030
1998	559	1645	187	54	1042
1999	576	1759	204	35	873
2000	639	1735	141	60	1031
2001	565	1616	150	47	999
2002	544	1527	130	48	922
2003	604	1723	152	60	1141
2004	562	1425	120	67	1011
2005	537	1444	146	37	1189
2006	542	1438	141	39	1189
2007	486	1357	141	33	1256
2008	484	1326	190	32	1061
2009	461	1239	134	41	1076
2010	415	1200	148	28	851
2011	415	1280	172	31	1116
2012	379	1261	132	24	1016
2013	353	1157	149	31	845
2014	314	767	89	19	626
2015	433	845	98	21	690
2016	439	854	99	22	697
2017	488	926	108	23	756
2018	487	782	91	20	639
2019	478	897	104	23	732
2020	421	825	96	21	673

NFR	5.E				
Name	Car fire	Detached house fire	Undetached house fire	Apartment building fire	Industrial building fire
SNAP	091009	091010	091011	091012	091013
Unit	fire	fire	fire	fire	fire
2021	419	816	95	21	667
2022	462	921	107	23	752

Source: MIA, Processing: Ekonerg Ltd

During the reporting period (1990 - 2022) there is a fluctuating trend of house and car fires. In 2022, the number of house and car fires increased by 10 - 13% compared to 2021.

Recalculation and improvements

There was no recalculation and other improvement.

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7. Natural sources (NFR 11)

7.1. Forest fires (NFR 11.B)

Source category description

Forest fires (NFR 11.B) are classified as natural source of emissions although they may be caused by the intentional or unintentional human activity. This source category presents data on activities from natural sources that cannot be controlled and therefore is not included in the national amount of emissions but are shown in the inventory under memo items.

Methodology, emission factors and activity data

For the emission calculation from source category 11.B, Tier 1 methodology and emission factors recommended by the GB2023 were applied. Croatia estimates the emission of SO_2, NOx, NMVOC, CO and NH_3 from this source category.

The emission of other pollutants (TSP, PM_{10}, $PM_{2.5}$, BC) will be calculated at the moment when the specific activity data kg wood burned proposed recommended by the GB2023 will be available.

Available activity data is area of forest burnt. The overview of activity data used for emission calculation from forest fire are presented in Table 7.1-1.

Table 7.1-1 Activity data of the sector 11.B – Forest fires

Year	Area of forest burnt, ha	Year	Area of forest burnt, ha	Year	Area of forest burnt, ha
1990	3805	2006	2987	2022	24226
1991	3805	2007	12628		
1992	964	2008	3449		
1993	8196	2009	2789		
1994	3723	2010	1944		
1995	633	2011	3277		
1996	2550	2012	5668		
1997	4025	2013	1999		
1998	10852	2014	191		
1999	4981	2015	6064		
2000	14661	2016	6733		
2001	1629	2017	48543		
2002	2919	2018	1506		
2003	13785	2019	2180		
2004	2889	2020	23994		
2005	629	2021	5995		

Data source: CBS, St.Y.

Recalculation and improvements

There was no recalculation.

7.2. Other natural sources – Animals (NFR 11.C)

The source category 11.C Other natural resources - Animals is included in the inventory of the Republic of Croatia for the first time for this submission.

Source category description

This source category includes emissions originating from wild-living animals. Emissions from the intestines and excreta are also included. Emissions from animal husbandry on farms (agriculture sector) or from pets, which are partly similar, but may be considered influenced by human behavior in many respects, are not covered. However, emissions from humans (breath, sweat, etc; excreta are dealt with in Chapter 5.D Wastewater Management) are included here, because they do not appear anywhere else and should be perceived differently to other anthropogenic emissions. This category presents data on activities from natural sources that cannot be controlled and therefore are not included in the national amount of emissions but are shown in the inventory under Memo items.

Methodology, emission factors and activity data

The calculation of ammonia emissions from category 11.C was performed using the EMEP/EEA Tier 1 methodology in accordance with GB2023. The Tier 1 methodology for category 11.C envisages the use of recommended emission factors. In addition to the recommended FEs, the approximate weights of the wild-living animals are listed, which according to the GB2023 instruction should be used for linear scaling of emissions for other species that are similar in weight to the one listed in the Table 8.1, p.6. GB2023. Based on the instructions, scaling was performed for each of the wild-living animal species recorded in the territory of the Republic of Croatia, and NH_3 emission factors were obtained, which were then used further in the calculation of NH_3 emissions for wild-living animals. The human FE is the recommended Tier 1 FE from GB2023. All FEs(NH_3) used are listed in Table 7.2-1 with the average weight of each species of the wild-living animal.

Table 7.2-1 Recommended emission factors for 11.C Other natural sources for the wild-living animals (recommended and scaled ones) and recommended emission factor for humans

Other natural sources		
Wild-living animals	**Assumed life weight, kg**	**FE (NH_3)**
Red deer	150	1.65
Fallow deers	60	0.66
Axis deer	70	0.77
Roe deer	20	0.27
Chamois	40	0.53
Moufflon	40	0.53
Bear	150	1.65
Wild boar	100	1.00
Rabbit	2	0.21
Fox	8	0.11
Pheasant	2	0.30
Other hairy wild-living animals	2	0.03
Wetland birds, various	1	0.15
Other feathered wild-living animals	1	0.15
Humans	-	0.05

The available activity data and their sources used for the emission calculation are:

- population of the Republic of Croatia for the period 1990 - 2022 (source: CBS, St.Y)
- number of the wild-living animals on 1 April for the period 2006-2022 (source: MP)

Missing data on number of the wild-living animals for the period 1990-2005 were estimated by the surrogate estimation method recommended by GB2023, if data for a longer period of time are missing.

The available surrogate data and their source are:

- hunting ground area in ha for the period 1992 to 2022 (source: CBS, database) i
- hunting of the wild-living animal by species for the period 1994 to 2022 (source: CBS, database).

The missing surrogate data were estimated by an expert estimate based on the mean value of the data for the selected period and the surrogate data in the nearest historical year to the missing years. Trends used surrogate data are listed in the document: "Report on inventory improvement for the sector other natural resources - wildlife and man (NFR 11.C)" (executor: Ekonerg, client MESD).

An overview of the activity data used to calculate ammonia emissions from wild-living animals and humans is shown in Tables 7.2-2 and 7.2-3.

Table 7.2-2 Activity data used to calculate NFR 11C emissions - Part 1

Year	Red deer	Fallow deers	Axis deer	Roe deer	Chamois	Moufflon	Bear	Wild boar
1990	3030	224	2	16278	407	979	474	4138
1991	3030	224	2	16278	407	979	474	4138
1992	3030	224	2	16278	407	979	474	4138
1993	3891	287	4	20897	532	1259	611	5312
1994	4024	298	4	21445	475	1144	548	3948
1995	2333	174	2	13988	362	854	411	2430
1996	1997	149	2	12160	351	845	411	2984
1997	2598	193	2	13353	430	1023	496	3602
1998	2272	168	2	14205	362	859	411	3833
1999	3407	251	2	16899	385	921	443	5536
2000	4630	342	4	20939	475	1117	538	6387
2001	5709	423	4	27714	486	1144	559	9108
2002	8062	597	7	29943	520	1241	601	10638
2003	6733	500	7	34232	543	1281	622	8989
2004	6820	505	7	36286	543	1290	622	10459
2005	6285	467	7	37433	520	1237	601	10485
2006	8955	1118	31	44948	792	1892	777	16785
2007	10689	1543	59	51603	999	2443	798	19887
2008	10248	1419	39	56702	847	2065	686	21153
2009	11843	1469	43	58891	996	2289	1025	23084
2010	14733	1438	43	68093	1093	2031	1008	24234
2011	13030	1658	9	61344	1148	2161	1000	24024
2012	12933	1912	42	61392	936	2285	1000	24251
2013	13967	2348	50	65305	1107	2289	1000	25982
2014	16400	3185	40	73330	1017	2420	1000	27384
2015	15139	2373	74	72070	1130	2187	1000	26791
2016	15730	2631	69	69892	1096	2201	1000	30234
2017	17000	2000	75	66000	1100	2130	1000	30000
2018	14957	1741	99	68478	1177	2132	1000	29807

Year	Red deer	Fallow deers	Axis deer	Roe deer	Chamois	Moufflon	Bear	Wild boar
2019	19348	2361	86	69808	1245	2593	1000	26522
2020	20154	2740	92	75848	1149	2695	1000	26201
2021	21122	2239	98	77346	1291	2700	1000	25732
2022	22025	2689	120	79862	1291	2636	1000	23923

Data source: wild animals: MP (2006-2022), Ekonerg (1990-2005) expert assessment, population: CBS, St.Y.

Table 7.2-3 Activity data used to calculate NFR 11C emissions - Part 2

Year	Rabbit	Fox	Pheasant	Other hairy wild-living animals	Wetland birds, various	Other feathered wild-living animals	Population
1990	38044	8287	108776	12645	20185	40601	4778000
1991	38044	8287	108776	12645	20185	40601	4513000
1992	38044	8287	108776	12645	20185	40601	4470000
1993	48842	10639	139649	16234	25916	52124	4641000
1994	61257	9647	125095	14719	32447	29173	4649000
1995	47644	7219	103412	11014	23434	14587	4669000
1996	34031	7143	138439	10899	21631	17828	4494000
1997	34031	8655	91736	13206	18026	29173	4572500
1998	27225	7250	90068	11060	10816	56726	4501000
1999	27225	7800	91736	11902	18026	66450	4554000
2000	30628	9438	98408	14402	14421	66450	4381000
2001	34031	9679	116755	14768	19828	72933	4305494
2002	40838	10493	131767	16010	23434	77795	4305384
2003	44241	10836	128431	16534	23434	72933	4305725
2004	51047	10918	130099	16660	25236	84278	4310861
2005	47644	10466	108416	15970	10816	74554	4312487
2006	62408	8105	59347	38117	26573	79471	4313530
2007	62997	8826	82018	32324	34655	104843	4311967
2008	75291	9342	157827	48818	45752	148125	4309796
2009	74054	11848	162640	44777	48957	220730	4302847
2010	81041	13473	153284	48732	50215	218543	4289857
2011	73970	12102	127426	35047	48708	256350	4280622
2012	70886	11967	147061	37725	49385	260243	4267558
2013	76200	13038	136206	39263	52431	262349	4255689
2014	82832	13727	138592	51155	63119	212073	4238389
2015	77867	12445	132608	44871	52149	177699	4203604
2016	74943	15531	129369	45321	53564	173159	4174349
2017	73000	14000	128000	45000	53000	170000	4124531
2018	66133	13037	76288	36937	36917	177576	4087843
2019	68660	14608	79314	41752	67570	222066	4065253
2020	73027	15781	82577	42316	120465	243740	4047680
2021	74848	15847	86245	48742	66636	247184	3878981
2022	78073	16485	93333	51898	72771	247255	3855641

Data source: wild animals: MP (2006-2022), Ekonerg (1990-2005) expert assessment, population: CBS, St.Y.

Recalculation and improvements

There was no recalculation.

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8. Recalculations and improvements

This chapter givesa summary of recalculations by sector, pollutant and year (subchater 8.1), planned improvements (subchater 8.2) and status of implementation of ERTs in-depth review recommendations (subchater 8.3). Additionally, in the Appendix 7 the impact of recalculation by pollutant, NFR/SNAP97 sector and year is presented for the historical trend, which shows the difference between latest and the previous submission, where a positive number indicates an increase in emissions and a negative number indicates a decrease.

8.1. Description and impact of recalculations on total inventory and trends

Recalculations are carried out annually due to the availability of new information, introduced sectoral improvements, implementation of higher tier (e.g. Tier 2), changing in methodology, due to identification of time series inconsistency, increase the accuracy of the estimates and reduce the uncertainty.

For this year's submission, the emissions of almost all pollutants were recalculated in the entire observed period 1990-2021. Appendix 7 shows the impact of the performed recalculations of emissions for 1990 - 2021 in relation to each pollutant and NFR / SNAP97 sector.

The impact of all performed recalculations on the total inventory and trends is shown in table 8.1-1. All recalculations, improvements and other activities that led to changes in emissions are shown in table 8.1-2.

Tablica 8.1-1 Impact of recalculations on the total emission per pollutant

Pollutant	Year of submission/ Differences	Unit	1990	1995	2000	2005	2010	2015	2020	2021
NOx	2024	kt	102.9	77.6	85.9	83.8	67.7	55.0	44.9	46.0
	2023	kt	104.8	79.2	88.3	86.5	69.5	54.5	46.1	46.1
	2024/2023	%	-1.8%	-2.1%	-2.7%	-3.2%	-2.6%	0.8%	-2.7%	-0.3%
NMVOC	2024	kt	173.9	119.8	104.1	113.5	91.0	70.5	69.2	69.2
	2023	kt	172.3	119.4	104.1	113.4	90.9	70.1	70.3	68.4
	2024/2023	%	0.9%	0.3%	0.0%	0.0%	0.1%	0.6%	-1.6%	1.2%
SO2	2024	kt	170.2	77.3	60.4	58.8	35.1	15.6	6.2	6.2
	2023	kt	170.1	77.3	60.4	58.7	35.0	15.6	6.1	5.6
	2024/2023	%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	0.6%	9.1%
NH3	2024	kt	50.5	38.0	39.0	39.7	35.4	30.4	31.1	31.1
	2023	kt	53.1	40.8	41.5	42.9	38.3	33.0	33.5	32.3
	2024/2023	%	-5.1%	-6.9%	-6.1%	-7.4%	-7.6%	-7.8%	-7.2%	-3.6%
PM2.5	2024	kt	39.9	37.7	35.6	43.4	38.3	32.2	27.8	27.8
	2023	kt	40.0	37.5	36.0	43.6	38.3	31.9	28.0	28.9
	2024/2023	%	-0.3%	0.5%	-1.1%	-0.6%	0.0%	1.2%	-0.7%	-4.1%
PM10	2024	kt	59.2	55.4	47.7	57.5	52.2	42.6	44.4	44.4
	2023	kt	59.3	52.3	49.7	57.5	51.3	39.8	46.3	42.8
	2024/2023	%	-0.1%	5.8%	-3.9%	0.0%	1.8%	7.2%	-4.1%	3.7%
TSP	2024	kt	93.3	91.1	73.1	86.7	80.5	60.8	77.6	77.6
	2023	kt	93.4	80.7	79.1	86.2	77.3	51.6	84.1	69.1
	2024/2023	%	-0.1%	12.9%	-7.6%	0.5%	4.2%	17.8%	-7.7%	12.4%
BC	2024	kt	5.5	5.1	5.3	6.2	5.4	4.5	3.7	3.7
	2023	kt	5.5	5.1	5.4	6.4	5.4	4.4	3.7	3.9
	2024/2023	%	-0.9%	-1.0%	-2.2%	-2.2%	-0.9%	1.8%	1.1%	-3.1%
CO	2024	kt	564.2	445.6	465.7	422.5	333.8	270.7	214.6	214.6
	2023	kt	571.2	449.7	471.6	426.7	335.7	269.7	217.4	228.7

Pollutant	Year of submission/ Differences	Unit	1990	1995	2000	2005	2010	2015	2020	2021
	2024/2023	%	-1.2%	-0.9%	-1.2%	-1.0%	-0.6%	0.4%	-1.3%	-6.1%
Pb	2024	t	528.7	263.5	146.3	15.4	10.0	10.0	7.5	7.5
	2023	t	527.6	262.4	144.8	13.7	8.2	7.9	5.5	6.3
	2024/2023	%	0.2%	0.4%	1.0%	12.3%	23.0%	27.0%	37.0%	18.6%
Cd	2024	t	1.2	0.9	0.9	1.2	1.0	0.9	0.8	0.8
	2023	t	1.2	0.9	0.9	1.2	1.0	0.9	0.8	0.8
	2024/2023	%	0.1%	0.3%	0.5%	0.5%	0.7%	0.9%	1.1%	-7.4%
Hg	2024	t	1.1	0.2	0.4	0.5	0.5	0.4	0.3	0.3
	2023	t	1.1	0.2	0.4	0.6	0.5	0.4	0.3	0.4
	2024/2023	%	-0.8%	-4.3%	-2.9%	-3.1%	-3.5%	-2.8%	-4.0%	-10.5%
As	2024	t	8.7	1.3	1.1	1.2	0.8	0.5	0.3	0.3
	2023	t	8.6	1.2	1.1	1.1	0.8	0.5	0.3	0.3
	2024/2023	%	0.1%	0.8%	1.4%	1.5%	2.3%	4.2%	7.5%	-4.6%
Cr	2024	t	5.7	4.1	3.8	4.4	3.3	2.9	2.6	2.6
	2023	t	5.3	3.7	3.2	3.7	2.6	2.2	1.9	2.0
	2024/2023	%	8.3%	10.6%	17.2%	17.2%	27.5%	35.3%	40.1%	31.6%
Cu	2024	t	16.9	14.9	19.7	23.6	23.9	24.9	26.4	26.4
	2023	t	7.3	6.2	7.5	9.5	8.3	8.2	9.7	9.8
	2024/2023	%	131.8%	140.9%	163.8%	147.9%	186.6%	203.6%	171.9%	168.2%
Ni	2024	t	17.1	13.9	12.7	13.8	7.8	4.6	2.4	2.4
	2023	t	17.0	13.8	12.6	13.7	7.7	4.5	2.3	2.5
	2024/2023	%	0.4%	0.4%	0.7%	0.7%	1.4%	2.5%	5.0%	-4.4%
Se	2024	t	0.5	0.3	0.3	0.4	0.4	0.3	0.3	0.3
	2023	t	0.5	0.3	0.3	0.4	0.4	0.3	0.3	0.4
	2024/2023	%	1.4%	1.9%	2.6%	2.3%	2.9%	3.4%	3.3%	-8.0%
Zn	2024	t	41.0	33.8	32.5	39.4	38.8	37.4	35.4	35.4
	2023	t	38.4	31.5	29.3	35.6	34.6	32.9	30.9	33.7
	2024/2023	%	6.6%	7.3%	11.0%	10.6%	12.1%	13.8%	14.4%	5.1%
PCDD/ PCDF	2024	g I-Teq	83.8	73.5	71.4	110.2	80.0	37.7	25.5	25.5
	2023	g I-Teq	89.0	78.8	78.0	116.8	82.1	39.6	25.5	27.4
	2024/2023	%	-5.9%	-6.7%	-8.3%	-5.6%	-2.5%	-4.8%	-0.2%	-6.8%
PAHs	2024	t	23.3	17.6	15.7	19.5	18.4	16.3	13.7	13.7
	2023	t	22.1	16.9	15.2	19.0	17.9	15.9	13.3	14.3
	2024/2023	%	5.8%	4.6%	3.6%	2.5%	2.9%	3.0%	2.6%	-4.7%
HCB	2024	kg	7.09	6.43	1.99	0.45	0.85	0.43	0.36	0.36
	2023	kg	7.09	6.43	1.99	0.45	0.85	0.43	0.36	0.33
	2024/2023	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.6%
PCBs	2024	kg	5.0	1.3	3.3	4.5	4.7	4.5	2.4	2.4
	2023	kg	5.0	1.3	3.3	4.5	4.7	4.5	2.4	3.1
	2024/2023	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-24.1%

Table 8.1-2 Improvements and other activity made in IIR 2024

NFR sector, Name	NFR sub-sector, Name	Description of improvements and other activity made
1.A Energy – fuel combustion	1.A.2.c Chemicals	For the series 2019-2021 the consumption of wood biomass was lacking, so it was added. The difference in emissions is negligible
1.A Energy – fuel combustion	1A2e Food, drink and tobacco	1A2e Fuel combustion in industry and construction: Food, drink and tobacco, an error was observed when entering liquid fuel in 2021 in the CollectER database, so it was corrected. The recalculation applied to all pollutants. Compared to last year's submission, emissions changed by about 1%
1.A Energy – fuel combustion	1.A.3.b. Road transport	Emissions were recalculated due to the transition to a new version of the COPERT model (5.7.2). In the COPERT database vehicles that are classified as light trucks with a load capacity above 3.5 t in the MUP's vehicle database are added. They have been added for the series from 2012 to 2021 in the Light duty vehicles in NII category. For the period from 2012 to 2021, electric vehicles were added to the database. Due to the aforementioned changes, the recalculations of the emissions of all reported pollutants have changed. Compared to last year's submission, emissions changed between 1% and 7% for all pollutants except heavy metals. In 2022, emissions are higher by over 100% in category 1A3bvi Tire and brake wear. The reason for such a large increase is, apart from the use of a new version of the COPERT model in which the FE has been revised and the inclusion of electric vehicles in the database.
1.A Energy – fuel combustion	1.A.2.g.vii Non-road mobile sources and machinery: Industry	Emissions were recalculated for the entire time series 1990-2020 due to changes in AD from the energy balance for the amount of fuel.
1.A Energy – fuel combustion	1.A.3.d.ii. National navigation (shipping)	Emissions of heavy metals for 2021 were recalculated due to AD corrections for lubricants, Emissions of all relevant pollutants for 2007 were recalculated due to AD corrections for diesel fuel in river transport.
1.A Energy – fuel combustion	1.A.4.b.i Residential	Emissions have been recalculated for the entire historical period due to the update of EFs in GB2023 for fossil fuels, i.e. natural gas, working gas, LPG (reduced level 1 FEs for As, Hg, and PCDD/F and PAHs have been removed from inventory), for solid fuels in boilers (reduced EFs of level 1 for Cd) and biomass - firewood (reduced FEs of level 2 for NH3).
1.B Fugitive emissions from fuel	NFR 1.B.2.a.iv Refining / storage	Emissions have been recalculated due to changes in factors according to the new GB 2023.
1.B Fugitive emissions from fuel	NFR 1.B.2.a.v Distribution of oil products	Emissions from 2017 until 2022 have been recalculated due to the implementation of emission control measures (VRU) when loading road tankers, rail tankers and marine tankers.
2 Industrial processes and product use	2.A.5.b Construction and demolition	Updating AD resulted in recalculation of $PM_{2.5}$, PM_{10} and TSP emissions for the whole time series.
2 Industrial processes and product use	2.D.3.h Printing	Recalculations of NMVOC emissions were made for the whole time series, due to the implementation of the Tier 2.
2 Industrial processes and product use	2.H.1 Pulp and paper industry	Recalculations were made for the whole time, due to the implementation of GB2023 EFs for SO_2, NOx, CO and TSP for neutral sulphite semi-chemical process and updated SO_2 EF for acid sulphite process.
3. Agriculture	3.B Manure management	NH_3 and NOx emissions for 2020 and 2021 were recalculated due to the transition to DZS data for farms of laying hens, fattening pigs and sows.

NFR sector, Name	NFR sub-sector, Name	Description of improvements and other activity made
3. Agriculture	3.D.a.2.a Organska gnojiva primijenjena na tlo	NH_3 and Nox emissions for the period 2019-2021 were recalculated due to EF corrections for fattening pigs and sows.
3. Agriculture	3.D.e Cultivated crops	Emissions for the period 20015-2021 were recalculated due to AD corrections for cropland area.
5 Waste	5.A Biological treatment of waste - solid waste disposal on land	PM emissions were recalculated for the period 1990 - 2012 due to new activity data on deposited waste. NMVOC emissions were recalculated for the period 1990 - 2021 due to the use of new country-specific emission factors for NMVOC for all years in the reporting period, based on CH_4 emissions estimated in the NIR report. CH_4 emissions estimated in the NIR report were recalculated for the entire reporting period, due to the use of the newly estimated values of the DOC parameter (degradable organic carbon) for municipal and industrial waste.
5 Waste	5.B.1 Biological treatment of waste - composting	Recalculation of NH_3 emissions from composting was carried out for the periods 2011 - 2012 and 2021 - 2022 due to the correction of data on the total annual mass of composted waste.
5 Waste	5.B.2 Biological treatment of waste - anaerobic digestion at biogas facilities	Recalculation of NH_3 emissions from anaerobic digestion at biogas facilities was carried out for the period 2013 - 2021 due to the correction of data on the total annual amount of N in feedstock.
5 Waste	5.C.1.b.i Industrial waste incineration	Recalculation of PCDD/F emissions from industrial waste incineration was carried out for the period 1990 - 2008 due to the use of new emission factor from GB2023.
5 Waste	5.C.1.b.iii Clinical waste incineration	Recalculation of NO_x, CO, SO_2, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, Cr, Cu, Ni, PCDD/F emissions from clinical waste incineration was carried out for the period 1990 - 2016 due to the use of new emission factors from GB2023.

8.2. Planned improvements

Planned improvements for the next or one of the next inventories are present in Table 8.2-1.

Table 8.2-1 Improvements planned for the next or one of the next inventory

NFR sector, Name	NFR sub-sector, Name	Improvements planned
1.A Energy – fuel combustion	1.A.2 Stationary combustion in manufacturing industries and construction	For NOx emission calculation, Croatia uses methodology disaggregated by fuel types (gas oil, fuel oil, natural gas, etc.) but not disaggregated by technology. As long-term goal, Croatia will estimate NOx emission by technology type.
1.A Energy – fuel combustion	1.A.1.a Public electricity and Heat production	As long term goal Croatia will take certain steps to justify the use of direct emissions for large point sources in the inventory.
1.A Energy – fuel combustion	1.A.4.b.i Residential	Further improvements in the quality and accuracy of collected data on biomass consumption activities in the residential sector are under consideration (Methodology and timeframe for future activities are under consideration, more systematic approach and improvement of the data collection system, application of regular frequency of conducting surveys with a previously established QA/QC system and the experiences of other member states are in the evaluation phase).
1.A Energy – fuel combustion	1.A.3.a Aviation (civil)	To switch to the calculation according to the methodology from GB2023 for the calculation of emissions from air transport, it is necessary to determine a representative aircraft. For this, it is necessary to collect and process more detailed data on aircraft and their movements in all airports in Croatia.

NFR sector, Name	NFR sub-sector, Name	Improvements planned
		This improvement is a TERT recommendation and it is included in the data collection program and will be implemented when the Ministry secures funds to align with the GB2023 methodology because due to the complexity of the work, this activity (improvement) cannot be carried out within the scope of activity for the annual inventory. Croatia has so far collected some incomplete data for the entire time series. The project of collecting and supplementing the missing data for the implementation of the methodology from GB2023, instead of the used methodology from GB2013, is planned for the next or one of the following submissions.
2 Industrial processes and product use	2.A.3 Glass production	Currently, both glass which is nationally produced and glass, which is imported and then processed in Croatia, is being included in calculations as nationally produced glass products, due to unavailability of disaggregated statistical data. Revision of applied method for emission calculation in line with specific national circumstances should be made to avoid overestimation of emissions for this category. At the moment, this matter is categorised as a long term plan for improvement, provided the required financial resources are made available.
2 Industrial processes and product use	2.D.3.d Coating applications	Croatia currently does not have sufficient data that would enable transition to the Tier 2. It is planned to further investigate this category and possibly available substitute data. After determining the most accurate approach, an improvement of emissions estimate will be implemented, which is planned for one of the next submissions.
3.Agriculture	3.B Manue management	Ammonia mitigation measures for cattle are planned to be included in the emission calculations. For this purpose, it is necessary to collect additional data on livestock housing and on methods of storage and application of manure on cattle farms, considering that data for cattle farms are not currently available. This improvement is planned for one of the following submisions.
3. Agriculture	3.D.1.a Mineral N-fertilizers	It is planned to include measures to reduce ammonia emissions in the calculation of ammonia emissions from the application of mineral N-fertilizers (namely urea and urea-based mineral fertilizers). For this purpose, it is necessary to collect data on the proportion of urea and other urea-based mineral fertilizers that are plowed into the soil during application. This improvement will be planned for one of the following inventories.
3. Agriculture	3.D.a.2.a Organic fertilizers applied to soils	According to the recommendation of TERT, it is planned to calculate NMHOS emissions from this sector. Currently, NMHOS emissions from sector 3.D.a.2.a are included in the emissions from sector 3.B. This improvement will be carried out when the Ministry secures the funds for the implementation, because due to the complexity of the work, this activity (improvement) cannot be carried out within the scope of activity for the annual inventory
3. Agriculture	3.D.a.2.c Other organic fertilizers applied to soils	According to the recommendation of TERT, it is planned to calculate all emissions from this sector, given that they are not reported for the time being due to lack of data. This improvement will be implemented when the Ministry secures the funds for the implementation, in one of the following submissions.
3. Agriculture	3.D.a.3. Urine and dung deposited by grazing animals	According to the recommendation of TERT, it is planned to calculate NMHOS emissions from this sector. Currently,

NFR sector, Name	NFR sub-sector, Name	Improvements planned
		NMHOS emissions from sector 3.D.a.3. are included in the emissions from sector 3.B. This improvement will be carried out when the Ministry secures the funds for the implementation, because due to the complexity of the work, this activity (improvement) cannot be carried out within the scope of activity for the annual inventory.
5 Waste	5.D.1 Domestic wastewater handling - latrines	Accuracy and completeness of activity data will be further improved by including data on the number of residents who use latrines from the 2021 Census (Census of Population, Households and Dwellings 2021, Dwellings by Occupancy Status), when it will be available. At the time the Report was prepared, the CBS confirmed that the data was not yet available.

8.3. Status of implementation of TERT and ERT in-depth review recommendations

For the Republic of Croatia, none of the two in-depth reviews of the emissions inventory NECD inventory review 2023 and Stage 3 inventory review 2023 UNECE CLRTAP was carried out in 2023 because the inventory was not submitted within the prescribed deadline.

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9. Projections

The preparation and submission of emission projections according to the Gothenburg Protocol is required every 4 years starting from 2015, and according to the NECD every 2 years starting from 2017. The year 2023 was the mandatory year for the preparation and submission of emission projections with a reporting deadline of March 15 (according to Table 3, Annex I of the NEC Regulation). The Republic of Croatia did not fulfill the obligation within the given deadline.

The Republic of Croatia has an obligation to reduce emissions for five (i.e six) pollutants: SO_2, NOx, NMVOC, NH_3, $PM_{2.5}$ (and if available BC) according to the Directive on the reduction of national emissions (Directive (EU) 2016/2284), hereinafter referred to as the NECD and the amended Gothenburg Protocol[45] to the UNECE Convention on Long-Range Transboundary Air Pollution (hereinafter referred to as the LRTAP Convention). Projections of emissions are made and reported on, in order to enable comparison with these obligations. The NECD has been transposed into national legislation through the NEC Regulation.

Annex I of the NEC Directive 2001/81/EC establishes the emission ceilings for certain atmospheric pollutants. Until 2010, member states had to limit their annual national emissions of these pollutants to an amount that did not exceed these emission ceilings. Directive 2001/81/EC was superseded by the revised NEC Directive and the amended GP[46] (for those countries that have accepted[47] it, among which is the Republic of Croatia). Obligations to reduce emissions from 2020 onwards are listed in Annex II of the revised NEC Directive (EU) 2016/2284 and in Annex II of the revised GP (tables 1.1-3 and 1.1-4).

These projections are made in accordance with Article 13 of the NEC Regulation using the methodologies adopted under the LRTAP Convention and in particular the EMEP Reporting Guidelines[48] and best practices presented in the EMEP/EEA Guidebook (GB2019) in Chapter 8 Projections.

Projections are reported in accordance[49] with Annex II and IV of the EMEP Reporting Guidelines as follows Annex II: Recommended structure for the Informative Inventory Report: Chapter 9: Projections (revised in 2021) and Annex IV: Projections reporting template (from 2014).

Projections of emissions are prepared for the scenario "with existing measures" (hereinafter: WM) and the scenario "with additional measures" (hereinafter: WAM) taking into account the definition of the scenario "without measures" (WOM). At the same time, the WM scenario is based on the application of valid policies and measures (hereinafter: PaM), the implementation of which is already underway, i.e. the application of PaM that have been adopted, while the WAM scenario is based on the application of planned PaM, i.e. PaM that have not yet been adopted.

The projections were made for the period 2020 - 2050 on an annual basis, with a step every 5 years until 2030 and every 10 years until 2050.

[45] The Gothenburg Protocol along with the LRTAP Convention is implemented in the EU through two instruments: National Emission Ceilings (NEC) and the Medium Combustion Plants directive). See the web link: https://www.ceip.at/reporting-instructions for information on budget reporting and emission data reporting requirements under the LRTAP Convention.

[46] The amended Gothenburg Protocol entered into force on 7 October 2019 and is currently accepted by 26 parties.

[47] https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-1-k&chapter=27&clang=_en

[48] EB Decisions: ECE/EB.AIR/122/Add.1, 2013/3 i 2013/4). 2014 Reporting Guidelines - Annex IV of the revised Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR.125).

[49] It is listed in accordance with Article 8 (1) and (5) and the requirements listed in Table C of Annex I and Part 2 of Annex IV of the NECD.

9.1. Methodology and basic model interface

Air pollutant emission projections for the Republic of Croatia have been prepared in accordance with the EMEP/EEA Guidebook. As a starting point, they take the latest reported historical time series (Croatian IIR 2022), where 2020 is the starting point, i.e. the last historical year. This ensured their coherence with the historical sequence (Lit. 19). The years for which projections of emissions of certain air pollutants were made are: 2025, 2030, 2040 and 2050.

Two scenarios were modeled: WM "with existing measures" which includes all measures implemented until the end of 2020 and WAM "with additional measures" which includes planned policies and measures defined in national energy and climate strategic and planning documents:

- Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 63/2021),
- Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 25/2020),
- Integrated national energy and climate plan for the Republic of Croatia for the period from 2021 to 2030, Ministry of Economy and Sustainable Development, 2020,
- Air pollution control program for the period from 2020 to 2029 (OG 90/2019),
- Waste Management Strategy of the Republic of Croatia (OG 130/2005),
- Waste Management Plan of the Republic of Croatia for the period 2017 - 2022 (OG 3/2017, 1/2022).

The Low-Carbon Sevelopment Strategy does not include the possible long-term effects of the COVID-19 pandemic, which appeared in 2020, as well as the impact and consequences of Russia's aggression against Ukraine in economic and energy terms.

Information on national policies and measures included in the scenarios is presented in Lit. 20 and 34. Measures to reduce emissions of greenhouse gases and air pollutants are identified and considered in the scenarios. There is a strong interaction between measures for greenhouse gas emissions and measures for air pollutants that have an impact on several sectors (cross-sectoral measures) or target specific sectors and form the basis for air pollutant projections.

The projections of air pollutants are consistent with the projections of greenhouse gas emissions reported in 2023 according to Regulation (EU) 2018/1999 2018 on the governance of the Energy Union and Climate Action (Lit. 20 - 23).

When preparing projections of emissions of air pollutants of the Republic of Croatia, Tier 1 and 2 models were applied in accordance with the EMEP/EEA Guidebook, depending on the importance of individual sectors for the emission of individual pollutants. Models of both tiers are implemented through the basic model interface "LEAP".

Tier 2 models included sector-specific future data on activity and, if necessary, the inclusion of future emission factors depending on the sector (and pollutant). In this sense, Tier 2 models include the stratification of the observed NFR categories at sub-activity (SNAP level) or even at the level of a large point source (LPS, which are also the most detailed levels of emission sources), which enables the application of specific future emission factors of a particular pollutant.

In the WM and WAM scenarios, PaM is also included to reduce emissions from the source and increase the removals of greenhouse gases. To determine the contribution of each individual PaM to emission reduction, the reduction potential was determined. In cases where the emission reduction potential of an individual PaM cannot be expressed separately, it is expressed as a

PaM package. All PaM used in the creation of air pollutant projections are listed and described in Lit. 20 and 34.

Basic model interface

The basic model interface used to create projections is “LEAP” (Low Emissions Analysis Platform). The LEAP model stores data for the last historical year (X-3), namely all sectoral activity data and emission factors up to SNAP and the corresponding NFR level and the level of large point sources (LPS) for the year 2020 and for future years. LEAP was used as a framework for the integration of sectoral projections and thus included input data from other sectoral models such as: MAED, MESSAGE, COPERT and engineering simulation models performed in the calculation interface for the sectors industrial processes and product use, agriculture, waste and residential. The results of these sectoral models are integrated into the LEAP model and are structured in accordance with the tabular structure of the GHG and pollutants emissions inventories in accordance with, as follows, UNFCCC (2006 IPPC Guidelines) and UNECE CLRTAP (GB2019). The models are of the "bottom-up" type, since they are based on sectoral data and individual emission sources, and the emissions of CO_2, CH_4, N_2O, HFC, PFC and SF_6 from greenhouse gases and SO_2, NOx, NMHOS, NH_3, $PM_{2,5}$ and BC from air pollutants. The structure and detail of the LEAP model has been upgraded with the necessary CRF and NFR categories for the purposes of preparing the projections of the Republic of Croatia, which are based on the most detailed SNAP and LPS levels. In this way, the LEAP model is used for projections of greenhouse gas emissions (CRF categories) and projections of air pollutant emissions (NFR categories). In LEAP, the same initial assumptions and activity data, according to both UNFCCC and CLRTAP conventions, were used to connect with the associated emission factors.

The process of preparing emission projections

Projections of air pollutant emissions are made in a five-step process that is described in detail in Lit. 34:

- Step 1: setting up a general modeling framework,
- Step 2: modeling of sectors, policies and measures,
- Step 3: calibration of the last historical year,
- Step 4: emissions estimations,
- Step 5: assessment of goals, policies and measures.

Assumptions

Assumptions, or parameters, for the creation of projections have largely remained unchanged, since in the period since the creation of the past projections, they were not updated by the national energy and climate strategic and planning documents (listed at the beginning of this section). However, there was a correction in the trend projections of the number of animals, namely poultry (broilers, laying hens and turkeys) due to the adjustment of the trend projections of input activity data for livestock production from the global FAO report[50] "*The Future of Food and Agriculture - Alternative Pathways to 2050"*.

[50] FAO. 2018. The future of food and agriculture – Alternative pathways to 2050. Rome. 224 pp. Licence: CC BY-NC-SA 3.0 IGO

Macroeconomic assumptions and policies and measures considered in the scenarios are outlined and defined in a step-by-step manner in accordance with different approaches and assumptions. The resulting calculations of emissions, both for greenhouse gases and air pollutants, were then evaluated with regard to the goals set for Croatia for 2030. The pre-set framework for preparing projections of GHG emissions and air pollutants defined by the national legislation does not provide the possibility for additional intervention in terms of alignment with the goals for 2030 in view of the NEC Directive.

9.2. Overview of used parameters, models and assumptions by sector

An overview of the parameters used to create projections of greenhouse gas emissions and projections of pollutant emissions and their sources are listed in Table 9.2-1.

Table 9.2-1. Parameters and their sources used to create projections by type and sector

General parameters / CRF / NFR sector	Data type	Data source
General parameters, intersectoral	GDP – yearly growth rate Population Coal price Fuel oil price Natural gas price Degree-day of heating	Integrated Energy-Climate Plan of the Republic of Croatia for the period from 2021 to 2030 Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 25/2020) Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 63/2021)
Energy	Fuel consumption Electricity generation Electricity imports Final energy demand	National energy balance Integrated Energy-Climate Plan of the Republic of Croatia for the period from 2021 to 2030 Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 25/2020)
Transport	Number of passenger kilometres Number of tonne-kilometres Energy demand in transport sector	ODYSSEE database Integrated Energy-Climate Plan of the Republic of Croatia for the period from 2021 to 2030 Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 25/2020)
Industrial processes and product use	Production index	Sectorial studies (cement, use of N_2O in the food industry and for medical purposes) National Bureau of Statistics Integrated Energy-Climate Plan of the Republic of Croatia for the period from 2021 to 2030 Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 63/2021)
	Use of solvents	Inventory Report of air pollutants on the Croatian territory under the Convention on Long-range Transboundary Air Pollution (CLRTAP)

General parameters / CRF / NFR sector	Data type	Data source
		Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 63/2021)
Agriculture	Number and type of livestock	National Bureau of Statistics Croatian Agricultural Agency Faculty of Agriculture FAOSTAT database
	Plant production	National Bureau of Statistics Statistical reports on plant production FAOSTAT database
Waste	The amount of generated solid waste (municipal, industrial, sludge from wastewater treatment) The amount of landfilled solid waste (municipal, industrial, sludge from wastewater treatment) The organic fraction of solid waste Share of methane recovered/flared The amount of composted organic waste	Law on Waste Management (OG 84/2021) Waste Management Plan of the Republic of Croatia for the period 2017 – 2022 (OG 3/2017, 1/2022) Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 63/2021) Ministry of Economy and Sustainable Development: - Waste Management Information System - Environmental Pollution Register

An overview of the general macroeconomic parameters used is given in Table 9.2-2.

Table 9.2-2. Projection parameters - general parameters

Parameter		2020.	2025.	2030.	2035.	2040.	2045.	2050.
GDP	mlrd. EUR (EC16)	46.3	51.6	57.5	62.9	68.7	74.8	81.3
Population	mil. stan.	3.984	3.834	3.755	3.648	3.532	3.413	3.295
Coal prices	EUR/t	6.4	7.9	8.6	9.1	9.6	10.1	10.6
Heavy Fuel Oil prices	EUR/barrel	62	83	94	103	111	119	127
Gas prices	EUR/Mbtu	70	77	80	81	82	83	84

9.2.1. Energy (stationary, mobile and fugitive emissions)

For the Energy sector (stationary, mobile and fugitive emissions), important strategies and plans include the Low Carbon Development Strategy, the Energy Development Strategy, the Long-Term Strategy for the Restoration of the National Building Fund until 2050 (OG 140/2020), the Integrated National Energy and Climate Plan, the Air Pollution Control Program and the existing legislative framework, which is listed below.

A number of programs in the field of energy efficiency were adopted: Program for using the potential for efficiency in heating and cooling for the period 2016-2030, Program for the development of circular management of space and buildings for the period from 2021 to 2030 (OG 143/2021), Program combating energy poverty, which includes the use of renewable energy sources in residential buildings in subsidized areas and areas of special state care for the period up to 2025 (OG 143/2021), Program for the Development of Green Infrastructure in Urban Areas for the Period from 2021 to 2030 (OG 147/2021) and programs related to energy renovation of buildings: Program for energy renovation of multi-apartment buildings for the period until 2030 (OG 143/2021), Program for energy renovation of buildings that have the status of cultural property for the period until 2030 (OG 143/2021), Program for energy renovation of public sector buildings for the period up to 2030 (OG 41/2022).

The requirements of Directive 2009/125/EC of the European Parliament and the Council of October 21, 2009 on the establishment of a framework for setting out the ecodesign requirements for energy-related products and its implementing regulation (Commission Regulation (EU) 2015/1185 of 24 April 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for solid fuel local space heaters (OJ L 193, 21.7.2015) (application from January 1, 2022) and Commission Regulation (EU) 2015/1189 of 28 April 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for solid fuel boilers (OJ L 193, 21.7. 2015) (application from January 1, 2020)) which are directly applicable for all member states, and for the Republic of Croatia on the day of entry into the EU. Furthermore, the requirements of the eco-design emission standards affect the emission factors of NOx, NMVOC, CO and $PM_{2.5}$ for new heating system installations.

The WM scenario includes measures to reduce greenhouse gas emissions resulting from existing regulations and the transfer of the EU acquis. The WAM scenario is based on the application of existing and additional measures. This scenario is equivalent to scenario S2 from Integrated National Energy and Climate Plan. For some objectives in the Plan, the instruments have not yet been determined, but it is expected that they will be through subsequent implementation documents.

In preparing the projections, a software packages MAED (Model for Analysis of Energy Demand) and MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) were used, in which was created a model of the energy sector in Croatia. For the needs of detailed modelling of the development and optimization of the power sector, a more advanced model was used, whose results were the inputs for the integrated energy model. The output data of the model are structured in accordance with the emission inventory structure according to: the United Nations Framework Convention on Climate Change (CRF structure) and the UNECE LRTAP convention (NFR structure) and are thus integrated into the basic model interface. It is an engineering simulation model in which scenarios are simulated and certain processes and decisions are optimized with regard to assumptions and limitations. The model is detailed, down to the level of individual production units, existing and future. In addition, a model for biomass combustion in residetial (NFR 1A4bi) was used, which was performed in the calculation interface, and the COPERT model, the results of which were integrated into the basic model interface. More information about the models can be found in Lit. 34.

Assumptions and models used to create emission projections for the WM scenario "with existing measures" and the WAM scenario "with additional measures" for the energy sector and for direct consumption and energy transformations are presented in Table 9.2-3.

Table 9.2-3 Assumptions and models for projections - Energy (stationary and mobile)

ENERGY (STATIONARY AND MOBILE)
Final energy demand
Final energy demand is projected in different sectors - industry, transport, services, households and agriculture, fisheries and forestry. The bases for projections of activities are national macroeconomic parameters. For the

projections of energy intensities, development of technology and changing of lifestyles was taken into account. The WM and WAM scenarios modelled the impacts of each measure.

The analyses were performed by sub-sectors:

- Industry - by industry and type of fuel used,
- Transport – by type of transport (road, air, marine and rail) and types of means of transport (cars, buses, motorcycles, light and heavy vans) or purpose (passenger and freight) and by type of technology and fuel used,
- Services – by branches (tourism, trade, education, health), climatic zone (coastal or continental Croatia), purpose (heating, water heating, cooking, cooling, electrical appliances and lighting), type of fuel used, heating demand is modelled on the level of useful and final energy,
- Residetial – by climatic zone (coastal or continental Croatia), purpose (heating, water heating, cooking, cooling, electrical appliances and lighting) and by type of fuel, heating demand is modelled on the level of useful and final energy,
- Agriculture, fisheries and forestry - by type of fuel.

Demographic trends – assumes a scenario of average fertility and average migration, in accordance with the population projections made for the purposes of developing the Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG 25/2020).

In the **WM scenario,** in the period until 2050, the development was simulated in accordance with the existing policy and measures and market development:

- market-driven improvements in energy efficiency and fuel switches in the industrial sector;
- renovation of 0.75% surface of the buildings annually to the nearly Zero Energy Building standard (includes the use of renewable energy);
- penetration of electric and hybrid vehicles with the share in total passenger activity in 2030 2.5% and in 2050 30%;
- it is assumed that there will be a stagnation in the use of rail and inland waterways transport for the transport of goods and most of the vehicles will be N2 and N3 category with diesel engines.

In the model for biomass combustion in the residential, for the WM scenario, the inflow dynamics of biomass combustion technologies until 2050 are assumed. It is assumed that the replacement of old biomass combustion technologies with higher $PM_{2.5}$ emissions will be a total of 20% by 2030, with a step of 2.9% per year of the defined percentages in 2020 (2021 - 2029). At the same time, in order to reach the total share of all technologies of 100%, new technologies with lower $PM_{2.5}$ emissions each grow with a step of 4.88% per year from the shares defined for 2020. In the period 2031 - 2050, stable shares expected for 2030, due to the big uncertainty of future economic and political developments.

Technology for biomass combustion		Last historic year	Inflow dynamics, WM scenario			
		2020	2025	2030	2040	2050
Old	Open stoves, fireplaces	9.6%	8.2%	6.9%	6.9%	6.9%
	Boilers < 50 kW	16.9%	14.5%	12.1%	12.1%	12.1%
	Closed conventional stoves	32.9%	28.3%	23.7%	23.7%	23.7%
New	Advanced / ecolabelled stoves and boilers	13.3%	16.0%	18.7%	18.7%	18.7%
	High-efficiency stoves	23.2%	27.9%	32.7%	32.7%	32.7%
	Pellet stoves and boilers	4.2%	5.1%	5.9%	5.9%	5.9%

In the **WAM scenario** follows the continuation of support to energy efficiency after 2020, with the following key assumptions:

- renovation of 1.3% of the buildings annually to the nearly-zero energy standard (include the use of renewable sources);
- support for the development of the share of electric vehicles to 3.5% in 2030 and 65% of the passenger road transport in 2050;
- support for the purchasing of the new electric and hybrid vehicles until the share of 1% in the total number of vehicles;
- intermodal shift with the goal to increase the share of the transport of goods to rails (electric locomotives) to 30% until 2050;
- in urban passenger transport, electrification of almost 85% of the entire passenger activity is expected by 2050;
- improvements in energy efficiency in the industry together with fuel switch towards the use of renewable energy and electricity.

In the model for biomass combustion in the residential, for the WAM scenario, the inflow dynamics of biomass combustion technologies until 2050 are assumed. A more intensive replacement of old technologies is expected for a total of 41.7% by 2030, and for 6.386% (open stoves and fireplaces), 5.01% (boilers) and 6.478% (closed conventional stoves) with steps as follows: -0.64%, -0.89% and -2.25% per year of the defined percentages in 2020 (2021 – 2029). At the same time, in order to reach the total share of all technologies of 100%, new technologies grow by: 15.557% (advanced/eco-labeled stoves and boilers), 2.025% (high efficiency stoves and boilers) and 37.88% (Pellet stoves and boilers) from 2021 to 2030 with the following steps: 1.89%, 0.43% and 1.47% per year of the shares defined for 2020. In the period 2031 - 2050, stable shares are expected for 2030, due to the big uncertainty of future economic and political developments.

Technology for biomass combustion		Last historic year	Inflow dynamics, WM scenario			
		2020	2025	2020	2025	2020
Old	Open stoves, fireplaces	8.9%	6.0%	3.0%	3.0%	3.0%
	Boilers < 50 kW	16.2%	12.1%	8.0%	8.0%	8.0%
	Closed conventional stoves	30.7%	20.3%	10.0%	10.0%	10.0%
New	Advanced / ecolabelled stoves and boilers	15.6%	24.3%	33.0%	33.0%	33.0%
	High-efficiency stoves	22.1%	24.0%	26.0%	26.0%	26.0%
	Pellet stoves and boilers	6.6%	13.3%	20.0%	20.0%	20.0%

Energy transformations and resources

The power system was analysed by the simulation of market development with the software for the hourly optimization of operation and development of the power system. The price of the emission allowances in the EU ETS was assumed as in the EU Reference scenario 2016.

The simulation of the operation of the refineries was done to satisfy the domestic demand as possible with the existing capacities, which mean without building new refineries and reducing production in WM and WAM scenarios.

In the **WM and WAM scenarios**, the assumptions are as follows, with the fact that in the case of the WAM scenario, the assumptions include the constant development of the policy to encourage renewable energy sources even after 2020:

- for the post-2020 period, the simulation of the market development with the software for the long-term development and operation of the power system was done based on the principle of cost minimization or ideal market conditions. The model included part of the district heating system in the area of big cities with CHP plants;
- the price of the emission allowances in the EU ETS was assumed as in the EU Reference scenario 2016;
- the analysis showed that renewable energy sources will be competent to a certain extent without the need of the public support for the solar PV system and wind;
- the analysis shows that new coal-fired power plants are not competitive due to the increase in the price of emission permits and the reduction of investment costs in renewable energy sources;
- a gradual decrease in net imports of electricity.

Sources: Lit. 20, 21, 34

The parameters used for the Energy sector for the WM scenario "with existing measures" are shown in tables 9.2-4 to 9.2-7, while the parameters for the WAM scenario "with additional measures" are shown in tables 9.2-8 to 9.2-11, and refer to: total energy consumption, total electricity generation, final energy consumption, transport and climate

Table 9.2-4 Projection parameters WM scenario – energy: total fuel consumption and electricity production

Parameter		2020	2025	2030	2035	2040	2045	2050
Total energy consumption								
Coal and coke	kten	361,2	56,91	54,6	48,6	42,5	36,4	30,3
Liquid petroleum fuels	kten	2,779.9	2,646.4	2,786.1	2,519.6	2,253.8	1,953.1	1,653.1
Gas	kten	2,534.0	1,053.5	1,152.7	1,193.9	1,235.1	1,262.1	1,289.1
Renewable	kten	3,160.6	1,248.2	1,316.1	1,334.0	1,363.9	1,237.0	1,110.2
Other	kten	437.9	24.8	10.6	10.3	10.0	9.0	8.1
Total	kten	9,273.6	6,778.3	7,111.1	6,958.4	6,805.8	6,445.8	6,085.7
Total electricity generation								
Coal	TWh	1.55	1.27	0.98	0.50	0.01	0.01	0.01
Liquid petroleum fuels	TWh	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Gas	TWh	2.40	2.49	2.59	3.22	3.85	3.88	3.91
Renewable	TWh	9.20	10.98	12.76	14.49	16.22	17.86	19.50
Nuclear	TWh	NO	NO	NO	NO	NO	NO	NO
Other	TWh	NO	NO	NO	NO	NO	NO	NO
Total	TWh	13.19	14.78	16.38	18.25	20.12	21.79	23.47

Table 9.2-5 Parameters on projections, WM scenario – Energy sector: final energy consumption

Parameter		2020	2025	2030	2035	2040	2045	2050
Final energy consumption								
Industry	kten	1,193.7	1,190.5	1,187.2	1,170.2	1,153.3	1,116.5	1,079.7
Transport	kten	2,012.1	2,165.9	2,319.7	2,254.7	2,189.6	2,029.9	1,870.2
Households	kten	2,284.7	2,369.6	2,454.5	2,364.3	2,274.1	2,128.9	1,983.8
Agriculture, forestry and fisheries	kten	247.5	223.1	198.8	193.5	188.2	179.8	171.5
Services	kten	749.2	850.0	950.9	975.9	1,000.9	998.7	996.5
Other	kten	NA	NA	NA	NA	NA	NA	NA
Total	kten	6,445.4	6,778.3	7,111.1	6,958.4	6,805.8	6,445.8	6,085.7

Table 9.2-6 Parameters on projections, WM scenario – transport

Parameter		2020	2025	2030	2035	2040	2045	2050
Number of passenger kilometres, all modes	10^9 pkm	40.0	41.4	43.2	44.0	44.5	46.2	47.3
Transport of goods	10^9 tkm	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Energy consumption in road transport	ktoe	2,012.1	2,165.9	2,319.7	2,254.7	2,189.6	2,029.9	1,870.2

Table 9.2-7 Parameters on projections, WM scenario – climate

Parameter	2020	2025	2030	2035	2040	2045	2050
Number of heating degree days	2,288	2,261	2,235	2,208	2,181	2,156	2,131

Table 9.2-8 Projection parameters WAM scenario – energy: total fuel consumption and electricity production

Parameter		2020	2025	2030	2035	2040	2045	2050
Total energy consumption								
Coal and coke	kten	361.2	56.0	52.8	45.5	38.2	31.1	24.0
Liquid petroleum fuels	kten	2,779.9	2,553.7	2,600.6	2,341.5	2,082.4	1,674.6	1,266.8
Gas	kten	2,534.0	988.7	1,023.2	1,004.6	986.0	937.2	888.5
Renewable	kten	3,160.6	1,279.7	1,379.2	1,338.1	1,297.0	1,163.9	1,030.9
Other	kten	437.9	24.8	10.6	10.3	10.0	9.0	8.1
Total	kten	9,273.6	6,649.9	6,854.3	6,594.6	6,334.9	5,855.1	5,375.3
Total electricity generation								
Coal	TWh	1.55	1.15	0.75	0.38	0.01	0.01	0.01
Liquid petroleum fuels	TWh	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Gas	TWh	2.40	2.51	2.62	2.65	2.69	3.19	3.69
Renewable	TWh	9.20	11.21	13.23	15.45	17.66	19.75	21.83
Nuclear	TWh	NO	NO	NO	NO	NO	NO	NO
Other	TWh	NO	NO	NO	NO	NO	NO	NO
Total	TWh	13.19	14.91	16.64	18.52	20.40	22.98	25.57

Tablica 9.2-9 Parameters on projections, WAM scenario – Energy sector: final energy consumption

Parameter		2020	2025	2030	2035	2040	2045	2050
Final energy consumption								
Industry	kten	1,193.7	1,189.1	1,184.5	1,164.9	1,145.2	1,106.2	1,067.2
Transport	kten	2,012.1	2,112.4	2,212.8	2,133.7	2,054.7	1,844.7	1,634.7
Households	kten	2,284.7	2,303.2	2,321.7	2,161.9	2,002.1	1,820.2	1,638.4
Agriculture, forestry and fisheries	kten	247.5	223.1	198.7	193.4	188.1	179.7	171.4
Services	kten	749.2	842.9	936.5	940.8	945.0	912.3	879.6
Other	kten	NA	NA	NA	NA	NA	NA	NA
Total	kten	6,445.4	6,778.3	7,111.1	6,958.4	6,805.8	6,445.8	6,085.7

Table 9.2-10 Parameters on projections, WAM scenario – transport

Parameter		2020	2025	2030	2035	2040	2045	2050
Number of passenger kilometres, all modes	10^9 pkm	40.0	41.4	43.2	44.0	44.5	46.2	47.3
Transport of goods	10^9 tkm	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Energy consumption in road transport	kten	2,012.1	2,112.4	2,212.8	2,133.7	2,054.7	1,844.7	1,634.7

Table 9.2-11 Parameters on projections, WAM scenario – climate

Parameter	2020	2025	2030	2035	2040	2045	2050
Number of heating degree days	2,288	2,261	2,235	2,208	2,181	2,156	2,131

9.2.2. Industrial proceses and product use

For the Industrial Processes and Product Use sector, important strategies and plans include the Low Carbon Development Strategy and the Integrated National Energy and Climate Plan, as well as the existing legislative framework presented below.

The Croatian Air Protection Act (OG 127/19, 57/22) and the Regulation on Limit Values of the Content of Volatile Organic Compounds in Certain Paints and Varnishes Used in Construction and Vehicle Finishing Products (OG 86/21) take over the EU Directive on decorative paints 2004/42/EC, which limits the content of solvents in paints and varnishes, as well as vehicle finishing products in order to reduce emissions of volatile organic compounds (hereinafter: VOC). This Regulation (OG 86/21) also transposes the Industrial Emissions Directive 2010/79/EU regarding economic activities with the relevant use of solvents, which the Regulation on Limit Values of Air Pollutant Emissions from Stationary Sources (OG 42/21) takes over. Installations must comply with the limit values of pollutant emissions into the air from stationary sources and with VOC emission limits or create a VOC emission reduction plan. Furthermore, all plants with an annual use of solvents above a certain threshold are obliged to submit to the competent authorities a balance on the use of solvents as well as emissions on an annual basis.

For the categories in the NFR 2 sector related to Industrial processes (NFR 2A,B,C,H,I,J,K,L), the calculation was used as part of the basic model interface "LEAP".

The model for NMVOC emission sources from the Solvents subsector (categories NFR 2D3a, 2D3d, 2D3e, 2D3f, 2D3g (except the production of pharmaceutical products), 2D3h and 2D3i) is an engineering simulation model performed in a tabular calculation interface. The model includes a defined impact of emission reduction technologies for each activity within the specified categories. The model is incorporated into the LEAP model through NMVOC emission factors that include emission reduction technologies specific to each individual activity.

For other categories in the Solvents subsector (NFR 2D3b, 2D3c, 2D3g - Production of pharmaceutical products and 2G), the calculation was used as part of the "LEAP" model interface.

Large sources of emissions within the Industrial processes sector – production of cement, lime and other mineral products, production of ammonia and nitric acid, and steel production, together with large energy sources, are included in the EU ETS system. Climate and energy policy framework until 2030 extends free allocation, still based on comparisons with benchmarks for products, heat, district heating and fuel. For the industry, the price of emission units on the ETS market, i.e. signals related to long-term price predictability will be the main drive.

Process emissions from economic activities, which, according to the IPCC methodology, are included in the sector of industrial processes and product use, are estimated on the basis of detailed sectoral projections of cement industry and of using N2O for medical purposes and in the food industry and projected macroeconomic indicators of gross value added by other industries, annual growth rate of gross domestic product and population trend. The application of measures defined by strategic and planning sectoral documents of producers is included, which is conditioned by market requirements, laws and regulations and requirements for the application of best available techniques in production processes.

The WM scenario assumes that production in industrial processes in the period up to 2050 will reach the planned maximum values. Implementation of procedural measures is prescribed by sectoral legislation.

The WAM scenario includes the application of cost-effective measures to reduce process emissions. Emissions from fuel combustion are included in the Energy sector. The scenario is based on the implementation of the planned measures specified in the Report on the Implementation of Policy and Measures for Reducing Emissions and Increasing the Sink of Greenhouse Gases.

Table 9.2-12 contains more detailed assumptions used in creating projections for the Industial processes and product use sector.

Table 9.2-12 Assumptions for projections – industrial processes and product use

INDUSTRIAL PROCESSES AND PRODUCT USE
The projections were carried out based on the expected development of certain industries, which includes the production goals by 2050. Projections of emissions are based on the state and projections of macroeconomic parameters from 2020 - the annual growth rate of the gross social product and gross added value and the decrease in the number of inhabitants, as well as the results of sectoral analyzes and studies (cement production and chemical production). The assumed future movement of macroeconomic parameters is the same in both scenarios.
In the **WM scenario** the following is assumed: • no installation of additional capacities; • production will reach the maximum value by 2050. Process emissions from activities included in the Industrial processes and product use sector were estimated based on detailed sectoral projections of the production of cement and chemicals (urea) and projected macroeconomic indicators on gross added value by industry, the annual growth rate of the gross domestic product and the decrease in the number of inhabitants. The scenario includes the implementation of measures defined in the strategic and sectoral planning documents included in the business policy of manufacturers, conditioned by market demands, laws and regulations and the requirements of the application of best available techniques in the production process.
In the WAM scenario, the following is assumed: • application of cost-effective measures to reduce process emissions in cement production by gradually reducing the share of clinker in production, i.e. increasing the share of mineral additives in cement. The main emissions from cement production are emissions from the kiln system. However, in this sector, only particle emissions are considered, which mainly originate from the activities carried out during the production of clinker in kilns. Emissions from furnaces are a combination of emissions from combustion and the production process, but emissions of other pollutants are assumed to originate mainly from fuel combustion and are therefore allocated to the Energy sector. By increasing the share of mineral additives in cement, the share of clinker is reduced and thus the need for clinker production, i.e., consequently, the emissions from this production process are also reduced. The assumption is that the share of clinker in cement in 2020 is the same as in the WM scenario, in 2030 it is 65%, and in 2050 it is 50% (NRT). From the assumed share of clinker in cement and projections of cement production (obtained from the manufacturer), clinker production until 2050 was calculated.

Sources: Lit. 20, 21, 34

In this sector, future data on activity are predominantly based on national projections of economic growth, industrial growth, and changes in the number of inhabitants.

Additional parameters used for projections in the sector NFR 2 Production processes and use of products are shown in table 9.2-13.

Table 9.2-13 Parameters on projections – Industrial processes and product use

Parameter (t)	2020	2025	2030	2035	2040	2045	2050
Clinker production – WM scenario	2350681	2525000	2585000	2585000	2585000	2585000	2585000
Clinker production – WAM scenario	2350681	2223431	2307565	2174436	2041308	1908179	1775050
Urea production (WM and WAM scenario)	437154	393577	350000	350000	300000	300000	300000

9.2.3. Agriculture

Important strategies and plans for the Agriculture sector include the Low Carbon Development Strategy, the Integrated National Energy and Climate Plan, the Air Pollution Control Program, and the Rural Development Program of the Republic of Croatia for the period 2014-2020. as well as the FAO report "The Future of Food and Agriculture - Alternative Pathways to 2050".

The positive effect of the implementation of policies and measures on the total emission of greenhouse gases and pollutants in the agricultural sector is reflected in the direct reduction of emissions of particulate matter (PM), NMVOC, CH_4, NOx and NH_3.

he model for Agriculture is an engineering simulation model performed in a tabular calculation interface for all NFR categories from the sector (NFR 3B Agriculture - Animals, NFR 3D Agriculture - Crops and soils, NFR 3F Field burning of agricultural residues). The model is detailed, down to the level of individual sources, existing and future. The model is of the "bottom-up" type, because it starts from sectoral data and individual emission sources.

Table 9.2-14 contains a list of more detailed assumptions used in preparing projections for the Agriculture sector.

Tablica 9.2-14 Pretpostavke za projekcije – Poljoprivreda

AGRICULTURE
The projections were carried out based on the expected future state of key parameters. In the period up to 2050, it is expected that there will be a maintenance of the current level or a slight reduction of the livestock fund (with the exception of a slight increase in non-dairy cattle and pigs), and a maintenance or a slight increase in plant production.
In the **WM scenario** the following is assumed: • Projections of key trends in input activity data for livestock and crop production (number of significant livestock species and production of significant crops) were taken from the global FAO report "The Future of Food and Agriculture - Alternative Paths to 2050", where BAU was used (business as usual) scenario of the mentioned report. Since there were certain differences in the activity data in the base year, the data of the BAU scenario of the FAO report were adjusted, but the identical trend was maintained. Historical data from 2020 was retained for insignificant crops. • The amounts of mineral fertilizers by type were obtained by extrapolation of the existing trend for the historical period 2000 - 2020. • Changes in the livestock breeding system and feeding regime (changes in the fertilization system and genetic progress, increase in feed digestibility and quality). • Implementation of the Rural Development Program in the period 2014-2020, including changes in the cattle management system (improvement of facilities or housing as well as the manure removal system and genetic improvements) and animal nutrition (forage processing with the aim of increasing digestibility, improving the quality of bulky fodder and improving grazing systems, feed processing with the aim of increasing digestibility, use of additives in animal feed);

AGRICULTURE
• The application of mineral fertilizers (nitrogen) to the soil remains at the level resulting from the trend of consumption of mineral fertilizers in the period from 2000 to 2020 - that is, it assumes that there will be no increase in the consumption of mineral fertilizers despite the estimated changes in plant production and livestock production.
In the **WAM scenario** the following is assumed: • Changing the feeding regime of cattle and pigs and the quality of forage, which includes the application of the potential for reducing emissions due to: changing the ratio of certain types of feed in the meal, the use of supplements and fats in feed, improving the quality of bulky feed and improving the grazing system, shortening the time of storage/disposal on manure farms, covering manure disposal sites, • Anaerobic manure decomposition and biogas production, which includes an increase in the share of cattle, pigs and poultry for anaerobic manure decomposition and an increase in biogas production (digesters) by 30% by 2050, • Improvement of livestock farms and manure management systems, • Improvement of methods of application of mineral fertilizers, • Improving and changing the tillage system (reduced tillage), • Hydromelioration procedures and disaster protection systems • Introduction of new cultivars, varieties and crops. • Reduction in the consumption of mineral fertilizers due to a lower need for nitrogen application due to new cultivars, varieties and cultures, improvements in the method of application and an increase in the proportion of slow-release fertilizers, hydromelioration measures and disaster protection systems.

Sources: Lit. 20, 21, 34

The parameters used for projections in the NFR 3 Agriculture sector are shown in table 9.2-15.

Tablica 9.2-15 Parametri za projekcije – poljoprivreda

Parametar		2020.	2025.	2030.	2035.	2040.	2045.	2050.
Dairy cattle	1000 heads	109	171	160	155	148	145	142
Non-dairy cattle	1000 heads	313	284	288	289	296	300	303
sheep	1000 heads	662	639	621	607	595	586	576
goats	1000 heads	86	68	66	65	63	63	62
horses	1000 heads	26	23	24	25	26	26	27
mules/asses	1000 heads	5	3	3	4	4	4	4
swine	1000 heads	1033	1204	1226	1220	1222	1221	1221
poultry	1000 heads	13057	10500	10800	11000	11500	11200	11220
laying hens	1000 heads	2865	2236	2211	2182	2169	2139	2117
broilers	1000 heads	9213	7189	7109	7018	6975	6879	6809
turkey	1000 heads	481	375	371	366	364	359	355
ducks	1000 heads	53	41	41	40	40	39	39
geese	1000 heads	9	9	9	9	9	9	9
crops	ha	1528702	1528702	1528702	1528702	1528702	1528702	1528702
grasslands	ha	1153221	1146308	1141064	1135820	1130576	1125332	1120087
Total burned crop area	kg of dry matter	170461	356006	368194	373541	378857	375735	374797
Mineral N fertilizers (WM)	t	98963	98267	95947	93626	91306	88986	86665

Parametar		2020.	2025.	2030.	2035.	2040.	2045.	2050.
Mineral N fertilizers (WAM)	t	98963	102664	98757	96407	94056	91706	89008

9.2.4. Waste

For the Waste sector, important strategies and plans include the Low Carbon Development Strategy, the Integrated National Energy and Climate Plan, the Waste Management Strategy of the Republic of Croatia, the Waste Management Plan of the Republic of Croatia for the period 2017 - 2022, with the existing legislative framework presented below.

The implementation and establishment of a complete waste management system in Croatia is made possible by the application and fulfillment of the goals defined by the Law on Waste Management (OG 84/2021) and the Waste Management Plan of the Republic of Croatia for the period 2023 - 2028 OG 84/2023). The Waste Management Act defines goals and deadlines for reducing the total mass of disposed waste and quantitative goals and deadlines for increasing the mass of separately collected and recycled waste, in accordance with EU directives (Directive (EU) 2018/850 of the European Parliament and of the Council of May 30, 2018 on amendments to Directive 1999/31/EC on landfills and Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste). The Republic of Croatia submitted a request to postpone the fulfillment of the goals and deadlines, because it was among the member states that disposed of more than 60% of municipal waste in landfills in 2013 and recycled less than 20% of municipal waste. A delay of 5 years is included in the projections. The European Commission has not yet approved the postponement of the goals and deadlines.

<u>The impact of sustainable waste management</u>

By preventing the generation, separate collection, recycling and recovery of waste, the amount of solid waste for disposal will be reduced to a minimum. All landfills will be rehabilitated, waste management centers will use advanced technologies that, in addition to obtaining raw materials for material recovery, chemically recycle waste, which produces various chemical compounds that can be used in industrial production (ethylene, ammonia, etc.) as and different fuels (hydrogen, synthetic gas, liquid fuels).

The establishment of a waste management system in accordance with the principles of the circular economy will contribute to resource efficiency with less negative impact on people and the environment. With a circular economy, the value of products, materials and resources will remain in the economy as long as possible. The use of production processes that consume less materials and energy, use resources without waste and include complete recycling at the end of the product's life will be encouraged. The design, construction and renovation of buildings will be carried out according to the principles of circular management of space and buildings with coordinated use of resources with the needs and functionality of buildings. Sustainable management of resources and extending the life of materials and products is the main determinant of the transition from the existing linear to a sustainable and competitive circular economy with low carbon emissions.

The model for Waste is an engineering simulation model performed in a bottom-up calculation interface. The model is structured in accordance with the tabular structure of the emissions inventory for NFR categories 5.A, 5.B, 5.C and 5.D.

The assumptions used in preparing the projections are shown in 9.2-16.

Table 9.2-16 Assumptions for projections – waste

OTPAD
Projections were carried out based on expected development and the future state of the parameters for the projections - the mass of produced and disposed waste (municipal, production, sludge from waste water treatment), the organic share of biodegradable waste, the share of recovered/flared methane and the mass of composted organic waste. Emission projections start from the situation and projections of macroeconomic parameters in 2020 - the projected dynamics of the annual growth rate of gross domestic product and the decline of the population. The WAM scenario is equal to the WM scenario since no additional measures to reduce emissions of greenhouse gases and pollutants are recognized. Through a comparative analysis of a group of countries with similar national characteristics, it was determined that the national legislation, which is harmonized with the EU legislation, prescribes measures that all member states must implement by a certain deadline and consider them within the framework of the WM scenario.
In the **WM and WAM scenarios** the following is assumed: • Solid waste disposal – reduction of the mass of produced and disposed waste due to the application of measures defined by sectoral legislation harmonized with EU legislation. The implementation and establishment of a complete waste management system in Croatia is made possible by the application and fulfillment of the goals defined by the existing legislative framework. • Composting – continuous increase in the mass of waste processed by composting due to the application of measures defined by sectoral legislation harmonized with EU legislation. The increase in the mass of waste that will be composted depends on the decrease in the mass of disposed biodegradable waste and the share of biodegradable waste that will be processed by composting and digestion. • Incineration of waste – incineration of hospital waste without energy recovery is no longer carried out. • Wastewater management – continuous increase in the amount of treated industrial wastewater and reduction in the amount of treated household wastewater and the number of residents in households using field toilets (toilets without flushing). • Other waste (fires on vehicles and buildings) – trends depend on projections of the number of vehicles and macroeconomic parameters. Emissions of greenhouse gases and air pollutants included in the Waste sector (in accordance with the IPCC and EMEP/EEA methodology) were estimated based on sectoral analyzes and projected macroeconomic indicators on the annual growth rate of the gross domestic product and the decrease in the number of inhabitants. The scenarios include the existing legal framework of the Republic of Croatia and the adopted EU legal framework from the Waste sector for the period up to 2035. Projections of emissions of greenhouse gases and pollutants are based on the implementation of measures prescribed by sectoral legislation, harmonized with EU legislation.

Sources: Lit. 20, 21, 34

The parameters used for projections in the NFR 5 Waste sector are presented in table 9.2-17.

Table 9.2-17 Parameters on projections – waste

Parameter		2020	2025	2030	2035	2040	2045	2050
Mass of produced waste (WM and WAM scenario)	t	2.273.117	2.212.504	2.204.261	2.189.563	2.178.611	2.171.490	2.168.263
Share of organic matter in municipal waste (WM and WAM scenario)	%	65	18	12	9	6	4	1
Mass of waste deposited in	t	1.459.906	553.126	440.852	328.434	217.861	119.432	21.683

Parameter		2020	2025	2030	2035	2040	2045	2050
landfills (WM and WAM scenario)								
Share of methane recovered/flared	%	8.6	4.2	4.5	4.6	4.1	3.7	3.2
Mass of composted waste (WM and WAM scenario)	t	77,313	478,343	679,235	773,148	864,598	949,649	1,034,773

9.3. Results

Main results

Total projected emissions in kt for all observed pollutants for 2025, 2030, 2040 and 2050 are shown in Table 9.3-1 together with historical emissions for 2005 and 2020 (as reported in 2022) compared to the base year 2005 in % for WM scenario "with existing measures".

Table 9.3-1 Trend of total emissions (historical and projected) in kt compared to the base year 2005 in % for the WM scenario "with existing measures"

Pollutant	Unit	Historic emission		WM scenario			
		2005	2020	2025	2030	2040	2050
NOx	kt	86.09	45.81	45.26	44.34	36.33	29.63
Comparison with the base year 2005	%	0	-40.28	-40.84	-41.76	-49.76	-56.47
SO_2	kt	58.69	6.13	8.06	9.96	8.22	7.32
Comparison with the base year 2005	%	0	-52.56	-50.63	-48.73	-50.47	-51.37
NMVOC	kt	113.54	70.30	62.08	63.31	60.67	54.90
Comparison with the base year 2005	%	0	-43.25	-51.47	-50.24	-52.87	-58.64
NH_3	kt	40.64	31.55	33.70	33.42	31.73	30.58
Comparison with the base year 2005	%	0	-9.08	-6.94	-7.22	-8.90	-10.06
$PM_{2,5}$	kt	43.64	28.50	27.00	26.38	22.67	17.37
Comparison with the base year 2005	%	0	-15.14	-16.64	-17.26	-20.97	-26.27
BC	kt	6.36	3.71	3.66	3.60	2.90	2.03
Comparison with the base year 2005	%	0	-2.66	-2.70	-2.76	-3.46	-4.33

Total projected emissions in kt for all observed pollutants for 2025, 2030, 2040 and 2050 are shown in Table 9.3-2 together with historical emissions for 2005 and 2020 (as reported in 2022) compared to the base year. 2005 in % for the WAM scenario "with additional measures".

Table 9.3-2 Trend of total emissions (historical and projected) in kt compared to base year 2005 in % for WAM scenario "with additional measures"

Pollutant	Unit	Historic emission		WAM scenario			
		2005	2020	2025	2030	2040	2050
NOx	kt	86.09	45.81	44.47	42.95	33.78	26.58
Comparison with the base year 2005	%	0	-40.28	-41.62	-43.14	-52.31	-59.52
SO_2	kt	58.69	6.13	7.85	9.64	7.67	6.61
Comparison with the base year 2005	%	0	-52.56	-50.84	-49.05	-51.02	-52.08
NMVOC	kt	113.54	70.30	58.93	57.73	55.55	51.20
Comparison with the base year 2005	%	0	-43.25	-54.62	-55.81	-57.99	-62.34
NH_3	kt	40.64	31.55	30.66	29.11	27.03	25.66
Comparison with the base year 2005	%	0	-9.08	-9.98	-11.53	-13.60	-14.98

Pollutant	Unit	Historic emission		WAM scenario			
		2005	2020	2025	2030	2040	2050
$PM_{2,5}$	kt	43.64	28.50	22.54	18.45	15.36	12.44
Comparison with the base year 2005	%	0	-15.14	-21.10	-25.19	-28.28	-31.20
BC	kt	6.36	3.71	3.25	2.89	2.20	1.58
Comparison with the base year 2005	%	0	-2.66	-3.11	-3.47	-4.16	-4.78

Compliance with national emission reduction commitments

According to Article 4, paragraph 3, of NEC Directive 2016/2284/EU emission of NOx and NMVOC from the source categories NFR 3.B (manure management) and 3.D (agricultural soils) are not accounted for the purpose of complying. The tables 9.3-3 and 9.3-4 meet this requirement.

Table 9.3-3 Total Croatian emissions (historical and projected) in kt calculated for the purpose of alignment with the NECD compared to the 2020 and 2030 targets and the WM scenario "with existing measures"

Pollutant		Historic emission		WM scenario				Target	Distance from target		Target	Distance from target		
		2005	2020	2025	2030	2040	2050	2020	2020	2025	2030	2030	2040	2050
NOx*	kt	81.46	42.04	41.45	40.60	32.74	26.17	56.21	-14.16	-14.76	35.03	5.57	-2.29	-8.86
SO_2	kt	58.69	6.13	8.06	9.96	8.22	7.32	26.41	-20.28	-18.35	9.98	-0.01	-1.75	-2.66
NMVOC*	kt	104.13	61.27	52.62	54.04	51.52	45.71	68.72	-7.45	-16.10	54.15	-0.10	-2.63	-8.44
NH_3	kt	40.64	31.55	33.70	33.42	31.73	30.58	40.23	-8.68	-6.53	30.48	2.94	1.26	0.10
$PM_{2.5}$	kt	43.64	28.50	27.00	26.38	22.67	17.37	35.78	-7.29	-8.78	19.64	6.74	3.03	-2.26

** According to Article 4, Paragraph 3 of the NEC directive 2016/2284/EU NOx and NMVOC emissions in sub-sectors 3.B and 3.D are included in the sums and should not be taken into account when checking compliance with emission reduction commitments..*

Regarding the achievement of Croatian goals according to the NEC directive 2016/2284/EU for 2030 in the WM scenario, Croatia will comply for SO_2 and NMHOS, while it will not comply for NOx, NH_3 and $PM_{2.5}$. The distance from the target for NOx for 2030 in the WM scenario "with existing measures" is 5.57 kt, for NH_3 2.93 kt, and for $PM_{2.5}$ 6.74 kt.

Table 9.3-4 Total Croatian emissions (historical and projected) in kt calculated for the purpose of alignment with the NECD compared to the 2020 and 2030 targets and the WAM scenario "with additional measures"

Pollutant		Historic emission		WAM scenario				Target	Distance from target		Target	Distance from target		
		2005	2020	2025	2030	2040	2050	2020	2020	2025	2030	2030	2040	2050
NOx*	kt	81.46	42.04	40.54	39.13	30.10	23.04	56.21	-14.16	-15.67	35.03	4.11	-4.92	-11.99
SO_2	kt	58.69	6.13	7.85	9.64	7.67	6.61	26.41	-20.28	-18.56	9.98	-0.34	-2.31	-3.36
NMVOC*	kt	104.13	61.27	49.47	48.47	46.40	42.01	68.72	-7.45	-19.25	54.15	-5.68	-7.75	-12.14
NH_3	kt	40.64	31.55	30.66	29.11	27.03	25.66	40.23	-8.68	-9.57	30.48	-1.37	-3.44	-4.82
$PM_{2,5}$	kt	43.64	28.50	22.54	18.45	15.36	12.44	35.78	-7.29	-13.25	19.64	-1.18	-4.28	-7.20

Regarding the achievement of Croatia's targets under the NEC Directive 2016/2284/EU for 2030 in the WAM scenario, Croatia will comply for all pollutants except NOx. The distance from the 2030 NOx target in the "scenario with additional measures" is 4.11 kt.

According to Table 3 of Annex II of the amended Gothenburg Protocol, ground emissions are not included in the calculation for the year 2005 for the member states of the European Union. Emissions from the ground are emissions from NFR 3D. Table 9.3-5 takes this requirement into account.

Table 9.3-5 Total Croatian emissions (historical and projected) in kt calculated for the purpose of harmonizing with the amended GP compared to the 2020 target and WM scenario "with existing measures"

Pollutant		Historic emission		WM scenario				Target	Distance from target				
		2005	2020	2025	2030	2040	2050	2020	2020	2025	2030	2040	2050
NOx*	kt	81,55	42,12	41,52	40,67	32,81	26,23	56,27	-14,15	-14,75	-15,60	-23,46	-30,04
SO_2	kt	58,69	6,13	8,06	9,96	8,22	7,32	26,41	-20,28	-18,35	-16,45	-18,19	-19,09
NMVOC	kt	113,54	70,30	62,08	63,31	60,67	54,90	74,94	-4,64	-12,86	-11,63	-14,27	-20,04
NH_3	kt	40,64	31,55	33,70	33,42	31,73	30,58	40,23	-8,68	-6,53	-6,81	-8,50	-9,65
$PM_{2,5}$	kt	43,64	28,50	22,54	18,45	15,36	12,44	35,78	-7,29	-13,25	-17,33	-20,42	-23,35

** Emissions from soil are not included in the calculation for the year 2005 for the member states of the European Union (according to table 3 of Annex II of the amended GP). Emissions from the soil are emissions from NFR 3D.*

Regarding the achievement of Croatian goals according to the amended Gothenburg Protocol for 2020 and all projected years, Croatia will meet the goals for all pollutants even with the WM scenario.

Results per pollutant

9.3.1. Nitrogen oxides (NOx)

he total NOx emission in Croatia was 86.1 kt in 2005 and 45.8 kt in 2020. In the historical trend, the reduction of the total NOx emission has been relatively constant since 2005 with the exception of 2007 and mostly follows the trend of total fuel consumption. The total reduction of NOx emissions in 2020 compared to 2005 is 47%.

The key emission sectors in 2020, which at the same time contribute to the greatest reduction of NOx emissions in the historical trend, are the four energy sectors. road transport (45% contribution to total emissions in 2020 and 37% reduction compared to 2005), small combustion (17% contribution to total emissions in 2020 and 46% reduction compared to 2005) and industry and construction (12% contribution to total emissions in 2020) .and 65% reduction compared to 2005) and energy plants (9% contribution to total emissions in 2020 and 65% reduction compared to 2005).

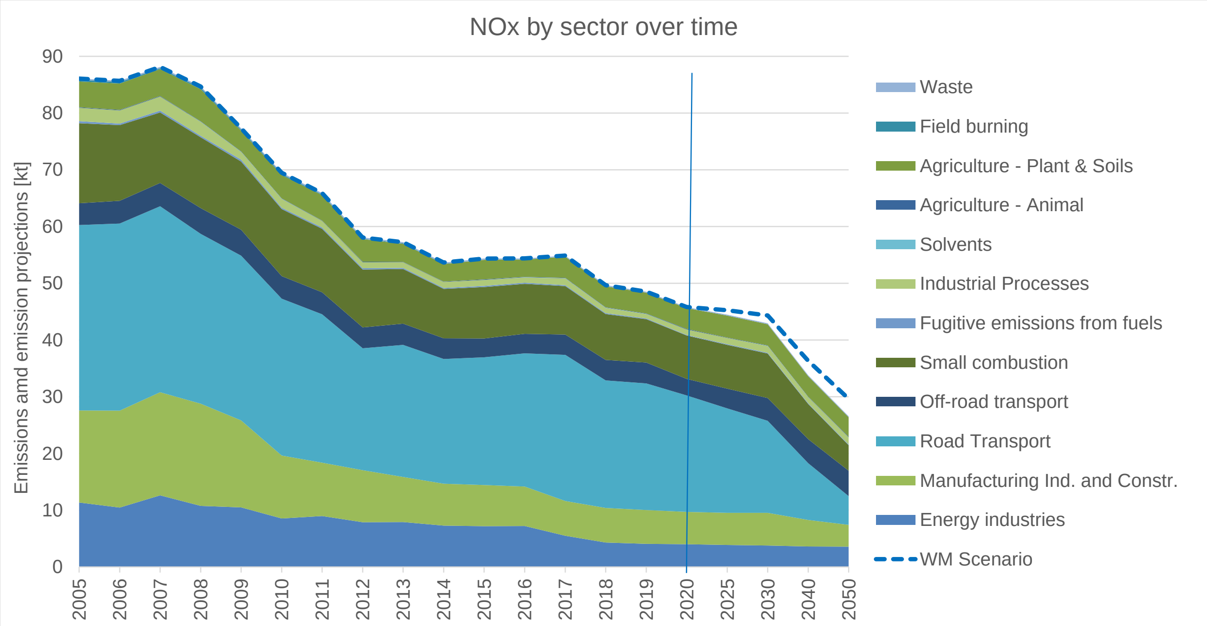

Figure 9.3-1 Trend of total emissions and projection of NOx emissions for WM and WAM scenario

Source: EKONERG ltd

WM scenario

In the WM scenario "with existing measures" total national emissions are expected to decrease to 44.3 kt by 2030 (-48.5% compared to 2005 and -3.2% compared to 2020).

It is expected that the main drivers of the trend of NOx emissions in the period up to 2030 will be road transport, small combustion, manufacturing industries and construction, and energy industries. It is expected that emissions from road transport will decrease by 18.7% by 2030 compared to 2020, while for other key categories they will increase.

Road transport has the largest contribution to NOx emissions in 2030 (37.7%). In this sector, until 2030, an increase in fossil fuel consumption of 8.1% compared to 2020 is predicted, which is related to the increase in the number of road vehicles. The decrease in emissions in this sector is based on the following assumptions:

- fleet transport combined with decreasing specific emission factors for EURO 6d (PC, LDV), EURO 6 (HDV), and EURO 5 (mopeds and motorcycles):
    - e.g. for diesel-powered passenger vehicles, the assumed FE NOx for 2020 is 280.8 kg/TJ, and in 2050 it is 21.3 kg/TJ, for gasoline-powered passenger vehicles, the assumed FE NOx for 2020 is 73.1 kg /TJ, and in 2050, is 17.6 kg/TJ
    - the entire fleet of vehicles in the Republic of Croatia will be Euro 6d in 2050, and the transition trend is linear from 2020 to 2050, at the same time old vehicles (PRE ECE, EURO 1, 2, 3) are being phased out;
- by 2030, the penetration of new BEVs (battery-powered electric vehicles) and hybrid vehicles is expected, whose share in total passenger activity in road transport will reach 2.5% in 2030, or 30% in 2050.

In the category of small combustion, an increase in emissions of 2.9% compared to 2020 is predicted until 2030, primarily due to an increase in the consumption of wood biomass in residential, but also due to the replacement of old combustion technologies with new ones that have slightly higher specific emission factors for NOx. By 2050, the renovation of the housing stock at the rate of 0.75% of the area of the stock of residential buildings per year is assumed to the standard of almost zero energy consumption.

In the categories of energy industries and manufacturing industries and construction, an increase in NOx emissions is predicted until 2030 (followed by 10.1% and 6.9% compared to 2020) due to the predicted increase in fuel consumption in thermal power plants and refineries by 37.2% within energy industries and by 22.8% in manufacturing industries and construction.

After 2030, a more significant reduction in NOx emissions is expected, with greater reductions in key categories, mostly due to the fact that in road transport all vehicles will be at least EURO 6d (i.e. EURO 5 for mopeds and motorcycles), and an improvement in energy efficiency is expected in other key categories and the consequent reduction of fuel consumption and fuel substitution in the industrial sector.

WAM scenario

In the "with additional measures" WAM scenario, total national emissions are expected to decrease to 43.0 kt by 2030 (-50.1% compared to 2005 and -6.2% compared to 2020).

It is predicted that NOx emissions from road transport (mostly passenger cars) will decrease by 21% from 2020 to 2030, as well as emissions from energy industries by 5.7%, while emissions from small combustion are predicted to increase by 2. 6% and from manufacturing industries and construction by 1.2%. in the same period. The drop in emissions in road transport is based on the assumption of intensification of the penetration of new electric and hybrid vehicles, whose share in total passenger activity in road transport reaches 3.5% in 2030, or 65% in 2050.

It is predicted that emissions from small combustion will decrease significantly from 2030 to 2050 due to the assumed renovation of 1.3% of buildings per year to the standard of near-zero energy consumption (including the use of renewable energy sources) and the consequent reduction in consumption of all types of fuel.

Improvements in energy efficiency in industry together with fuel switching towards greater use of renewable energy sources and electricity in manufacturing industry and construction result in a 33.3% reduction by 2050 compared to 2030.

In the category of energy plants, the reduction of coal intake and higher consumption of biomass and natural gas in thermal power plants results in a reduction of emissions of 5.7% by 2030 compared to 2020 and 13.5% by 2050 compared to 2030, with the fact that in 2040 there is no more use of coal.

Table 9.3-6 Croatian total NOx emissions (historical and projected) in kt

Source category		Historic emission, kt				Projected emission, kt				
NFR	Name	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
	TOTAL	86.09	69.49	54.36	45.81	45.26	44.34	36.33	29.63	WM
		86.09	69.49	54.36	45.81	44.47	42.95	33.78	26.58	WAM
1A1	Energy Industries	11.37	8.55	7.20	4.01	4.22	4.42	4.52	4.26	WM
		11.37	8.55	7.20	4.01	3.90	3.78	3.62	3.59	WAM
1A2	Manufacturing Industries and Construction	16.21	11.10	7.23	5.70	5.97	6.10	5.32	4.87	WM
		16.21	11.10	7.23	5.70	5.65	5.77	4.67	3.85	WAM
1A3b	Road Transport	32.69	27.64	22.54	20.53	18.67	16.70	10.96	6.06	WM
		32.69	27.64	22.54	20.53	18.39	16.22	10.00	5.04	WAM
1A3a, c,d,e	Off-Road Transport	3.84	3.98	3.31	2.92	3.48	4.02	3.78	3.98	WM
		3.84	3.98	3.31	2.92	3.47	4.01	4.22	4.49	WAM
1A4	Small combustion	14.12	11.82	9.08	7.62	7.73	7.84	6.76	5.42	WM

Source category		Historic emission, kt				Projected emission, kt				
NFR	Name	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
		14.12	11.82	9.08	7.62	7.74	7.82	6.20	4.51	WAM
1B	Fugitive Emissions	0.33	0.24	0.18	0.11	0.13	0.15	0.13	0.12	WM
		0.33	0.24	0.18	0.11	0.13	0.14	0.12	0.11	WAM
2A,B,C, H,I,J,K,L	Industrial Processes	2.35	1.55	1.07	0.96	1.07	1.20	1.07	1.27	WM
		2.35	1.55	1.07	0.96	1.07	1.20	1.07	1.27	WAM
2D, 2G	Solvent	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.02	WM
		0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.02	WAM
3B	Agriculture - Animals	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.07	WM
		0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.07	WAM
3D	Agriculture - Crops & Soils	4.54	4.08	3.44	3.69	3.74	3.67	3.52	3.39	WM
		4.54	4.08	3.44	3.69	3.86	3.75	3.61	3.46	WAM
3F,I	Field Burning of crop residues	0.31	0.19	0.03	4E-04	8E-04	8E-04	9E-04	9E-04	WM
		0.31	0.19	0.03	4E-04	8E-04	8E-04	9E-04	9E-04	WAM
5	Waste	0.21	0.23	0.21	0.17	0.17	0.17	0.17	0.17	WM
		0.21	0.23	0.21	0.17	0.17	0.17	0.17	0.17	WAM

9.3.2. Sulphur oxides (SO_2)

The total emission of SO_2 in Croatia was 58.7 kt in 2005 and 6.1 kt in 2020, which is a reduction of 89.6%. The reduction is mainly the result of reducing the sulfur content in fuel oils, reducing their consumption and switching to natural gas, and installing desulfurization units in plants.

The key emission sectors in 2020, which at the same time contribute to the largest reduction in SO_2 emissions in the historical trend, are three energy sectors: manufacturing industries and construction (31.5% contribution to total emissions in 2020 and 81.1% reduction compared to 2005), fugitive emissions from fuel (31.5% contribution to total emissions in 2020 and 45.4% reduction compared to 2005) and energy plants (19.6% contribution to total emissions in 2020 and 96.3% reduction compared to 2005).

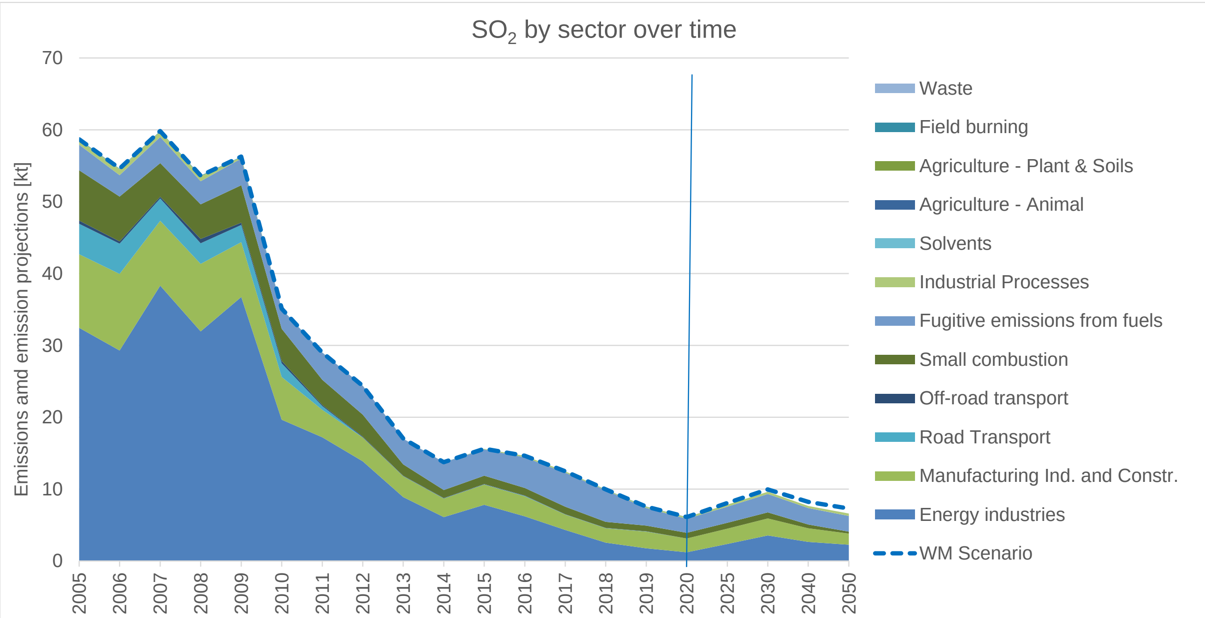

Figure 9.3-2 Emission trend and SO_2 emission projection for the WM and WAM scenarios

Source: EKONERG ltd.

WM scenario

In the WM scenario "with existing measures" the total national SO_2 emission is expected to reach 10.0 kt. Compared to 2005, this is a decrease of 83%. However, compared to 2020, this means an increase of 62.7% (ie +3.84 kt). Appropriate reduction measures (eg reduction of sulfur content in liquid fuels, waste gas treatment) have mostly already been implemented. The reduction potential is therefore negligible with the projected increase in fuel use in all key categories until 2030. Emissions from power plants are expected to increase by as much as 3.1 times (+2.47 kt) due to the projected increase in petroleum coke intake (by as much as 9.5 times in 2030 compared to 2020) in the refinery category (NFR 1A1b). The increase in emissions from manufacturing industries and construction will be slightly lower, by 29.9% (+0.58 kt) and from fugitive emissions from fuel by 34.7% (+0.67 kt).

WAM scenario

In the "with additional measures" WAM scenario, total national emissions are expected to decrease to 9.6 kt by 2030 (-83.6% compared to 2005). And in this scenario compared to 2020, it is an increase of 57.3% (i.e. +3.51 kt). The reason for the slightly greater reduction in emissions compared to the WM scenario "with existing measures" is due to a slightly greater expected reduction in coal intake in the category of thermal power plants and heating plants (NFR 1A1a) and lower fuel consumption, together with the replacement of fuel towards greater use of renewable energy sources and of electricity in manufacturing industries and constructiondue to the assumed improvement of energy efficiency.

Table 9.3-7 Croatian total SO_2 emissions (historical and projected) in kt

Source category		Historic emission, kt				Projected emission, kt				
NFR	Name	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
	TOTAL	58.69	35.10	15.61	6.13	8.06	9.96	8.22	7.32	WM
		58.69	35.10	15.61	6.13	7.85	9.64	7.67	6.61	WAM
1A1	Energy Industries	32.46	19.67	7.83	1.20	2.44	3.67	2.74	2.34	WM
		32.46	19.67	7.83	1.20	2.37	3.55	2.66	2.26	WAM
1A2	Manufacturing Industries and Construction	10.23	5.93	2.81	1.93	2.23	2.50	2.16	1.99	WM
		10.23	5.93	2.81	1.93	2.12	2.37	1.89	1.55	WAM
1A3b	Road Transport	4.25	1.91	0.03	1E-03	1E-03	1E-03	1E-03	6E-04	WM
		4.25	1.91	0.03	1E-03	1E-03	1E-03	1E-03	5E-04	WAM
1A3a, c,d,e	Off-Road Transport	0.45	0.33	0.06	3E-03	5E-03	0.01	0.01	0.01	WM
		0.45	0.33	0.06	3E-03	5E-03	0.01	0.01	0.01	WAM
1A4	Small combustion	7.00	4.48	1.15	0.80	0.83	0.86	0.58	0.28	WM
		7.00	4.48	1.15	0.80	0.82	0.83	0.53	0.26	WAM
1B	Fugitive Emissions	3.54	2.72	3.66	1.93	2.27	2.60	2.44	2.36	WM
		3.54	2.72	3.66	1.93	2.25	2.56	2.30	2.20	WAM
2A,B,C, H,I,J,K,L	Industrial Processes	0.68	0.01	0.06	0.24	0.27	0.30	0.27	0.32	WM
		0.68	0.01	0.06	0.24	0.27	0.30	0.27	0.32	WAM
2D, 2G	Solvent	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	WM
		0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	WAM
3B	Agriculture - Animals	NA	NA	NA	NA	NA	NA	NA	NA	WM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3D	Agriculture - Crops & Soils	NA	NA	NA	NA	NA	NA	NA	NA	WM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3F,I	Field Burning of crop residues	0.07	0.04	0.01	9E-05	2E-04	2E-04	2E-04	2E-04	WM
		0.07	0.04	0.01	9E-05	2E-04	2E-04	2E-04	2E-04	WAM
5	Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WM
		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	WAM

9.3.3. Non-methane volatile organic compounds (NMVOC)

The total emissions of NMVOC in Croatia amounted to 113.5 kt in 2005 and 70.3 kt in 2020. This corresponds to a reduction of 38.1%. The reduction is the result of the implementation of measures in key emission sectors concerning the reduced use of volatile organic solvents and solvent-based products in the solvent category and the inclusion of reduction technologies with lower NMVOC emissions and due to the increased use of catalysts and diesel cars in the road transport category.

In 2020, the main sources of NMVOC emissions in Croatia were solvent categories with a share of 40.6%, small combustion with a share of 27.3%, agriculture - animals with 10.4% and road transport with 6.6% of total emissions NMVOC.

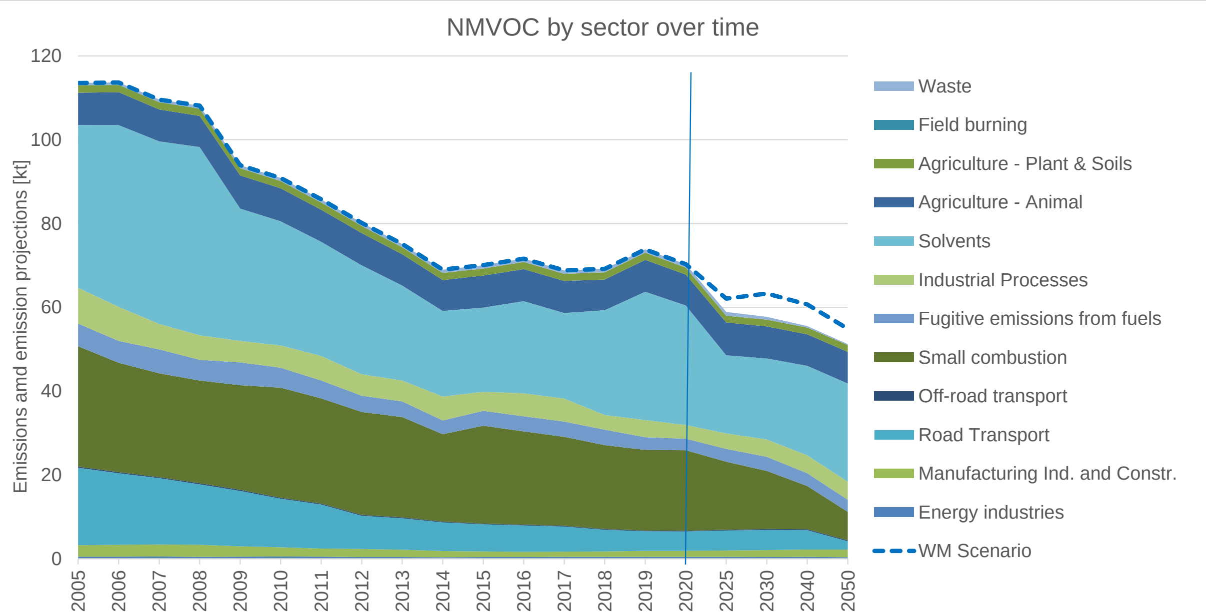

Figure 9.3-3 Emission trend and NMVOC emission projection for WM and WAM scenario

Sourc: EKONERG ltd

WM scenario

In the WM scenario "with existing measures", total national NMVOC emissions are expected to decrease to 63.3 kt by 2030 (-44.2% compared to 2005 and -9.9% compared to 2020).).

The largest reduction is expected to be achieved in the solvent category by 32.1% by 2030 (ie -9.1 kt). Although economic growth is predicted, which will result in an increase in the use of solvents in the period up to 2030, emissions will be significantly reduced, as a result of further implementation of Croatian regulations that regulate the content of volatile organic compounds in products. A significant reduction in emissions is predicted in the coating application category (NFR 2D3d) by 49.4% (-6.20 kt) compared to 2020. This is partly due to the fact that the historical trend of emissions is calculated using the Tier 1 method, while for Tier 2 method was used for emission projection, so consistency in methodology is not ensured for that category. The emission factors for the projections reflect expected technological changes and regulations on environmental protection prepared using GAINS assumptions for Croatia, which due to the lack of information was not done for the historical trend, and the emissions for that category are in a more recent trend (since 2013, when the application of the regulations began which regulates the content of volatile organic solvents in products) overestimated.

In the category of small combustion (mainly residential), a decrease of 1.5% (i.e. -0.3 kt) is predicted in the period from 2020 to 2030. This is mainly due to the trend towards low-emission technologies (types of combustion) and predicted lower emission factors for new biomass combustion technologies (requirements for eco-design, section 4.1, tables 3 and 4) and the predicted increase in biomass use by residential that reduces this emission reduction.

It is predicted that emissions in road transport (NFR 1A3b) will increase by 13.3% (i.e. 0.62 kt) until 2030 due to the expected increase in the number of gasoline and diesel vehicles and the impact of exhaust gas treatment (catalysts) in the period until 2030, the small share of electric and hybrid vehicles, which becomes significant in the period after 2030, does not come to the fore.

Emissions from agriculture - animals are projected to increase by 3.7% (i.e. 0.27 kt) by 2030 compared to 2020, mainly caused by the increase in the number of dairy cattle and swine in Croatia.

WAM scenario

In the WAM scenario “with additional measures”, total national emissions are expected to decrease to 57.7 kt by 2030 (-49.2% compared to 2005 and -17.9% compared to 2020).

In the WAM scenario, compared to the WM scenario, in 2030 there will be a smaller increase in road transport emissions by 3% (0.14 kt)) compared to 2020 due to a smaller increase in the number of cars (gasoline and diesel) and some a greater share of electric and hybrid vehicles, which becomes noticeable in the period after 2030. In the category of small combustion, a more noticeable emission reduction of 28% (i.e. -5.38 kt) is expected due to a smaller increase in biomass consumption as a result of the introduction of energy efficiency measures in buildings and an increase in the use of electricity and a decrease in the use of fossil fuels and the expected greater penetration of biomass combustion techniques with lower emissions in residential (section 4.1, table 4). For the remaining two key categories (agriculture - animals and solvents) this scenario equals the WM scenario.

Table 9.3-8 Croatian total NMVOC emissions (historical and projected) in kt

Source category		Historic emission, kt				Projected emission, kt				
NFR	**2005**	**2010**	**2005**	**2010**	**2005**	**2010**	**2005**	**2010**	**2050**	**Scenarij**
	TOTAL	113.54	90.88	70.08	70.30	62.08	63.31	60.67	54.90	113.54
		113.54	90.88	70.08	70.30	58.93	57.73	55.55	51.20	113.54
1A1	Energy Industries	0.48	0.50	0.38	0.44	0.45	0.47	0.53	0.40	0.48
		0.48	0.50	0.38	0.44	0.42	0.40	0.44	0.33	0.48
1A2	Manufacturing Industries and Construction	2.72	2.24	1.35	1.41	1.49	1.55	1.59	1.58	2.72
		2.72	2.24	1.35	1.41	1.54	1.67	1.75	1.84	2.72
1A3b	Road Transport	18.52	11.59	6.49	4.67	5.02	5.29	4.76	2.55	18.52
		18.52	11.59	6.49	4.67	4.76	4.81	4.64	2.01	18.52
1A3a, c,d,e	Off-Road Transport	0.24	0.24	0.18	0.16	0.19	0.22	0.19	0.19	0.24
		0.24	0.24	0.18	0.16	0.19	0.22	0.21	0.21	0.24
1A4	Small combustion	28.76	26.24	23.33	19.22	19.12	18.94	15.22	9.94	28.76
		28.76	26.24	23.33	19.22	16.24	13.85	10.32	6.77	28.76
1B	Fugitive Emissions	5.41	4.79	3.57	2.71	3.06	3.43	3.25	3.13	5.41
		5.41	4.79	3.57	2.71	3.04	3.38	3.06	2.92	5.41
2A,B,C, H,I,J,K,L	Industrial Processes	8.55	5.31	4.51	3.32	3.70	4.12	4.27	4.30	8.55
		8.55	5.31	4.51	3.32	3.70	4.12	4.27	4.30	8.55
2D, 2G	Solvent	38.88	29.64	20.11	28.52	18.70	19.38	21.35	23.43	38.88
		38.88	29.64	20.11	28.52	18.70	19.38	21.35	23.43	38.88

Source category		Historic emission, kt				Projected emission, kt				
NFR	2005	2010	2005	2010	2005	2010	2005	2010	2050	Scenarij
3B	Agriculture - Animals	7.67	7.86	7.65	7.34	7.80	7.61	7.50	7.54	7.67
		7.67	7.86	7.65	7.34	7.80	7.61	7.50	7.54	7.67
3D	Agriculture - Crops & Soils	1.75	1.70	1.69	1.69	1.66	1.65	1.65	1.65	1.75
		1.75	1.70	1.69	1.69	1.66	1.65	1.65	1.65	1.75
3F,I	Field Burning of crop residues	0.07	0.04	0.01	9E-05	2E-04	2E-04	2E-04	0.00	0.07
		0.07	0.04	0.01	9E-05	2E-04	2E-04	2E-04	0.00	0.07
5	Waste	0.51	0.72	0.80	0.82	0.90	0.65	0.35	0.20	0.51
		0.51	0.72	0.80	0.82	0.90	0.65	0.35	0.20	0.51

9.3.4. Ammonia (NH_3)

The total emission of NH_3 in Croatia was 40.6 kt in 2005 and 31.6 kt in 2020. This corresponds to a reduction of 22.3%.

The main source of NH_3 emissions is the agriculture sector with a share of 82.6% in 2020. Within the sector, 67% of NH_3 emissions come from agriculture - crops and soil (NFR 3D), i.e. the application of mineral N-fertilizers to the soil, and 33% from agriculture - animals (NFR 3B), i.e. manure management. The mentioned categories are also key for NH_3 emissions in Croatia.

The significant reduction in emissions in the historical period can be explained by the reduction in the number of animals and the application of techniques with lower NH_3 emissions to an increasing number of pig, poultry and cattle farms.

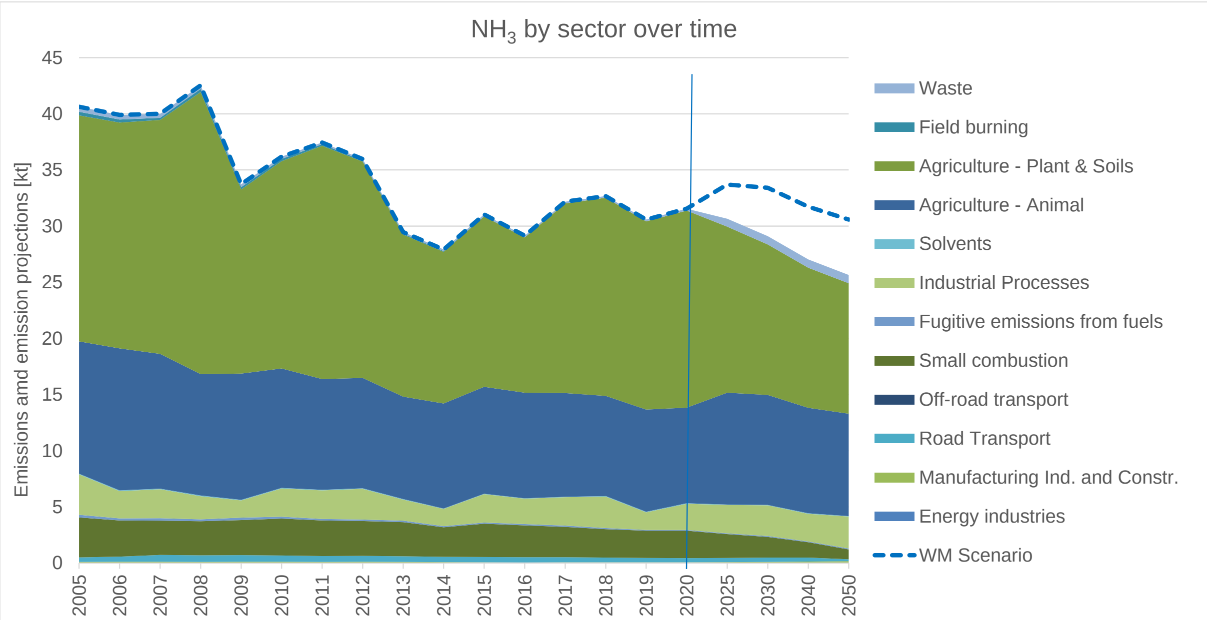

Figure 9.3-4 Emission trend and NH_3 emission projection for the WM and WAM scenarios

Source: EKONERG ltd

WM scenario

In the WM scenario "with existing measures", total national emissions are expected to decrease to 33.4 kt by 2030 (-17.8% compared to 2005). For the period between 2020 and 2030, NH_3 emissions show an increase of 5.9%.

The increase in the number of animals (pigs by +18.7% and dairy cattle by +45.5% between 2020 and 2030) is the main reason for the increase in national NH_3 emissions and for the NFR 3B category by 17.7% (+1.51 kt). The impact of low-emission fertilizer spreading techniques between 2020 and 2030 is not significant, so the decrease in the 3D category by 3.6% (- 0.62 kt) is mainly the result of a decrease in the consumption of mineral N-fertilizers.

WAM scenario

In the WAM scenario "with additional measures", total national emissions are expected to decrease to 29.1 kt by 2030 (-28.4% compared to 2005). In the period from 2020 to 2030, the total national NH_3 emissions are expected to decrease by 7.8%.

The main reason for the emission reduction is the impact of additional measures listed in the Croatian Air Pollution Control Program, the Low Carbon Strategy and the Integrated National Energy and Climate Plan in the NFR 3D agriculture - crops and soil category, which will reduce emissions by 23.6% (-4.1 kt) between 2020 and 2030. The reduction is somewhat greater than in the WM scenario due to the application of additional measures such as the reduction of urea consumption and its replacement with KAN (fertilizer with lower NH_3 emissions), the intensification of measures related to the prevention of nitrogen loss in agricultural production, the technique of applying animal manure to the soil with less emissions.

In the category 3B agriculture - animals, an increase in the number of swine and dairy cattle is expected, as in the WM scenario, which is the reason for the increase in emissions by 15% (1.3 kt) between 2020 and 2030. The increase is somewhat smaller compared to the WM scenario, due increased application of techniques related to animal housing systems and animal manure storage, improved animal nutrition and efficient feeding.

Table 9.3-9 Croatian total NH_3 emissions (historical and projected) in kt

Source category		Historic emission, kt				Projected emission, kt				
NFR	NFR	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
	TOTAL	40.64	36.19	31.04	31.55	33.70	33.42	31.73	30.58	WM
		40.64	36.19	31.04	31.55	30.66	29.11	27.03	25.66	WAM
1A1	Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	WM
		0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	WAM
1A2	Manufacturing Industries and Construction	0.08	0.09	0.05	0.06	0.06	0.07	0.09	0.10	WM
		0.08	0.09	0.05	0.06	0.07	0.09	0.12	0.15	WAM
1A3b	Road Transport	0.41	0.56	0.47	0.36	0.40	0.42	0.38	0.24	WM
		0.41	0.56	0.47	0.36	0.37	0.38	0.36	0.18	WAM
1A3a, c,d,e	Off-Road Transport	6E-04	4E-04	2E-04	2E-04	3E-04	3E-04	3E-04	2E-04	WM
		6E-04	4E-04	2E-04	2E-04	3E-04	3E-04	3E-04	2E-04	WAM
1A4	Small combustion	3.56	3.29	2.97	2.44	2.41	2.37	1.89	1.22	WM
		3.56	3.29	2.97	2.44	2.11	1.84	1.36	0.88	WAM
1B	Fugitive Emissions	0.22	0.16	0.11	0.07	0.08	0.09	0.08	0.08	WM
		0.22	0.16	0.11	0.07	0.08	0.09	0.08	0.08	WAM
2A,B,C, H,I,J,K,L	Industrial Processes	3.61	2.52	2.53	2.33	2.52	2.73	2.46	2.85	WM
		3.61	2.52	2.53	2.33	2.52	2.73	2.46	2.85	WAM
2D, 2G	Solvent	0.06	0.06	0.03	0.05	0.04	0.04	0.04	0.04	WM
		0.06	0.06	0.03	0.05	0.04	0.04	0.04	0.04	WAM
3B	Agriculture - Animals	11.78	10.63	9.52	8.51	10.13	10.02	9.77	9.62	WM
		11.78	10.63	9.52	8.51	9.96	9.79	9.39	9.12	WAM
3D	Agriculture - Crops & Soils	20.12	18.47	15.18	17.56	17.34	16.93	16.26	15.67	WM
		20.12	18.47	15.18	17.56	14.79	13.41	12.48	11.61	WAM

Source category		Historic emission, kt				Projected emission, kt				
NFR	NFR	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
3F,I	Field Burning of crop residues	0.32	0.20	0.03	4E-04	9E-04	9E-04	9E-04	9E-04	WM
		0.32	0.20	0.03	4E-04	9E-04	9E-04	9E-04	9E-04	WAM
5	Waste	0.46	0.20	0.15	0.17	0.70	0.73	0.74	0.75	WM
		0.46	0.20	0.15	0.17	0.70	0.73	0.74	0.75	WAM

9.3.5. Particulate matter ($PM_{2,5}$)

The total emission of $PM_{2.5}$ in Croatia was 43.6 kt in 2005 and 28.5 kt in 2020. This corresponds to a reduction of 34.7%.

The biggest reductions were achieved in the category of small combustion (NFR 1A4bi) by gradually switching to modern biomass instalations with lower $PM_{2.5}$ emissions (eco-design, pellet systems, high-efficiency stoves) and in road transport (NFR 1A3bi-iv) by introducing stricter standards for particle emissions in road vehicles (Euro 4, Euro 5, Euro 6 standard vehicles equipped with catalysts, diesel particulate filters (DPF) and addition of additives).

The key source in 2020 was the category of small combustion with a share of 76.2%. The achieved reduction of 37.6% compared to 2005 occurred mainly due to the replacement of traditional biomass instalations in residential with modern instalations with improved combustion technology, and to a lesser extent due to the implementation of energy efficiency measures in buildings and family homes. The category industrial processes (NFR 2A,B,C,H,I,J,K,L) is the second key source with a share of 9.4% in total emissions in 2020, whose emissions have increased by 92% compared to 2005. due to the increase in road construction and asphalting activities.

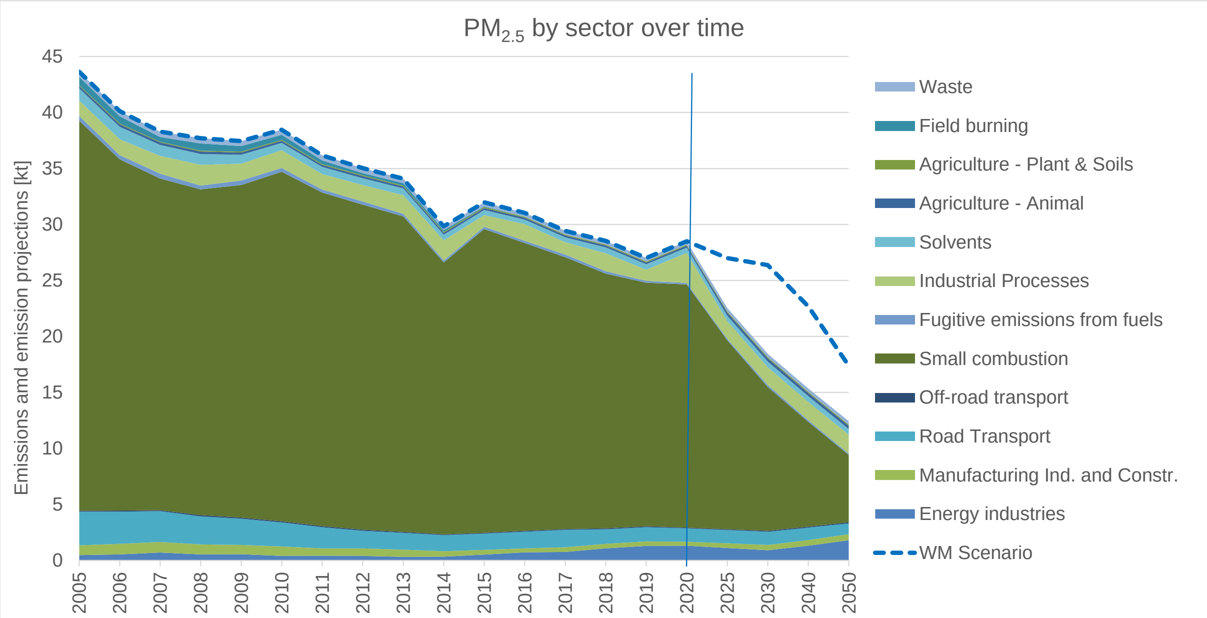

Figure 9.3-5 Emission trend and $PM_{2.5}$ emission projection for WM and WAM scenarios

Source: EKONERG ltd

WM scenario

In the WM scenario "with existing measures", total national emissions are expected to decrease to 26.4 kt by 2030 (-39.6% compared to 2005 and -7.4% compared to 2020).

Under the WM scenario, $PM_{2.5}$ emissions from NFR 1.A.4 small combustion are expected to decrease by 6.6% (i.e. -1.4 kt) in 2030 compared to 2020. By 2030, an increase is expected the use of biomass in home fireplaces, so the reduction of $PM_{2.5}$ emissions is mainly the result of the trend of further replacement of traditional instalations with modern heating biomass combustion techniques and at the same time the influence of eco-design provisions for the installation of new heating systems. In the period after 2030, more intensive application of energy efficiency measures in buildings and family houses is expected, and therefore a reduced demand for energy from biomass. The above is also supported by the influence of provisions on ecological design for the installation of new heating systems.

In the category of industrial processes (NFR 2A,B,C,H,I,J,K,L) it is expected that there will be a reduction of $PM_{2.5}$ emissions in 2030 by 39.7% (i.e. -1.1 kt) compared to 2020. Although the production industry is expected to increase, the decrease in emissions is mainly due to the expected decrease in the production of the mineral N-fertilizer urea.

WAM scenario

In the "with additional measures" WAM scenario, total national emissions are expected to decrease to 18.5 kt by 2030 (-57.7% compared to 2005 and -35.2% compared to 2020).

PM2.5 emissions from NFR 1A4 small combustion are expected to decrease by 40.9% (i.e. -8.9 kt) by 2030 compared to 2020 due to lower biomass inputs in energy consumption, but also lower fossil fuel inputs as a result of energy efficiency measures in buildings and family houses, greater use of electricity from renewable sources and more intensive introduction of modern biomass burning technologies in home fireplaces, replacement in relation to the WM scenario.

For total $PM_{2.5}$ emissions from industrial processes, in the WAM scenario, an additional, but not so significant reduction in emissions is expected as a result of a reduction in emissions in the cement production category (NFR 2A1) due to the application of an additional measure to reduce the share of clinker in cement production.

Table 9.3-10 Croatian total $PM_{2.5}$ emissions (historical and projected) in kt

Source category		Historic emission, kt				Projected emission, kt				
NFR	2005	2010	2005	2010	2005	2010	2005	2010	2050.	Scenarij
	TOTAL	43.64	38.46	31.97	28.50	27.00	26.38	22.67	17.37	WM
		43.64	38.46	31.97	28.50	22.54	18.45	15.36	12.44	WAM
1A1	Energy Industries	0.47	0.40	0.52	1.32	1.35	1.38	1.81	2.30	WM
		0.47	0.40	0.52	1.32	1.11	0.91	1.31	1.80	WAM
1A2	Manufacturing Industries and Construction	0.88	0.85	0.43	0.35	0.39	0.43	0.44	0.44	WM
		0.88	0.85	0.43	0.35	0.41	0.47	0.51	0.55	WAM
1A3b	Road Transport	3.00	2.15	1.45	1.20	1.20	1.21	1.17	1.09	WM
		3.00	2.15	1.45	1.20	1.19	1.18	1.11	0.96	WAM
1A3a, c,d,e	Off-Road Transport	0.08	0.09	0.07	0.07	0.08	0.09	0.08	0.09	WM
		0.08	0.09	0.07	0.07	0.08	0.09	0.09	0.10	WAM
1A4	Small combustion	34.83	31.22	27.12	21.72	21.06	20.28	16.13	10.36	WM
		34.83	31.22	27.12	21.72	16.85	12.83	9.36	6.01	WAM
1B	Fugitive Emissions	0.42	0.33	0.21	0.13	0.15	0.17	0.15	0.13	WM
		0.42	0.33	0.21	0.13	0.15	0.17	0.15	0.12	WAM
2A,B,C, H,I,J,K,L	Industrial Processes	1.40	1.60	1.04	2.68	1.58	1.62	1.67	1.75	WM
		1.40	1.60	1.04	2.68	1.56	1.59	1.63	1.69	WAM
2D, 2G	Solvent	1.07	0.65	0.46	0.48	0.49	0.50	0.51	0.52	WM
		1.07	0.65	0.46	0.48	0.49	0.50	0.51	0.52	WAM
3B		0.23	0.20	0.17	0.16	0.30	0.30	0.29	0.29	WM

Source category		Historic emission, kt				Projected emission, kt				
NFR	2005	2010	2005	2010	2005	2010	2005	2010	2050.	Scenarij
	Agriculture - Animals	0.23	0.20	0.17	0.16	0.30	0.30	0.29	0.29	WAM
3D	Agriculture - Crops & Soils	0.07	0.08	0.09	0.09	0.09	0.10	0.10	0.10	WM
		0.07	0.08	0.09	0.09	0.09	0.10	0.10	0.10	WAM
3F,I	Field Burning of crop residues	0.73	0.46	0.06	9E-04	2E-03	2E-03	2E-03	2E-03	WM
		0.73	0.46	0.06	9E-04	2E-03	2E-03	2E-03	2E-03	WAM
5	Waste	0.47	0.44	0.35	0.31	0.31	0.31	0.31	0.31	WM
		0.47	0.44	0.35	0.31	0.31	0.31	0.31	0.31	WAM

9.3.6. Black carbon (BC)

The total emission of BC in Croatia amounted to 6.4 kt in 2005 and 3.7 kt in 2020. This corresponds to a reduction of 41.7%.

The biggest reductions were achieved in the category of small combustion (NFR 1A4bi) by the gradual transition to modern biomass instalations with lower $PM_{2.5}$ emissions (eco-design, pellet systems, high-efficiency stoves) and in road transport (NFR 1A3bi-iv) and the introduction stricter standards for particle emissions in road vehicles (Euro 4, 5, 6 standard vehicles equipped with catalysts, diesel particulate filters (DPF) and addition of additives).

With a share of 71.8%, the category of small fireplaces (dominated by NF 1A4bi residential) was the main source of total $PM_{2.5}$ emissions in 2020. The achieved reduction of 31.8% compared to 2005 occurred mainly due to the replacement of traditional biomass instalations in residential with modern instalations with improved combustion technology, and to a lesser extent due to the implementation of energy efficiency measures in buildings and family houses.

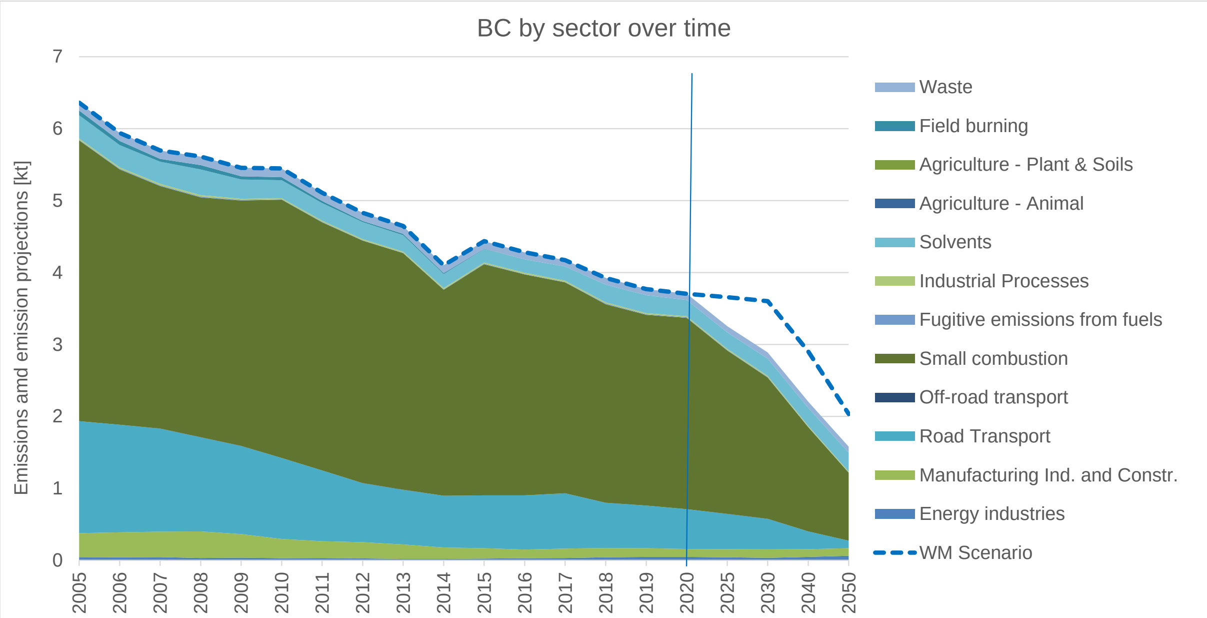

Figure 9.3-6 Emission trend and BC emission projection for WM and WAM scenario

Source: EKONERG ltd

WM scenario

In the WM scenario "with existing measures", total national emissions are expected to decrease to 3.6 kt by 2030 (-43.4% compared to 2005 and -2.8% compared to 2020).

It is expected that the main drivers of the BC emissions trend in the period up to 2030 will be road transport. Contrary to the general trend, emissions from the categories of small combustion are expected to remain unchanged.

BC emissions from road transport (NFR 1A3b) are expected to decrease by 22% (i.e. -0.1 kt) from 2020 to 2030. While exhaust emissions from passenger cars, LDVs and mopeds and motorcycles are expected to fall for 2030 (due to greater penetration of vehicles equipped with filters and to a lesser extent due to a slightly higher share of BEVs), emissions from road and tire brake wear should increase slightly due to an increase in the total number of vehicles and thus vehicle kilometers traveled. Emissions from HDV should also increase slightly due to slightly lower penetration of vehicles equipped with filters.

Under the WM scenario, BC emissions from NFR 1.A.4 small combustors in 2030 are expected to remain almost at the same level as in 2022, a decrease of 0.1% (ie -0.004 kt). The stable trend of BC emissions is mainly a consequence of the trend of increasing consumption of biomass in home combustion instalations, not so ambitious application of energy efficiency measures in buildings and family houses (until 2050, the renovation of the housing stock is assumed at the rate of 0.75% of the area of the stock of residential buildings per year up to the standard almost zero energy consumption) and a gradual transition to low-emission wood biomass combustion technologies, as an influence of eco-design provisions for the installation of new heating systems, which nullify the expected increase in biomass consumption as an energy source.

WAM scenario

In the "with additional measures" WAM scenario, total national emissions are expected to decrease to 2.9 kt by 2030 (-54.6% compared to 2005 and -22% compared to 2020).

BC emissions from the residential-dominated category of small combustors (NFR 1A4) are projected to decrease by 26.2% (i.e. -0.7 kt) by 2030 compared to 2020, and from road transport by 23.8% (i.e. -0.7 kt).

Table 9.3-11 Croatian total BC emissions (historical and projected) in kt

Source category		Historic emission, kt				Projected emission, kt				
NFR	2005	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
	TOTAL	6.36	5.45	4.44	3.71	3.66	3.60	2.90	2.03	WM
		6.36	5.45	4.44	3.71	3.25	2.89	2.20	1.58	WAM
1A1	Energy Industries	0.04	0.03	0.02	0.05	0.05	0.05	0.06	0.08	WM
		0.04	0.03	0.02	0.05	0.04	0.03	0.05	0.06	WAM
1A2	Manufacturing Industries and Construction	0.33	0.27	0.14	0.11	0.11	0.11	0.10	0.09	WM
		0.33	0.27	0.14	0.11	0.11	0.12	0.11	0.11	WAM
1A3b	Road Transport	1.56	1.13	0.73	0.55	0.49	0.43	0.27	0.13	WM
		1.56	1.13	0.73	0.55	0.49	0.42	0.25	0.10	WAM
1A3a, c,d,e	Off-Road Transport	1E-03	1E-03	1E-03	6E-04	9E-04	1E-03	1E-03	1E-03	WM
		1E-03	1E-03	1E-03	6E-04	9E-04	1E-03	1E-03	1E-03	WAM
1A4	Small combustion	3.90	3.59	3.21	2.66	2.66	2.66	2.12	1.37	WM
		3.90	3.59	3.21	2.66	2.27	1.96	1.45	0.94	WAM
1B	Fugitive Emissions	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	WM
		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	WAM
2A,B,C, H,I,J,K,L	Industrial Processes	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	WM
		0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	WAM
2D, 2G	Solvent	0.32	0.25	0.18	0.23	0.23	0.24	0.25	0.26	WM

Source category		Historic emission, kt				Projected emission, kt				
NFR	2005	2005	2010	2015	2020	2025	2030	2040	2050	Scenario
		0.32	0.25	0.18	0.23	0.23	0.24	0.25	0.26	WAM
3B	Agriculture - Animals	NA	NA	NA	NA	NA	NA	NA	NA	WM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3D	Agriculture - Crops & Soils	NA	NA	NA	NA	NA	NA	NA	NA	WM
		NA	NA	NA	NA	NA	NA	NA	NA	WAM
3F,I	Field Burning of crop residues	0.07	0.04	0.01	9E-05	2E-04	2E-04	2E-04	2E-04	WM
		0.07	0.04	0.01	9E-05	2E-04	2E-04	2E-04	2E-04	WAM
5	Waste	0.11	0.12	0.11	0.09	0.09	0.09	0.09	0.09	WM
		0.11	0.12	0.11	0.09	0.09	0.09	0.09	0.09	WAM

9.4. Explanation of emissions that exceeded the value of the mandatory reduction after 2010/2020

Regarding the achievement of Croatian goals according to the NEC directive 2016/2284/EU for 2030 in the WM scenario, Croatia will comply for SO_2 and NMVOC, while it will not comply for NOx, NH_3 and $PM_{2.5}$. The distance from the target for 2030 in the WM scenario "with existing measures" for NOx is 5.57 kt, for NH_3 2.93 kt, and for $PM_{2.5}$ 6.74 kt (table 9.3-3). The reason for the above is given below for each pollutant.

In the WM scenario"with existing measures", total national NOx emissions are expected to decrease to 44.3 kt by 2030 (-48.5% compared to 2005 and -3.2% compared to 2020). It is expected that the main drivers of the trend of NOx emissions in the period up to 2030 will be road transport, small combustion, manufacturing industries and construction, and energy industries. It is expected that emissions from road transport will decrease by 18.7% by 2030 compared to 2020, while for other key categories they will increase. Road transport has the largest contribution to NOx emissions in 2030 (37.7%). In this sector, until 2030, an increase in fossil fuel consumption of 8.1% compared to 2020 is predicted, which is associated with the expected economic growth, the increase in the standard of living and, consequently, with the increase in the number of road vehicles. The drop in emissions in this sector is based on the impact of measures in new vehicles (EURO 6d (PC, LDV), EURO 6 (HDV), and EURO 5 (mopeds and motorcycles)), and not so much on the penetration of new BEVs (battery electric vehicles) and hybrid vehicles whose share in total passenger activity in road transport reaches 2.5% in 2030 (for comparison, this percentage increases to 30% in 2050). In the category of small combustion, an increase in emissions of 2.9% compared to 2020 is predicted until 2030, primarily due to the expected increase in the consumption of wood biomass in residential, but also due to the replacement of old combustion technologies with new ones that have slightly higher specific emission factors for NOx. Until 2050, the renovation of the housing stock at the rate of 0.75% of the area of the stock of residential buildings per year is assumed to the standard of almost zero energy consumption, which is not ambitious in the WM scenario. In the categories of energy industries and manufacturing industries and construction, an increase in NOx emissions is predicted until 2030 compared to 2020, due to the predicted increase in fuel consumption in thermal power plants and refineries. The consumption is particularly noticeable for refineries, for which in both scenarios an increase in production with existing capacities is expected, along with an increase in the consumption of coke, refinery gas and electricity.

In the WM scenario "with existing measures", total national NH_3 emissions are expected to decrease to 33.4 kt by 2030 (-17.8% compared to 2005), but in the period up to 2030 emissions show an increase of 5.9%. The increase in the number of animals (swine by +18.7% and dairy cattle by +45.5% between 2020 and 2030) is the main reason for the increase in national NH_3 emissions and for category 3B manure management by 17.7% (+1, 51 kt). The impact of techniques for spreading fertilizers with low emissions between 2020 and 2030 is not significant, so the not so significant decrease in the category 3D production of crops and agricultural soils by 3.6% (- 0.62 kt) is mainly the result of the predicted decrease in mineral N consumption -fertilizers, of which urea is dominant in NH_3 emissions, but its reduction in the WM scenario is not ambitious enough.

In the WM scenario "with existing measures", total national $PM_{2.5}$ emissions are expected to decrease to 26.4 kt by 2030 (-39.6% compared to 2005 and -7.4% compared to 2020). According to the WM scenario, emissions from category 1.A.4 small combustion are expected to decrease by 6.6% (i.e. -1.4 kt) in 2030 compared to 2020. By 2030, the use of biomass is expected to increase in residential, so the not so significant reduction in $PM_{2.5}$ emissions is mainly the result of the trend of further replacement of traditional instalations with modern heating biomass combustion techniques and at the same time the influence of eco-design regulations for the installation of new heating systems. In the period up to 2030, the application of energy efficiency measures in buildings and family houses, and therefore the reduced demand for energy from biomass, is not ambitious. In the category of industrial processes (2A,B,C,H,I,J,K,L) it is expected that there will be a reduction of $PM_{2.5}$ emissions in 2030 by 39.7% (i.e. -1.1 kt) in compared to 2020. The decrease in emissions is mainly due to the expected decrease in the production of the mineral N-fertilizer urea, while the expected increase in the manufacturing industry until 2030 reduces this decrease in emissions.

Regarding the achievement of Croatia's targets under the NEC Directive 2016/2284/EU for 2030 in the WAM scenario, Croatia will comply for all pollutants except NOx. The distance from the 2030 NOx target in the "scenario with additional measures" is 4.11 kt (Table 9.3-4). The reason for the above is given below.

In the "with additional measures" WAM scenario, total national NOx emissions are expected to decrease to 43.0 kt by 2030 (-50.1% compared to 2005 and -6.2% compared to 2020). It is predicted that NOx emissions from road transport (mainly passenger cars) will decrease by 21% from 2020 to 2030, as well as emissions from energy industries by 5.7%, while emissions from the category of small combustion are expected to increase by 2.6% and from manufacturing industries and construction for 1.2% in the same period. The drop in emissions in road transport is based on the assumption of the intensification of the penetration of new electric and hybrid vehicles, whose share in the total passenger activity in road transport reaches 3.5% in 2030 (for comparison, this percentage increases to 65% in 2050). It is predicted that emissions from small combustion by 2030 will not significantly decrease compared to the WM scenario (-0.02 kt), due to the expected increase in fuel consumption (biomass) in residential until 2030, which is slightly lower in the WAM compared to the WM scenario, but also due to the predicted more intensive application of measures to replace old combustion technologies with new ones compared to the WM scenario, which have somewhat higher specific emission factors for NOx. In the category of energies industries, the reduction of coal intake and higher consumption of biomass and natural gas in thermal power plants results in a reduction of emissions of 5.7% until 2030 compared to 2020, with the fact that in 2040 there is no more use of coal, but at the same time for the category of refineries expects an increase in production with existing capacities until 2030.

It can be concluded that the goals and assumptions set until 2030 by the Low Carbon Development Strategy, the Energy Development Strategy and the Integrated National Energy and Climate Plan are the main reason for not fulfilling the obligation to reduce NOx in 2030. The goals and assumptions become more ambitious only after 2030, so this can be seen in the achievement of the set goal in the period after 2030.

9.5. Clarifications related to the reporting format

In the Annex IV-A emission projection table, aggregate category 5 Waste is shown, while subcategories 5A – 5E are not shown. For collective category 5, for pollutant BC, the notation key NE was used, although the notation keys are different depending on the subcategory 5A – 5E: NA, NE, IE and NO.

For discharge categories 1.A.5 Other, 3.B.4.a Bison, 3.B.4.h Other and 6.A Other, the Republic of Croatia uses the label "NO" - not regulated, i.e. does not exist.

For the projections of emissions in 2020, the label "NR" was used - not relevant because 2020 is the last historical year and the emissions were calculated for it and shown in the corresponding column.

Photo by Ekonerg Ltd.

10. Reporting of gridded emissions and LPS

Starting in 2017, EU Member States must report spatially disaggregated emissions (grid data) and emissions from large point sources (hereinafter: LPS) every four years as defined in section A of Annex VI of the CLRTAP reporting guidelines, as prescribed in Table 3 of Schedule 1 of the NEC Regulation. In the Croatian submission of spatially distributed emissions, spatially distributed emissions also include emissions from LPS, which are also reported separately. In 2017 and 2021, the Republic of Croatia fulfilled its obligation and reported on updated spatially disaggregated emissions and LPS emissions.

This chapter contains contains descriptions of the methodology used in the preparation of spatially disaggregated emissions of the Republic of Croatia. A detailed description of the grid preparation methodology and the methods used for the production of spatially disaggregated emissions are given in the documents: *Mapping methodology in the EMEP grid* and *Methodology for the development of the register of air pollutants for small and diffuse sources*. The documents are in Croatian and are not publicly available.

Spatially disaggregated emissions of the Republic of Croatia in the 0.1 ° x 0.1 ° EMEP network were first reported on 1 May 2017 for years: 1990, 1995, 2000, 2005, 2010 and 2015. Spatially disaggregated emissions of the following pollutants were submitted: NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, BC, CO, Pb, Cd, Hg, PCDD / PCDF, PAHs, HCBs and PCBs, which are also and mandatory for spatially disaggregated emissions reporting. Submitted spatially disaggregated emissions of the Republic of Croatia are aggregated into GNFR sectors (source names): A_PublicPower, B_Industry, C_OtherStationaryComb, D_Fugitive, E_Solvents, F_RoadTransport, G_Shipping, H_Aviation, I_Offroad, J_Waste, K_AgriLivestock, L_AgriOther, N_Natural, O_AviCruise, P_IntShipping. The submission in 2017 also included emissions from LPSs by source categories (GNFR) for the relevant pollutants and for the years: 1990, 1995, 2000, 2005, 2010 and 2015.

Submitted spatially disaggregated emissions for the Republic of Croatia (Annex V of the Reporting Guidelines 2014) also include LPS emissions, which are also submitted separately in Annex VI of the Reporting Guidelines 2014.

This year's submission on 1 May 2021 will include spatially disaggregated emissions for 1990, 1995, 2000, 2005, 2010, 2015 and 2019, all mandatory pollutants and GNFR sectors, identical to the submission in 2017. It will also include LPS emissions for 2019 by source category (GNFR) for relevant pollutants (see Table 1.1-6). LPS emissions submitted in 2017 will not be updated, and TERT recommendations and incentives related to the reporting of LPS emissions will be included in the reporting of their emissions in 2019.

Spatially disaggregated shows of the Republic of Croatia are available on the Internet link: https://emep.haop.hr/. Spatially disaggregated emissions for five air quality zones in the Republic of Croatia in the same resolution are also available at this link, as well as spatially disaggregated emissions for four air quality agglomerations and one city of interest in a finer resolution of 500 m x 500 m based on EMEP resolution.

Spatially disaggregated emissions of the Republic of Croatia were prepared in accordance with the Guidelines 2014 and Annexes V and VI to the Guidelines and the EMEP / EEA methodology. Spatially disaggregated emissions of the Republic of Croatia reported in 2017 are available on the website of the central database EIONET at web link: http://cdr.eionet.europa.eu/hr/un/clrtap/gridded/ and on the CEIP website at web link: https://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2017_submissions/.

Spatially disaggregated emissions to be reported on 1 May 2021 are in line with the set of proxy data used in the preparation of spatially disaggregated emissions submitted in 2017 and pollutant emissions for the period 1990 - 2019 reported on 15 February 2021. Also, they include all the improvements made until the submission of the inventory in 2021, and in that sense, the addition of a set of proxy data and spatially disaggregated emissions.

Spatial disaggregated emissions for the territory of the Republic of Croatia was carried out by using the EkoReGis model, which is based on numerous national geographical data sets. As the model is very complex and includes many spatial data, only the most important input data and descriptions of the methodology are included in the IIR report. More details on the applied methodology and model can be found in the document: „*Izvješće o prostorno raščlanjenim emisijama za područje republike hrvatske i pripadajuće zona kvalitete zraka*“ (Lit. 17). The document is not publicly available and is in Croatian language.

10.1. Summary of main changes

This chapter summarizes the main changes and improvements in the methodology for individual GNFR application categories in 2021 compared to those reported in 2017. Implemented changes / improvements are as follows:

- Updated national emissions of air pollutants for 1990, 1995, 2000, 2005, 2010 and 2015 according to the submission in 2021 for the period (1990-2019).
- Within the category NFR 2.D.3.i, 2.G Other solvent and product use, a new activity is included - Use of fireworks.
- Inclusion of a new NFR category 3.D.a.3 Urine and dung deposited by grazing animals for the following animals (dairy cows, other cattle, sheep, goats, horses, mules/asses).
- Inclusion of a new category NFR 3.D.a.2.a Animal manure applied to soils.
- Inclusion of a new category NFR 3.D.a.2.b Sewage sludge applied to soils.
- Inclusion of a new category NFR 5.B.1 Biological treatment of waste - composting.
- For NFR category 2.D.3.e Degreasing the activity data has been changed.
- Inclusion of a new category NFR 3.D.c Farm-level agricultural operations including storage, handling and transport of agricultural products and PM emission calculation.
- Inclusion of a new NFR category 3.D.e Cultivated crops and NMVOC emission calculation.
- Inclusion of new categories NFR 1.A.2 Manufacturing industries and construction for 1990, 1995 and 2000, namely 1.A.2.a Iron and steel, 1.A.2.b Non-ferrous metals, 1.A.2.c Chemicals, 1.A.2.d Pulp, paper and print, 1.A.2.e Food processing, beverages and tobacco and 1.A.2.f Non-metallic minerals.
- Within the category NFR 2.D.3.g Chemical products, a new activity is included - Asphalt blowing.
- Inclusion of a new NFR category 3.D.f Use of pesticides and HBC emission calculation.
- Inclusion of a new NFR category 3.F Field burning of agricultural residues.
- Emissions from category NFR 5.D.1 Domestic wastewater handling sector is transferred to NFR 5.D.2 Industrial wastewater handling, and from NFR 5.D.3 Other wastewater - Latrines in NFR 5.D.1 Domestic wastewater handling.
- Included emissions for 2019 of all LPS by source categories (GNFR) for relevant pollutants reported in the EPR and HLAP database.
- Included emissions for 2019 of LPS from the Agriculture (farms) sector by source categories (GNFR) for relevant pollutants calculated by the manufacturer based on the number of heads per species and existing NH_3 emission reduction techniques.

10.2. Methodology and models

An EkoReGis model has been developed for the preparation of spatially disaggregated emissions for the Republic of Croatia. The methodology built into the EkoReGis model follows the prescribed EMEP / EEA methodology in accordance with GB2019. The EkoReGis model was developed by EKONERG d.o.o. as part of the project: "*Development of a pollutant emission register with spatial distribution of emissions in the high-resolution EMEP network*" (Lit. 17).

The EkoReGis model was developed according to the requirements for reporting on gridded emissions according to the EMEP / EEA methodology and includes all emission sources that exist or have existed in the reporting years: 1990, 1995, 2000, 2005, 2010, 2015. and 2019 on the territory of the Republic of Croatia, for those pollutants for which there is an obligation to report disaggregated emissions. The result of the model is a spatially disaggregated emissions and their visual representation in the EMEP grid in the resolution 0.1° x 0.1°, including the spatial disaggregation for five air quality zones, as well as in the grid in resolution 500 m x 500 m for four air quality agglomerations and one city of interest. Emissions for the agglomeration area were not updated in 2021 and the latest available data are from 2017.

The results of this model are spatial emission data that represent the input for air quality modeling, and which are the input data for estimating atmospheric concentrations and precipitation. EkoReGis was primarily developed to be applicable for mandatory reporting of network emissions under CLRTAP.

For this year's submission, the views of spatially disaggregated inventories for the years 1990, 1995, 2000, 2005, 2010 and 2015 have been updated, and a new spatially disaggregated inventory for 2019 has been prepared.

10.2.1. Purpose and components of the model

EkoReGis was developed for the purpose of obtaining improved quality of spatial emissions data (higher resolution) and further application of these data in air quality modelling to assess the current state of air quality, air quality forecasting, air quality planning, source division and air pollution exposure studies.

Prior to the establishment of the EkoReGis model, the Republic of Croatia has reported on national gridded emissions in the EMEP grid, the resolution of 50 km x 50 km.

The EkoReGis model incorporates four key components for the full application of the EMEP / EEA methodology for spatial emissions disaggregation:

- national pollutant emissions officially submitted in accordance with UNECE CLRTAP and NECD;
- prepared geocoded networks for the Republic of Croatia, 5 air quality zones, 4 agglomerations and one city of interest;
- available proxy data sets;
- engineering models by air pollutant emission categories (NFR, SNAP).

All four components were used to describe each of the quadrants belonging to the Republic of Croatia, Croatian zones, agglomerations and one city. Each of the quadrants of the prepared geocoded grid is defined by a unique number (quadrant ID) and associated attributes, different proxy data. Ultimately, the national emission according to the defined engineering model via proxy data is associated in each of the quadrants.

A simplified view of the methodology that includes all of the above is shown in Figure 10.2-1.

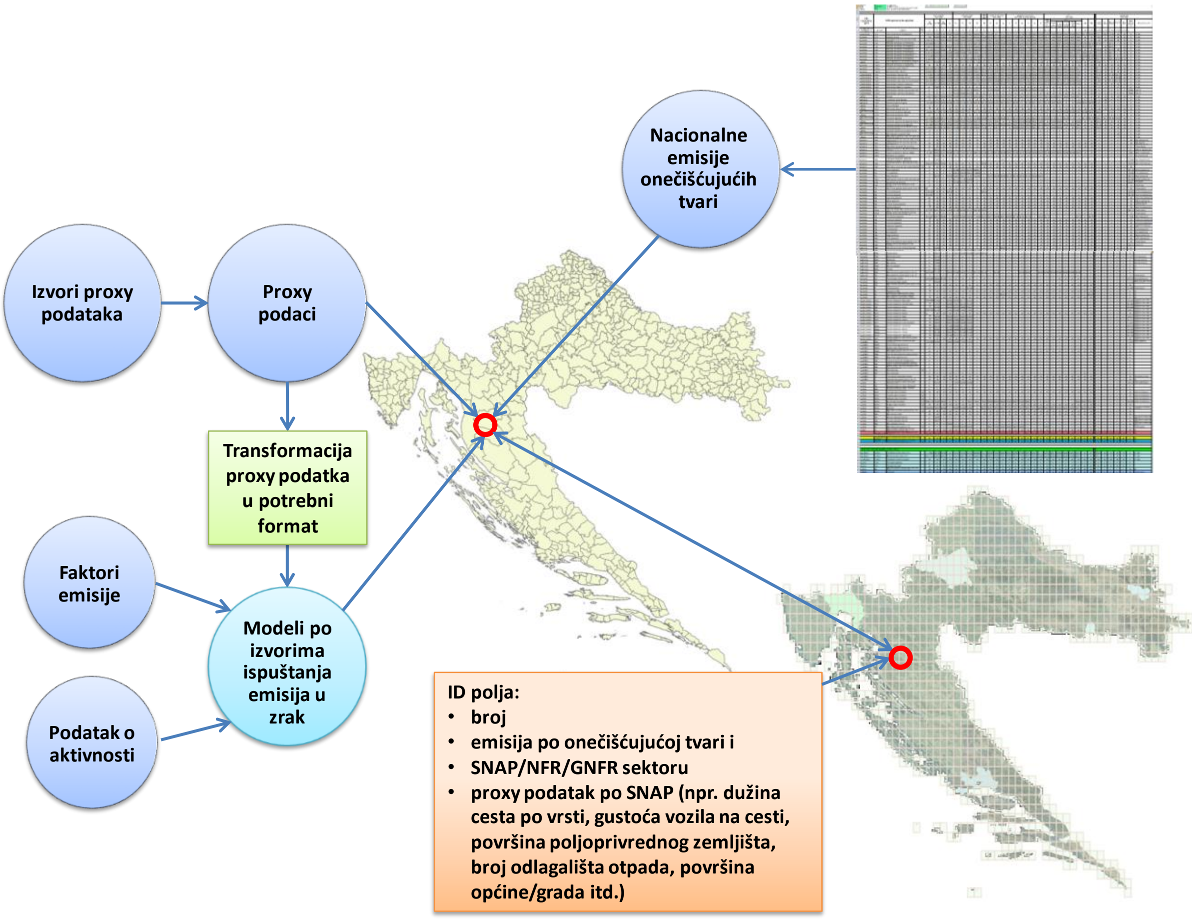

Figure 10.2-1 Simplified presentation of the methodology for spatial disaggregation of air pollutant emissions in the Republic of Croatia

Source: Ekonerg d.o.o.

10.2.2. Preparation of geocoded grid

The first step in creating the EkoReGis model was to prepare the grid. In doing so, Croatia specific data defining the grid cells and fraction of grid cells[51] was used (available at the link: https://www.ceip.at/ms/ceip_home1/ceip_home/new_emep-grid/grid_definition/), which is overlapped with the Central Register of Territorial Units (Figure 10.2-2 left). Overlaps identified nonconformities, so the assigned Croatia specific data was corrected (Figure 10.2-2 on the right) by removing the red-marked cells and adding the green ones. In the original, the EMEP grid for the Republic of Croatia contains 927 quadrants, and the corrected network contains 926. Information on the correction was sent to the CEIP - Center on Emission Inventories and Projections (Emep.Emissions emep.emissions@umweltbundesamt.at).

[51] SRI shapefile file specific to the Republic of Croatia with a network definition of 0.1 ° x0.1 ° (long-lat)

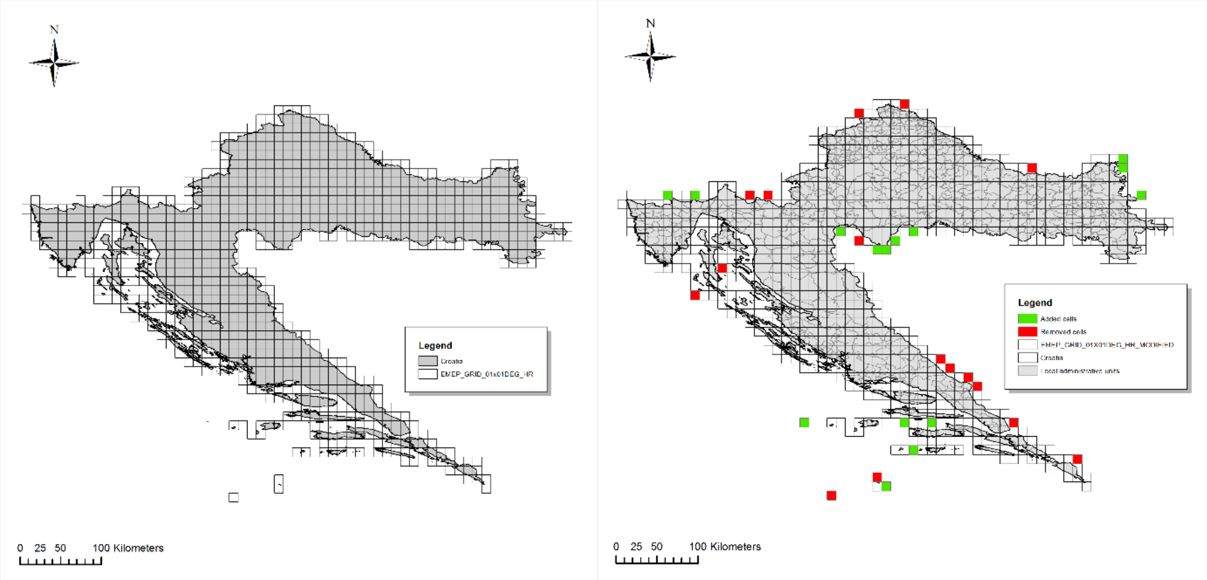

Figure 10.2-2 Original EMEP grid for the Republic of Croatia (left) and cross-section of the modified EMEP grid with the Central Register of Territorial Units of the Republic of Croatia (right)

Source: „Metodologija kartiranja u EMEP mreži“, Contractor: CEA (now MESD), Executor: Ekonerg Ltd.

10.2.3. Geospatial coverage of the EkoReGis model

The EkoReGis model covers the area defined by the national land and sea border (Figure 10.2-3 left) and the Register of Spatial Units of the Republic of Croatia (20 counties and the City of Zagreb with county status) (Figure 10.2-3 right) and the areas of five zones and four agglomerations defined by the Zone and agglomeration according to the levels of air pollution in the territory of the Republic of Croatia (OG 24/14) (Figure 10.2-4).

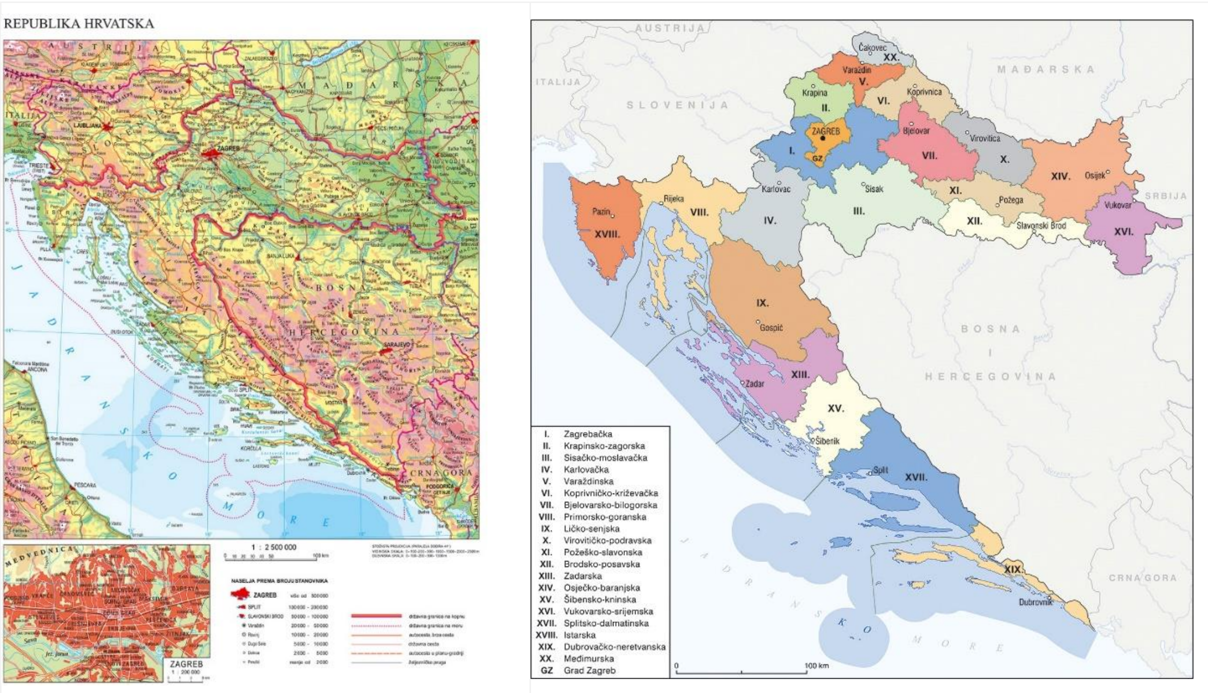

Figure 10.2-3 Border of the Republic of Croatia (left) and the Register of Spatial Units of the Republic of Croatia (right)

Source: Figure left: https://www.e-sfera.hr/dodatni-digitalni-sadrzaji/df78e11f-04a6-4cee-bd08-17c1abeb572e/; Figure right: https://commons.wikimedia.org/wiki/File:Counties_of_Croatia-fr.svg

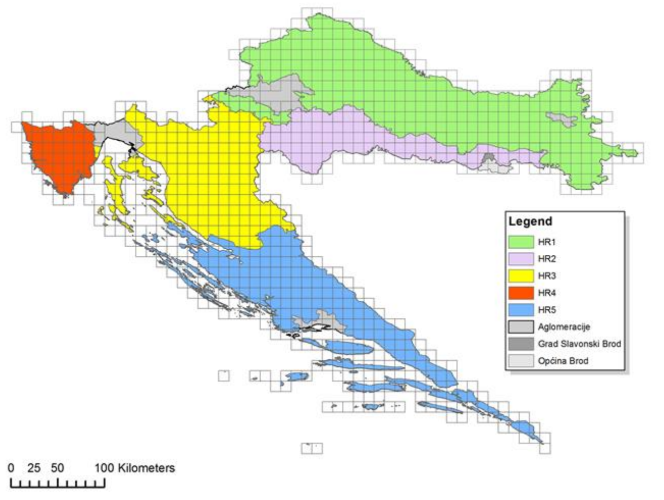

Figure 10.2-4 Cross-section of the modified EMEP network for the Republic of Croatia with Croatian areas of five air quality zones and four agglomerations

Source: „Metodologija kartiranja u EMEP mreži", Contractor: CEA (now MESD), Executor: Ekonerg Ltd.

There are three main climatic regions in Croatia: continental, central (mountainous) and coastal (maritime). These three climatic regions are conditioned by extremely diverse relief with three main types: lowland - Pannonian Croatia, mountainous - Mountainous Croatia and coastal Primorska Croatia (Figure 10.2-5). The central part of Croatia is the coldest with a mountain climate, and the continental part is somewhat milder with a continental climate than in the central part. The coastal part of Croatia has a mild Mediterranean climate. Climatic characteristics were one of the parameters used for the spatial analysis of emissions from the category NFR 1.A.4.b.i Residential.

Figure 10.2-5 Climatic regions of the Republic of Croatia

Source: https://www.e-sfera.hr/dodatni-digitalni-sadrzaji/df78e11f-04a6-4cee-bd08-17c1abeb572e/

10.2.4. Quantification and spatial distribution of diffuse sources in the territory of the Republic of Croatia in the EkoReGis model

Spatial distribution of emissions into grid quadrants with multi-country, zone, agglomeration, municipality and city boundaries uses Equation 2:

$$EM_{pi_K} = EM_{pi_{HR}} \times f \times \left(PROXY_{pi_K} / PROXY_{pi_{HR}}\right) \tag{2}$$

Where is:

EM_{pi_K}	= emission of pollutant pi, in quadrant *K*
$EM_{pi_{HR}}$	= total pollutant emission p_i for the territory of the Republic of Croatia
f	= fraction of grid quadrant *K* (1 or <1)
$PROXY_{pi_K}$	= data associated with the pollutant pi, within quadrant *K* (e.g. population in that quadrant)
$PROXY_{pi_{HR}}$	= proxy data associated with the pollutant pi, total for the territory of the Republic of Croatia (e.g. total population in the Republic of Croatia)

For EMEP grid cells that 100% belong to the territory of the Republic of Croatia, zone, agglomeration, municipality or city, Equation 2 is used for the distribution of emissions in that specific cell, where the fraction of that cell (f) is equal to number one.

For EMEP grid cells belonging to the territory of the Republic of Croatia, zone, agglomeration, municipality or city in a percentage less than 100%, Equation 2 is also used for emission distribution in this specific cell, where the fraction of that cell (f) is less than number one. This is the situation in many quadrants, and each state, zone, agglomeration, municipality or city has an assigned percentage if it shares an area with a neighbouring state, zone, agglomeration, municipality or city.

After preparing the necessary grid for the Republic of Croatia and allocating the amount of fractions to each quadrant, the LPS and other point sources were defined and their emission was subtracted from the national emission according to the corresponding GNFR / NFR / SNAP category. With the method of subtracting point sources emissions from the national total emissions, the values of diffuse source emissions were obtained, which were further processed.

Following the basic methodological approach for spatial mapping of emissions, in the EkoReGis model, emissions of LPS and other point sources are considered separately and their emissions are assigned to the grid quadrant exactly where they are located using the coordinates of each object. The object coordinate represents the proxy data for the point source allocation. LPS emissions are included in the Annex V Annex together with diffuse sources and other point sources, but are also reported separately in Annex VI of the Reporting Guidelines 2014. Details related to LPS and their spatial allocation are given in Subchapter 10.4.

Emissions from Small combustion, unreported or unregulated point sources and other diffuse sources (eg. polygons) are shown in the EkoReGis model in the area of the quadrant to which its x and y coordinates belong and are not represented according to their exact position as is the case with LPS. In the EkoReGis model, these emissions are quantified and spatially distributed by using nationally calculated emissions for a specific source category and linking them through the model with "proxy" statistics, such as the number of employees, number of inhabitants, etc.

Following the emission classification process, different spatial forms were managed in the next stage, including different sizes of grids, polygons, lines, each determined by the spatial characteristics of the source data.

The EkoReGis model combines a large number of geographical and statistical data sets (so-called proxy data), which needed to be adapted, combined and incorporated into a unifying format. The application of different sets of proxy data results in different patterns of spatial disaggregation of emissions in each of GNFR / NFR / SNAP category. To obtain a map of spatially disaggregated diffuse emissions, the EkoReGis model has combined and adapted the spatial data of different spatial projections such as WGS84, HTRS96, GK5 and GK6 to a common EMEP grid with a resolution of 0.1 ° x 0.1 °. This needed to be done so that different sectors / sources could be combined and linked. In this way, any future change, improvement or correction is much simpler. The sets of national proxy data used in the EkoReGis model are listed by sector in following Chapter 10.2.5.

The spatial distribution of emissions in the EkoReGis model was performed at the SNAP level of source categorization, i.e. at the most detailed level of the emission calculation in order to ensure the most detailed distribution of emissions. The SNAP level was applied for all sectors from SNAP 01 to 10. To meet the prescribed format according to ECE/EB.AIR.125[52] emission sources at the SNAP level were aggregated to the NFR level and then the NFR level to the required GNFR level.

10.2.5. Datasets (Proxy data)

A large number of national geographic data sets have been implemented in the EkoReGis model in the preparation of different distribution keys. The application of these data sets results in different patterns of spatial breakdown of national emissions in each GNFR category. The detail of the emission allocation, in addition to the emission calculation methodology, also depends on the detail of the available proxy data.

The data sets used and also available for the allocation of national emissions to the EMEP grid are listed in Tables 10.2-1 - 10.2-5, together with the data owners and the link to GNFR / NFR. Table 10.2-6 shows the data sets for the allocation of emissions from categories NFR 11.B, 1.A.3.ai (ii), 1.A.3.a.ii (ii) and 1.A.3.di (i) which do not enter the national total emissions.

The same proxy data sets were used for the 2021 submission as for the 2017 submission, but also supplemented for new category sources (see Chapter 10.1).

Table 10.2-1 General datasets for the allocation of national emissions to the EMEP network and links to GNFR and NFR

Dataset for emissions allocation	**Source**
EMEP grid for CRO	EMEP
Register of Spatial Units of the Republic of Croatia (RPJ)	MESD (originally DGU)
Digital orthophoto map (DOF) at a scale of 1: 5000	MESD (originally DGU)
Area of county, municipality / city, settlements in defined quadrants of networks: 0.1˚ x 0.1˚ and 500 m x 500 m	Calculated by overlapping the EMEP grid, RPJ and DOF for the Republic of Croatia by the Executor
Number of inhabitants of the county, municipality / city, settlement	CBS, Census 2011

[52] Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution prepared by TFEIP and published by the CLRTAP Executive Body

Table 10.2-2 Data sets for the allocation of national emissions from the Energy sector to the EMEP grid

GNFR	NFR	Dataset for emissions allocation	Source
A_PublicPower	1.A.1.a a. Public electricity and heat production	Geographical locations and drain height for thermal power plants, heating plants, public heating plants The amount of CO_2 emissions per public heating plant	MESD – EPR, Google maps
B_Industry	1.A.1.b Refineries	Geographical locations and drain height for refineries, heating devices and process furnaces heating devices	MESD – EPR, Google maps
B_Industry	1.A.1.c Manufacture of solid fuels and other energy industries	Geographical locations of coke ovens and flares in hydrocarbon fields The amount of CO_2 emissions during coke processing and during the oil and gas extraction process	INA Ltd. MESD - NEB MESD – EPR, ETS NIR Google maps
B_Industry	1.A.2.a Iron and steel 1.A.2.b Non-ferrous metals 1.A.2.c Chemicals 1.A.2.d Pulp, paper and print 1.A.2.e Food processing, beverages and tobacco1.A.2.f Non-metallic minerals	Geographical locations of the plant, employees in that industry	MESD - NEB MESD – EPR, ETS Google maps CBS
B_Industry	1.A.2.g.vii Mobile Combustion in manufacturing industries and construction	Number of employees in construction sector in the Republic of Croatia, distribution by municipalities	CBS
H_Aviation	1.A.3.Aviation (civil) - LTO	Number of LTO cycles in domestic and international transport by airports and the air landing places, Geographical locations of airports and the air landing places, Area of airports and the air landing places, Length of routes in the Republic of Croatia for domestic transport Length of routes in the Republic of Croatia for international transport to the Croatian border	Airports in the Republic of Croatia, Air landing places of the Republic of Croatia, CCAA, Google maps, DOF, AirlineRouteMapper The Global Airport Database
F_RoadTransport	1.A.3.b (i-vii) Road transport	Georeferenced road network, Counting transport on public roads by type of vehicle, Counting transport on motorways by type of vehicle, Counting transport on unclassified roads by type of vehicle, Number of vehicles by type and by county with the corresponding registration number, Distance travelled by vehicle type	Croatian roads, Croatian Motorways Ltd. (interactive map) MI vehicle database

GNFR	NFR	Dataset for emissions allocation	Source
I_Offroad	1.A.3.c Railways	Geo-referenced railway network with marked non-electrified and electrified rail sections and Marshalling Yards, Passenger transport by Marshalling Yard, Transport of goods by Marshalling Yards in the Republic of Croatia	HŽ Infrastruktura d.o.o., CBS
G_Shipping	1.A.3.d National navigation (shipping)	Geo-referenced network of inland waterways, geo-referenced network of sea routes, Geographical locations of the Harbour Master's Offices and Statistical ports, Maritime transport density, Maritime transport: transport of ships, passengers and goods by the Harbour Master's Offices and Statistical ports, Inland waterways transport: Transport of goods by the Harbour Master's Offices on inland waterways	MPPI - GIS database of the inland waterways and harbours, Real time ship maps - AIS Marine Transport_files CBS
C_OtherStationaryComb	1.A.4.a Commercial/institutional	Number of employees in service activities in the Republic of Croatia, distribution by municipalities	CBS
C_OtherStationaryComb	1.A.4.b.i Residential	Number of Housing units: − distribution by municipalities - for zones of the Republic of Croatia − distribution by settlements - for agglomerations of the Republic of Croatia − distribution by city districts - for the City of Zagreb Information on the method of heating and the type of energy used: − distribution by municipalities - for zones of the Republic of Croatia − distribution by settlements - for agglomerations of the Republic of Croatia − distribution by city districts - for the City of Zagreb	CBS
C_OtherStationaryComb	1.A.4.c.i c. Agriculture/forestry/fishing	Number of animals (cattle, pigs and poultry) in the Republic of Croatia, distribution by municipalities	CBS
I_Offroad	1.A.4.b.ii Residential	Number of households in municipalities / cities	CBS
I_Offroad	1.A.4.c.ii Agriculture / Forestry / Fishing	Geographical locations of arable land and areas under forests in municipalities / cities	MESD - CLC
D_Fugitive	1.B.1.a Fugitive emissions from solid fuels: Coal mining and handling	Geographic location of coal mines	MESD
D_Fugitive	1.B.1.b Fugitive emissions from solid fuels: Solid fuel transformation	Geographic location of coke plant	MESD

GNFR	NFR	Dataset for emissions allocation	Source
D_Fugitive	1.B.2.a.i Oil - Exploration, production, transport	Geographic locations of active oil fields, Area of each oil field, Amount of crude oil extracted in oil fields	INA Ltd.
D_Fugitive	1.B.2.b Natural gas - Exploration, production, transport	Geographic locations of active gas fields, Area of each gas field, Amount of gas extracted from fields, Natural gas transmission network	INA Ltd.
D_Fugitive	1.B.2.a.iv Refining, storage	Geographic locations of the plants for Fluid coking, Catalytic reforming, Catalytic Cracking, Sulphur recovery, and areas for Storage and handling of petroleum products	MESD – EPR, Google maps
D_Fugitive	1.B.2.a.v Distribution of oil products	Geographic locations of dispatch stations, gasoline terminals and service stations	MESD – service stations database
D_Fugitive	1.B.2.c Venting and flaring (oil, gas)	Geographic locations of flares in gas extraction and Geographic locations of flares in oil refineries Quantities of gas flared by locations of the flares	INA Ltd.

Table 10.2-3 Datasets for allocation of national emissions from the IPPU sector to the EMEP network

GNFR	NFR	Dataset for emissions allocation	Source
B_Industry	2.A.1 Cement production	Geographic locations of plants (coordinates), height of stacks	MESD – EPR
B_Industry	2.A.2 Lime production	Geographic locations of plants (coordinates), amount of produced lime per plant, total produced lime in Croatia, height of stacks	MESD – EPR, MESD - ETS CBS
B_Industry	2.A.3 Glass production	Geographic locations of plants (coordinates), amount of produced glass/mineral wool per plant, total produced glass in Croatia, height of stacks	MESD - ETS CBS
B_Industry	2.A.5.a Quarrying and mining of minerals other than coal	Geographic locations of quarries, surface area	MESD - Exploitation and exploration fields of mineral resources in Croatia
B_Industry	2.A.5.b Construction and demolition	Number of employees by economic activities	CBS
B_Industry	2.B.1 Ammonia production	Geographic location of plant (coordinates), height of stack	MESD – EPR, Google maps
B_Industry	2.B.2 Nitric acid production	Geographic locations of plants (coordinates), height of stacks	MESD – EPR Google maps
B_Industry	2.B.10.a Other	Geographic locations of plants (coordinates), number of employees by economic activities	MESD – EPR, CBS, Google maps
B_Industry	2.C.1.1. Steel production in OHF	Geographic location of plant (coordinates), height of stack	MESD – EPR, Google maps
B_Industry	2.C.1.1. Steel production in EAF	Geographic locations of plants (coordinates), amount of produced steel	MESD – EPR, MESD – ETS, Google maps

GNFR	NFR	Dataset for emissions allocation	Source
		per plant, total produced steel in Croatia, height of stacks	
B_Industry	2.C.1.2 Pig iron production	Geographic location of plant (coordinates), height of stack	MESD – EPR, Google maps
B_Industry	2.C.1.5 Rolling mills	Geographic locations of plants (coordinates), amount of rolled steel per plant, total rolled steel in Croatia	MESD – EPR CBS Google maps
B_Industry	2.C.2 Ferroalloys production	Geographic locations of plants (coordinates)	Google maps
B_Industry	2.C.3 Aluminium production	Geographic locations of plants (coordinates)	Google maps
E_Solvents	2.D.3.a Domestic solvent use including fungicides	Population, Surface area by counties, municipalities, cities	CBS
B_Industry	2.D.3.b Road paving with asphalt	Georeferenced road network	Hrvatske ceste
B_Industry	2.D.3.c Asphalt roofing	Number of employees by economic activities	CBS
E_Solvents	2.D.3.d Coating applications	Number of employees in economic activities that use coating applications in municipalities/cities (*Industrial and other coating applications*), population in municipalities/cities (*Decorative coating application*)	CBS
E_Solvents	2.D.3.e Degreasing	Number of employees in economic activities that use degreasing (e.g. shipyards, metal processing),	CBS
E_Solvents	2.D.3.f Dry cleaning	Number of employees in accommodation and food service activities (e.g. hotels)	CBS
E_Solvents	2.D.3.g Chemical products	Number of employees in chemical industry	CBS
E_Solvents	2.D.3.h Printing	Number of employees in printing industry	CBS
E_Solvents	2.D.3.i Other solvent use	Number of employees in manufacturing industry, by county and municipality / city	CBS
E_Solvents	2.G Other product use	Population, population density, urban and rural areas	CBS
B_Industry	2.H.1 Pulp and paper industry	Geographic locations of plants (coordinates), height of stacks	CBS, MESD – EPR
B_Industry	2.H.2 Food and beverages industry	Number of employees in food and beverages industry, by county and municipality / city	CBS
B_Industry	2.I Wood processing	Number of employees in wood processing industry, by county and municipality / city	CBS
B_Industry	2.K Consumption of POPs and heavy metals	Population in counties, municipalities, cities	CBS

Table 10.2-4 Datasets for the allocation of national emissions from the Agriculture sector to the EMEP grid

GNFR	NFR	Data set for emission allocation	Source
K_AgriLivestock	3.B.1 Dairy cattle and other cattle	Number and distribution of dairy cows and other cattle by counties and municipalities Number and distribution of dairy cows and other cattle by farms, geographical locations of farms	Ministry of Agriculture, CBS, CAA
K_AgriLivestock	3.B.2 Sheep	Number and distribution of sheep by counties and municipalities	Ministry of Agriculture, CBS,

GNFR	NFR	Data set for emission allocation	Source
			CAA
K_AgriLivestock	3.B.3 Swine	Number and distribution of swine categories by counties and municipalities Number and distribution of swine categories by farms, geographical locations of farms	Ministry of Agriculture, CBS, CAA
K_AgriLivestock	3.B.4.d Goats	Number and distribution of goats by counties and municipalities	Ministry of Agriculture, CBS,
K_AgriLivestock	3.B.4.e Horses	Number and distribution of horses by counties and municipalities	Ministry of Agriculture, CBS,
K_AgriLivestock	3.B..4.f Mules and asses	Number and distribution of mules and asses by counties and municipalities	Ministry of Agriculture, CAA
K_AgriLivestock	3.B.g.i Poultry	Number and distribution of poultry categories by counties and municipalities Number and distribution of poultry categories by farms, geographical locations of farms	Ministry of Agriculture, CAA
L_AgriOther	3.D.1.a Mineral N fertilizers	Utilized agricultural area and crop yields by counties and municipalities, CLC Croatia (agricultural areas)	Ministry of Agriculture, APPRR - ARKOD, CBS
L_AgriOther	3.D.a.2.a	Number and distribution of animal categories by counties and municipalities	Ministry of Agriculture, CBS, CAA
L_AgriOther	3.D.a.2.b	Applied sewage sludge by counties and municipalities	MESD
L_AgriOther	3.D.a.3	Number and distribution of animal categories by counties and municipalities	Ministry of Agriculture, CBS, CAA
L_AgriOther	3.D.c	Utilized agricultural area by counties and municipalities	Ministry of Agriculture, CBS
L_AgriOther	3.D.e	Grassland area and area of cropland, CLC Croatia: Area under crops (wheat, rye, rape) by counties and municipalities	Ministry of Agriculture, CBS, MESD
L_AgriOther	3.D.f	Utilized agricultural area by counties and municipalities	Ministry of Agriculture, CBS
L_AgriOther	3.F	Area under crops (wheat, barley, maize, oats, rye, peas, beans, soybeans) and crop yields	Ministry of Agriculture, CBS

Table 10.2-5 The data sets for the allocation of national emissions from the Waste sector to the EMEP grid

GNFR	NFR	Dataset for emissions allocation	Source
J_Waste	5.A Biological treatment of waste - solid waste disposal on land	Geographical locations of landfills, mass of waste per landfills, total mass of landfilled waste in the Republic of Croatia.	MESD – EPR and Waste Management Information System
J_Waste	5.B.1 Biological treatment of waste - composting	Geographical locations of composting plants, mass of composted waste per composting plant, total mass of composted waste in the Republic of Croatia.	MESD – EPR/ROO
J_Waste	5.C.1.b.i Industrial waste incineration	Geographical locations of the installations in which the waste is incinerated without energy recovery, mass of waste incinerated in the installation, total mass of incinerated industrial waste in the Republic of Croatia.	MESD – EPR/ROO

GNFR	NFR	Dataset for emissions allocation	Source
J_Waste	5.C.1.b.iii Clinical waste incineration	Geographical locations of hospitals in which the waste is incinerated without energy recovery, mass of waste incinerated in the hospital, total mass of incinerated clinical waste in the Republic of Croatia.	MESD – EPR/ROO
J_Waste	5.C.1.b.v Cremation	Geographical location of the crematorium.	MESD – EPR/ROO
J_Waste	5.D.1 Domestic wastewater handling	Geographical locations of central wastewater treatment plants, quantity of treated wastewater by counties or municipalities. Number of inhabitants by counties, municipalities and cities of the Republic of Croatia. Number of persons in occupied dwellings with sewerage installations by city/municipality of the Republic of Croatia.	MESD – EPR/ROO, Croatian Bureau of Statistics (CBS)
J_Waste	5.D.1 Domestic wastewater handling - latrine	Number of inhabitants with latrine, by counties and municipalities.	CBS
J_Waste	5.D.2 Industrial wastewater handling	Quantity of treated industrial wastewater, according to NKD 2007., by counties or municipalities.	CBS
J_Waste	5.E Other waste - Fires on vehicles and buildings	Number of fires by categories (eg vehicles, industrial and other buildings), by counties. Geographical location of the fire.	Ministry of the Interior

Table 10.2-6 Datasets for allocation of national emissions to the EMEP network from categories that are not included in total national emissions

GNFR	NFR	Dataset for emissions allocation	Source
N_Natural	11.B Forest fire	Vectorized data in the database - Number and locations of forest fires and forest area affected by fire	DUZS, Corine Land Cover
O_AviCruise	1.A.3.a. (ii) Aviation cruise	Number of LTO cycles in domestic and international transport at airports and ports, Geographical locations of airports and ports, Area of airports and piers, Length of routes in the Republic of Croatia for domestic transport Length of routes in the Republic of Croatia for international transport to the border of the Republic of Croatia	Airports and ports of the Republic of Croatia, CCAA, Google Maps, DOF, AirlineRouteMapper The Global Airport Database
P_IntShipping	1.A.3.d.i(i) International maritime transport (ship bunkers)	Location of the port for receiving bunker fuel (Port of Rijeka)	Bunker Ports News Worldwide

10.2.6. Allocation indicators by GNFR categories

This subchapter provides a summary overview of allocation indicators by all GNFR categories.

The relationship between the GNFR category and the spatial disaggregation patterns is given in Table 10.2-7. This method of spatial distribution is applied to all observed pollutants.

Table 10.2-7 GNFR categories and associated allocation indicators

GNFR	Allocation indicators
A_PublicPower	For 1.A.1.a - Thermal power plants (TPP), Public cogeneration plants (PCP) - Geographic locations, direct emissions. For 1.A.1.a - Heating plants (PHP) - Geographic locations and share in proportion to CO_2 emissions per Public heating plant.
B_Industry	For 1.A.1.b Refineries, 2.A.1 Cement production, 2.A.2 Lime production, 2.C.1 Iron and steel production, 2.C.2 Ferroalloys production, 2.C.3 Aluminium production, 2.H.1 Pulp and paper production, 2.B Chemical industry (2.B.1 Ammonia, 2.B.2 Nitric acid, 2.B.10.a - Sulfuric acid, NPK fertilizers, Urea, Black carbon, Ammonium phosphate, polyethylene LD, Ethylene, Propylene, 1,2 dichloroethane, Vinyl chloride, Polyvinyl chloride, Styrene, Polystyrene, Formaldehyde, Ethyl benzene) emissions are distributed at a specific point at the plant site. For Polyethylene LD, emissions are evenly distributed at two locations. For 2.B.1 Ammonia, 2.B.2 Nitric acid, 2.B.10.a - Sulfuric acid, NPK fertilizers, Urea, Black carbon, Ammonium phosphate emissions are showed at the same location (one company). For 2.H.1 Pulp and paper industry, emission was evenly distributed to three production sites for 1990 and to one site for other years. For 1.A.1.c.i- Geographic location of the point source (Coke plant) and share of CO_2 emission. For1.A.1.c.iii - Process of extracting oil and gas (hydrocarbons) in proportion to the mass of gas flared on flares at geospatial locations of flares in hydrocarbon fields. For 1.A.2, 2.B.10.a (Formaldehyde), 2.H.2, 2.I in proportion to number of employees (NKD 2007) in the category C= MANUFACTURING INDUSTRY in the city/municipality. For 2.A.5.a in proportion to the area of each exploitation field (except hydrocarbons) to the geospatial location of the individual exploitation field. For 2.A.5.b and 2.D.3.c in proportion to number of employees (NKD 2007) in the category F=CONSTRUCTION in city/municipality. For 2.D.3.b in proportion to road section length in a quadrant. For 2.K in proportion to population in the city/municipality.
C_OtherStationary Comb	For 1.A.4.a.i Commercial / institutional: Stationary in proportion to the number of employees (NKD 2007) in the category of I so S, i.e. in the SERVICES sector in the city / municipality. For 1.A.4.b.i Residential: stationary combustion in proportion to the data on the number of household units, their area, the method of units heating and the type of energy used, in the city / municipality. Details on the specific energy consumption by type and unit of area and their purpose (cooking, heating and preparation of hot water) were obtained by conducting a detailed survey conducted in 2014 for the territory of the Republic of Croatia. The results of the survey were matched with the census (2001 and 2011) with the inclusion of climatic conditions present in the territory of the Republic of Croatia (Figure 10.2-5) through the degree-day function for individual heating methods. In the last step, the pairing results were linked to the national energy balance. For 1.A.4.c.i Agriculture / Forestry / Fishing: Stationary in proportion to the number of animals (cattle, pigs and poultry) in the municipality / city.
D_Fugitive	For 1.B.1.a Coal mines: uniformly to all geospatial mine locations (1990 only) For 1.B.1.b Coke plant: to the geospatial location of one source.

GNFR	Allocation indicators
	For 1.B.2.a.i Oil exploration, production, transport: in proportion to the amount of oil produced (in tonnes) and the area of the oilfield polygon to the geospatial location of the oilfield area. For 1.B.2.a.iv Refining / storage (Fluid coking unit, Catalytic reforming unit, Catalytic cracking unit regenerator, Claus plant, Storage and handling of petroleum products): proportional to emissions from relevant sources to the geospatial locations of these sources. For 1.B.2.a.v Gasoline transport: for refinery dispatch stations a uniform distribution to the geographical locations of the dispatcher, for gasoline terminals a uniform distribution to the geographical locations of the terminals, and for gasoline stations a uniform distribution to all geographical locations of petrol stations. For 1.B.2.b Natural gas exploration/production: in proportion to the amount of natural gas produced and the area of the natural gas exploitation field polygon to the geospatial locations of the natural gas exploitation field. For 1.B.2.b Natural gas transmission in proportion to the length of the transmission line section in the network quadrant. For 1.B.2.c Flares: for combustion in gas fields in proportion to the amount of gas flared at geospatial locations of flares in gas fields, for combustion in refineries in proportion to the amount of gas flared on flares at locations in refineries.
E_Solvents	For 2.D.3.a, 2.G in proportion to population in the city/municipality. For 2.D.3.d in proportion to the average value of the number of employees (NKD 2007) in category C= MANUFACTURING INDUSTRY and population in the city/municipality. For 2.D.3.e, 2.D.3.g, 2.D.3.h and 2.D.3.i, 2.G in proportion to number of employees (NKD 2007) in category C= MANUFACTURING INDUSTRY in the city/municipality. For 2.D.3.f in proportion to number of employees (NKD 2007) in category I= ACOMMODATION ACTIVITIES in the city/municipality.
F_RoadTransport	For 1.A.3.b.(i-iv): • for Highways in proportion to the average annual daily transport at toll stations by type of vehicle and motorway length in quadrant (proportional to PGDP (section of each road type from one automatic counting point to the first following automatic counting point for each type of road: motorway, state road or county road) and a section of motorway length in the grid quadrant). • for Urban roads in proportion to the number of registered vehicles (90% - for 21 cities) of the same registration number in the city / municipality and the section of the length of the city road in the grid quadrant. • for Rural roads in proportion to the number of registered vehicles (10% - 14 cities) of the same registration number in the city / municipality and the section of rural road length in the grid quadrant. For 1.A.3.b.v, 1.A.3.b.vi, 1.A.3.b.vii proportional to the length of the section of all types of roads in the grid quadrant.
G_Shipping	For 1.A.3.d National navigation (maritime) proportional to the transport intensity of ships, passengers and goods on sea routes and at the locations of the Harbour Master's Offices and Statistical ports. For 1.A.3.d National navigation (river - inland navigation) proportional to the transport intensity of goods by the Harbour Master's Offices on inland waterways and in proportion to the length of the navigable part of the river (waterway section) in a quadrant.

GNFR	**Allocation indicators**
H_Aviation	For 1.A.3.a Aviation (Civil) (LTO) on areas of the polygons, geospatial locations of the airport and the air landing places locations in proportion to transport intensity of passengers and goods and LTO cycles in domestic and international transport.
I_Offroad	For 1.A.3.c Railway proportional to the intensity of passenger and freight transport on non-electrified and electrified lines and at 13 Marshalling Yards to the georeferenced rail network and geospatial locations of Marshalling Yards. For 1.A.4.b.ii Residential: Household and gardening (mobile) in proportion to the number of households in the municipality / city. For 1.A.4.c.ii Agriculture / Forestry / Fishing; Off road vehicles and other machinery - Agriculture (SNAP 080600) in proportion to the size of arable agricultural land in the municipality / city. For 1.A.4.c.ii Agriculture / Forestry / Fishing; Off road vehicles and other machinery - Forestry (SNAP 080700) in proportion to the size of the area under forests in the municipality / city. For 1.A.2.g.vii Mobile Combustion in manufacturing industries and construction: mobile sources in proportion to the number of employees (NKD 2007) in category F = CONSTRUCTION in the city / municipality.
J_Waste	For 5.A Biological treatment of waste - solid waste disposal on land in proportion to the mass of landfilled solid waste to geospatial locations of active landfills. For 5.B1 Biological treatment of waste - composting in proportion to the mass of composted waste to geospatial locations of composting plants. For 5.C.1.b.i Industrial waste incineration in proportion to the mass of incinerated industrial waste without energy recovery to geospatial locations of installations for industrial waste incineration. For 5.C.1.b.iii Clinical waste incineration in proportion to the mass of incinerated clinical waste without energy recovery to geospatial locations of installations for clinical waste incineration. For 5.C.1.b.v Cremation: emissions are distributed at a point at the location of the crematorium. For 5.D.1 Domestic wastewater handling by locations of central municipal wastewater treatment systems in the Republic of Croatia in proportion to the number of persons in occupied dwellings/buildings with sewerage installation in the city/municipality. For 5.D.1 Domestic wastewater handling – latrine in proportion to the number of dwellings for permanent and occasional residence with a toilet without flusher, without a toilet in the dwelling and unknown in the municipality/city. For 5.D.2 Industrial wastewater handling in proportion to the number of employees (NKD 2007.) in category C = MANUFACTURING in the city/municipality. For 5.E Other waste uniform distribution to geospatial locations of fires on vehicles and buildings in the Republic of Croatia.
K_AgriLivestock	For 3.B Manure management: in proportion to the animal number by species in the county/ city/ municipality/ on the farm, and uniformly per segment of agricultural area in the county/ city/ municipality/ on the farm.
L_AgriOther	For 3.D Crop production and agricultural soils,: in proportion to the pasture areas and area under crops in the county/ city/ municipality.
O_AviCruise	For 1.A.3.a Aviation (Civil) (cruise) in proportion to the intensity (density) of the air route on the length of routes in the Republic of Croatia for domestic transport and the length of routes in the Republic of Croatia for international transport to the Croatian border.

GNFR	Allocation indicators
P_IntShipping	For 1.A.3.d.ii (080404) International maritime navigation, in proportion to the transport intensity of ships, passengers and goods in ports of international importance.
N_Natural	For 11.B Forest fires evenly on geospatial locations of forest fires.

11.3 Results of spatial distribution of emissions (visualization)

A visualized view of the results of the spatial disaggregation of emissions is available at the link: https://emep.haop.hr/, from which the representations in Figures 11.3-1 - 11.3-5 for NOx, SO_2, NH_3, NMVOC and $PM_{2.5}$ are taken. The Figures are related to emissions in 2019. In addition to the above, the link also provides views for years: 1990, 1995, 2000, 2010 and 2015 for all observed pollutants for which there is an obligation to spatial disaggregation of emissions. Figures also include emissions from LPSs.

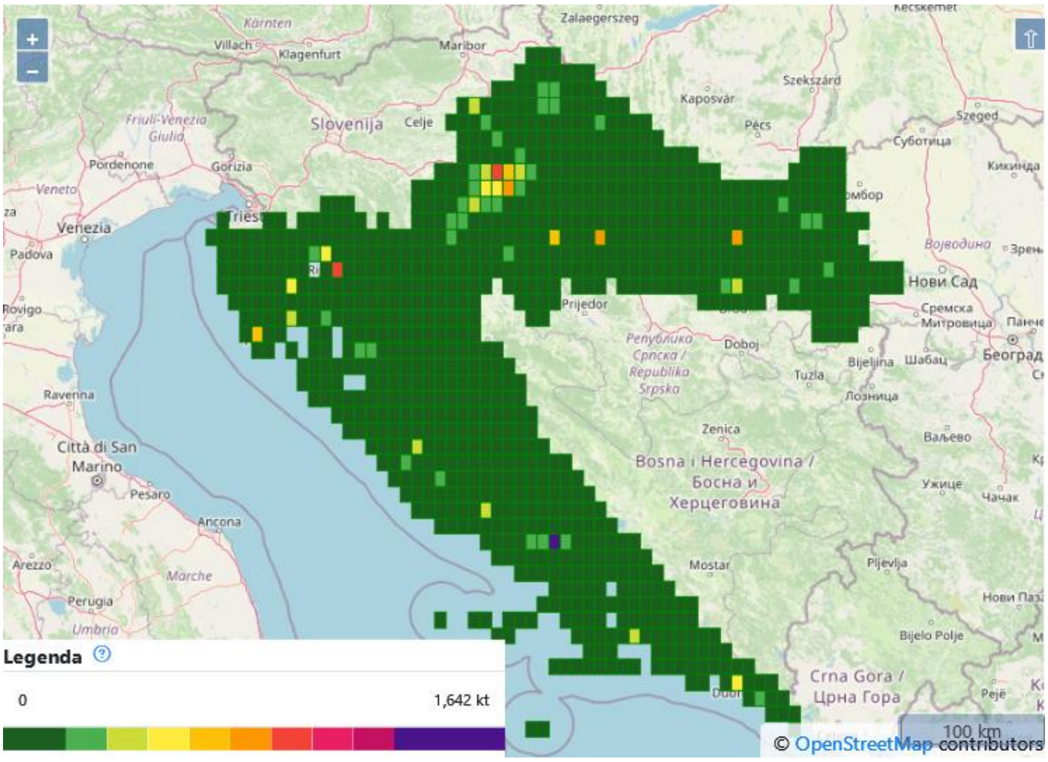

Figure 10.3-1 Spatially disaggregated NOx emissions in the Republic of Croatia, 2019

Source: https://emep.haop.hr/

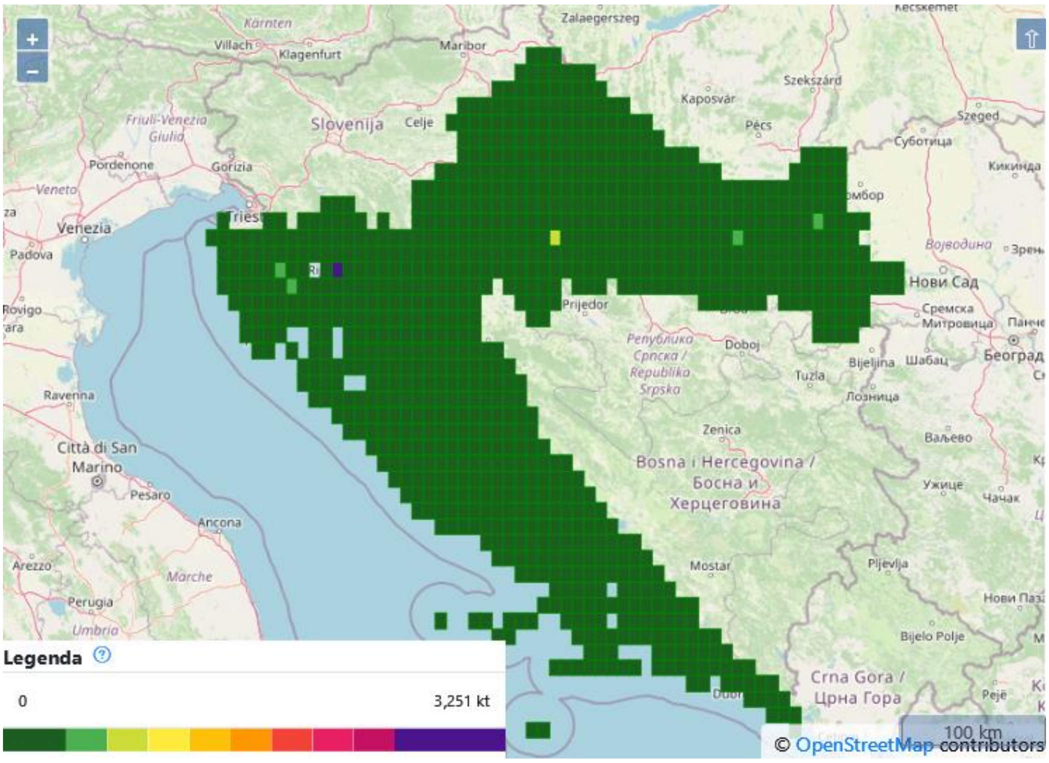

Figure 10.3-2 Spatially disaggregated SO_2 emissions in the Republic of Croatia, 2019

Source: https://emep.haop.hr/

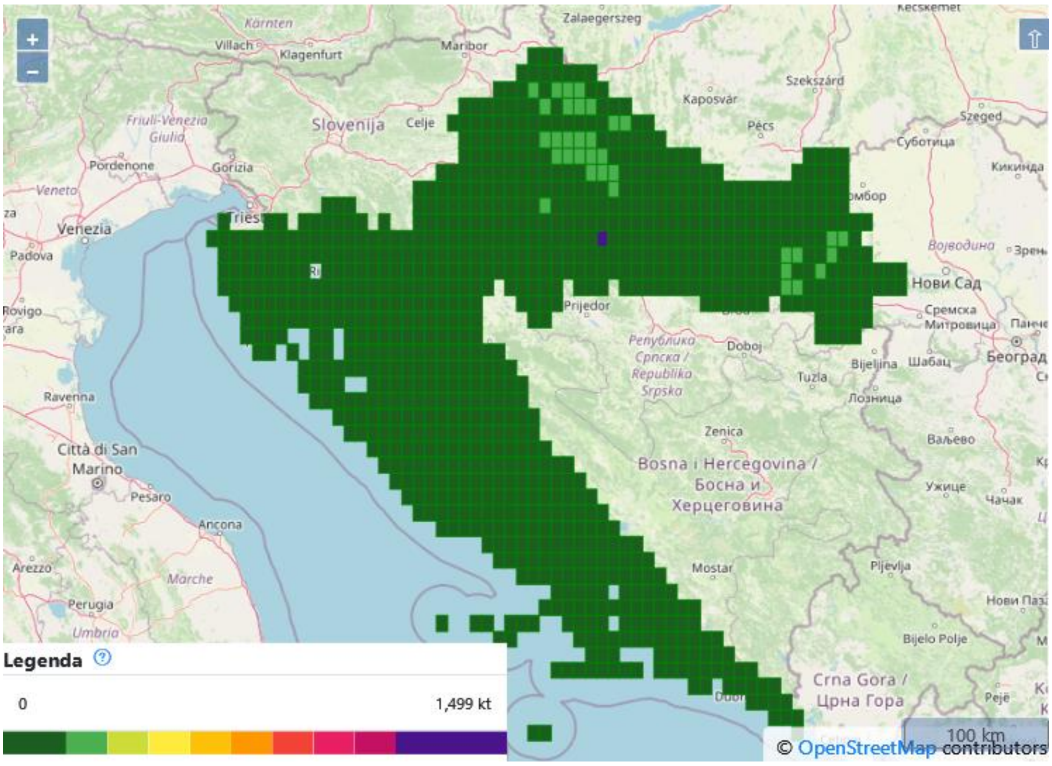

Figure 10.3-3 Spatially disaggregated NH_3 emissions in the Republic of Croatia, 2019

Source: https://emep.haop.hr/

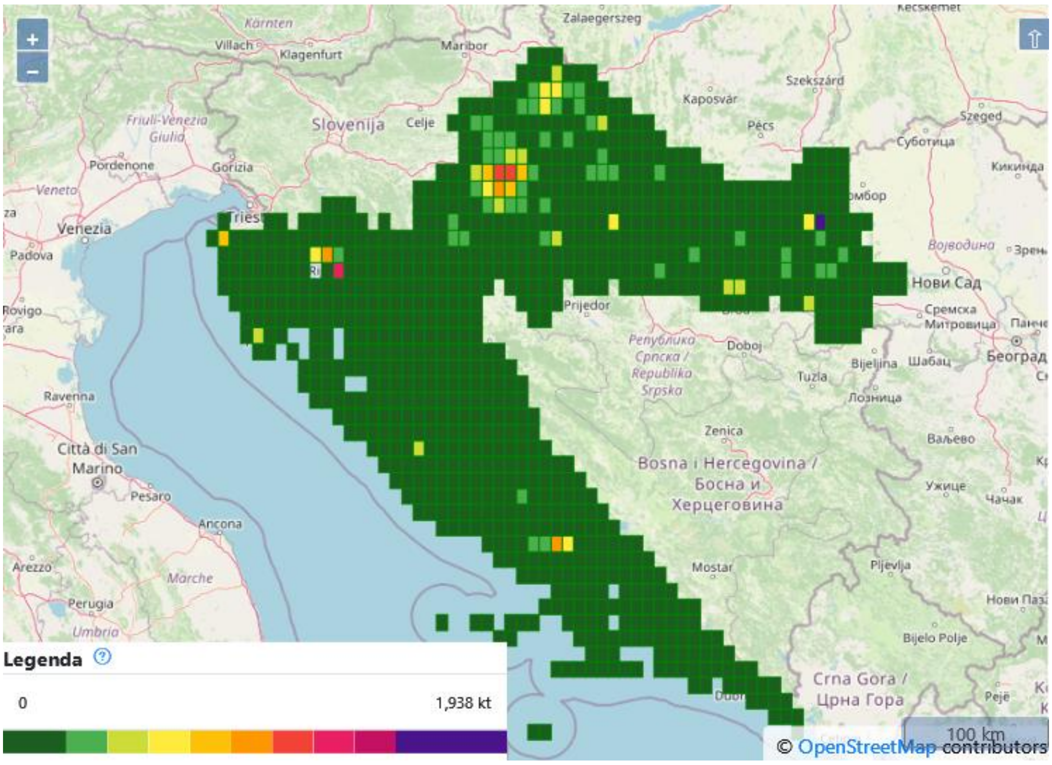

Figure 10.3-4 Spatially disaggregated NMVOC emissions in the Republic of Croatia, 2019

Source: https://emep.haop.hr/

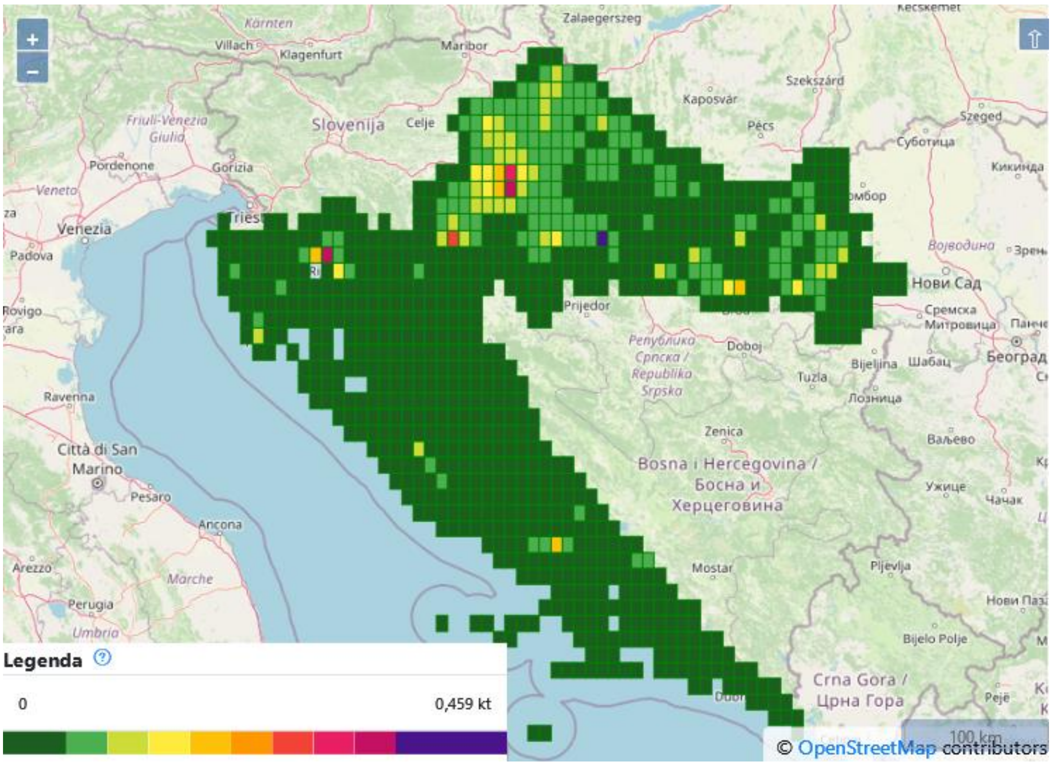

Figure 10.3-5 Spatially disaggregated $PM_{2.5}$ emissions in the Republic of Croatia, 2019

Source: https://emep.haop.hr/

11.4 Large point sources (LPS)

10.4.1. The LPS determination method

Large point sources (LPS) are reported according to the definitions of the ECE Guidelines (ECE 2014). LPS are defined as facilities or installations whose emissions of at least one of the 14 pollutants exceed the defined limit value given.

The method used to determine which LPS plant is described in the definition of LPS in the 2014 Reporting Guidelines “Large Point Sources” (LPS) are defined as installations[53] whose combined emissions, within a limited identifiable area of the site area, exceed the pollutant emission thresholds shown in Figure 10.4-1.

The Republic of Croatia prescribes stricter thresholds for most pollutants in the Ordinance on the Environmental Pollution Register (OG 87/15) (further in text: the Ordinance on EPR) and the related Annex 2 (eg thresholds for air emissions of SO_2 are 3,000 kg/year, NO_2 600 kg/year, PM_{10}: 200 kg/year, Hg 1 kg/year, etc.). The thresholds defined by the Ordinance on EPR are not at the same time an indication that the LPS plant is observed, but an indication that the plant is obliged to submit data on air pollutant emissions defined in Annex 2 of the Ordinance on EPR, when the total amount of emissions by individual pollutants from Annex 2 of the Ordinance on EPR, collectively for all discharges at the level of the organizational unit is greater than or equal to the discharge threshold.

List of pollutants to be reported for an LPS if the applicable threshold value is exceeded, based on thresholds specified in annex II to the E-PRTR Regulation

Pollutants/substances	*Thresholds in kilograms per year (kg/year)*
SO_X	150 000
NO_x	100 000
CO	500 000
NMVOCs	100 000
NH_3	10 000
$PM_{2.5}$	50 000
PM_{10}	50 000
Pb	200
Cd	10
Hg	10
PAHs (Sum of the four indicator PAHs)	50
PCDD/F	0.0001
HCB	10
PCBs	0.1

Figure 10.4-1 List of pollutants to be reported for LPS if the applicable threshold value is exceeded, based on the thresholds listed in Annex II. E-PRTR Regulation

[53] As defined in Article 2 (4) and (5) of the E-PRTR Regulation cited later in paragraph 9 above, “facility” means one or more installations at the same location operated by the same natural or legal person and “location ”Indicates the geographical location of the facility.

The list of Croatian LPS fot the year 2019 submitted in 2021, included 103 plants. Of these, 23 are plants from the Energy and Industrial Processes sector, for which emissions were reported to the EPR database, 6 plants from the Product Use sector (Solvents) for which emissions are reported to the HLAP database. The rest are farms, which belong to the GNFR category K_AgricultureLivestock and which were calculated by the Executor, based on the number of animals on each farm in 2019 and data on installed NH_3 emission reduction techniques, as there are no publicly available emission data for them yet.

Information related to the physical height of the stack is reported with height classes, and LPSs locations are given in WGS 84 decimal coordinates.

In accordance with the given criterion that the set of LPS, GNFR and altitude class must appear only once (according to Annex VI of the Reporting Guidelines 2014), for LPS where there is more than one hight class at the site (e.g. refineries), for the needs the class with the highest stack height was assigned to the reporting.

As part of the LPSs submission in 2021, for the years 1990, 1995, 2000, 2010 and 2015 for which there are several GNFRs at the site in the inventory (e.g. for refineries: GNFR B_Industry for NFR 1.A.1.b Refineries, D_Fugitive for NFR 1.B.2.a.iv Fugitive oil emissions: Refining / storage and 1.B.2.c Flares (oil, gas, combined oil and gas) for categorization of LPS emission reporting associated is the corresponding GNFR (non-compliance with the given criterion). The mentioned application included, in addition to emissions reported in the EPR database, emissions calculated by the manufacturer and for which the EPR obligor has no obligation to report.

LPSs for 2019 submitted in 2021 contain only reported emissions (in the EPR database) and do not include emissions calculated by the manufacturer, for which the EPR obligor has no obligation to report. For the categorization of LPS emission reporting, the GNFR is determined as follows: in accordance with the classification of the organizational unit on site (LPS) in E-PRTR: Facility Details, Main activity (NACE) and using the Mapping Table[54] linking the categories of different reporting formats (NACE, SNAP, NFR, CRF, E-PRTR, GAINS / RAINS) determined a single LPS GNFR.

LPSs in 2019 are plants for the production of electricity and heat, production of other non-metallic mineral products (cement, glass, other), sugar factories, plant for the production of mineral fertilizers and other chemicals, plants for the production of refined petroleum products (refineries) and cow, pig and poultry farms.

An overview of LPSs geospatial locations in accordance with the submission in 2021, can be seen in Figure 10.4-2.

[54] The table was prepared by a team of Finnish and Estonian broadcast experts (last updated on December 6, 2019) and is available at: https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2019/06122019_conversiontablereportingcodes_.xlsx

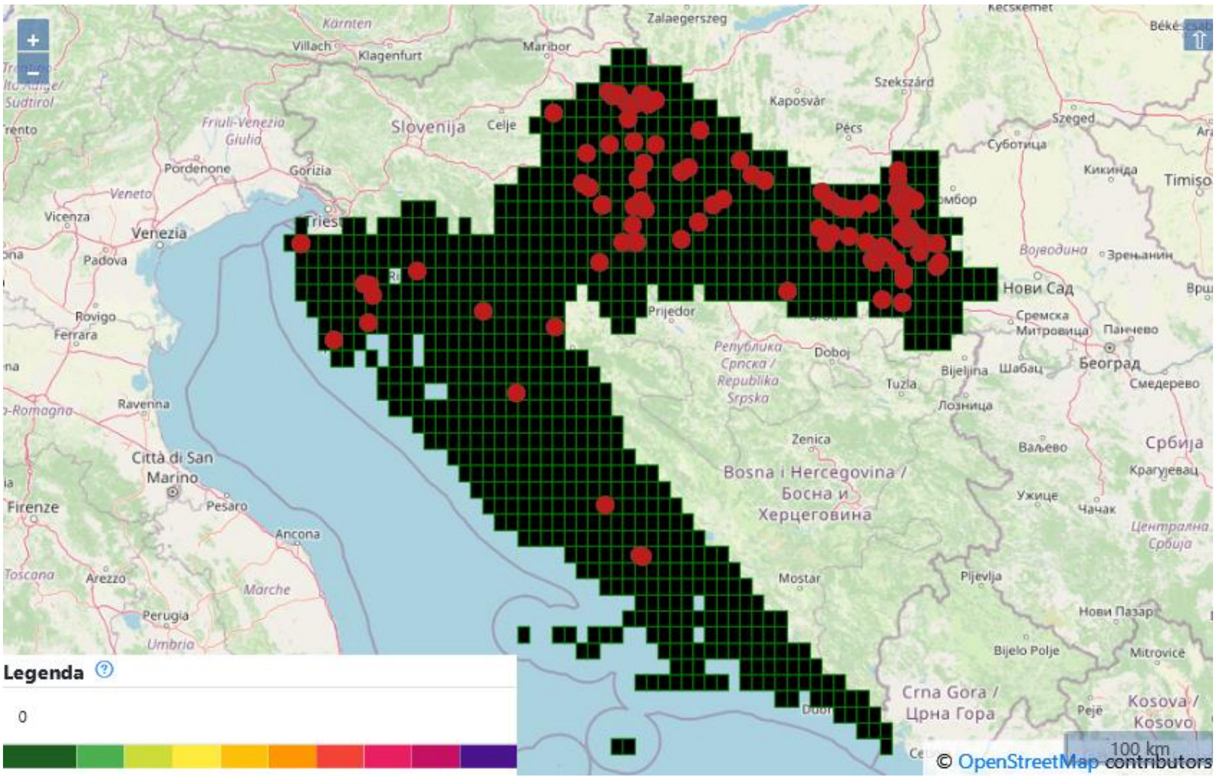

Figure 10.4-2 Geospatial locations of LPSs in the Republic of Croatia, 2019

Source: [*https://emep.haop.hr/*](https://emep.haop.hr/)

10.4.2. List of the LPS and their emissions in 2022

An overview of total emissions for LPS in 2022 is shown in Table 10.4-1. LPS emissions were taken from databases EPR and HLAP and supplemented, if necessary, by emission calculations in accordance with the EMEP / EEA methodology (CollectER database), and emissions for farms in the agricultural sector were fully calculated using the EMEP/EEA methodology.

The table also shows total LPS emissions, total national emissions and the percentage contribution of LPS to total national emissions for 2022.

Table 10.4-1 List of LPS and their emissions for 2022

Emissions	NOx	NM VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	PCDD/ PCDF	PAHs	HCB	PCBs
LPS	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
EPR DATABASE															
Vetropack Straža d.d.	0.523	0	0.295	0	0	0	0	0	0	0	0	0	0	0	0
Hrvatska industrija šećera- pogon Županja	0	0.601	0	0	0	0	0	0	0	0	0	0	0	0	0
UNI VIRIDAS d.o.o. za energetiku - 1 Kogeneracijsko postrojenje Viridas Biomass	0.210	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MORE d.o.o. za trgovinu i proizvodnju	0	0	0	0	0	0.068	0	0	0	0	0	0	0	0	0
ENERGANA ŽUPANJA društvo s ograničenom odgovornošću za proizvodnju energije	0.134	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLAVONIJA OIE d.o.o. obnovljivi izvori energije i trgovina	0.142	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BE-TO KARLOVAC d.o.o. za proizvodnju i usluge	0.146	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ENERGANA GOSPIĆ 1 d. o. o. za proizvodnju električne struje i topline	0.122	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strizivojna hrast d.o.o.	0	0	0.161	0	0	0	0	0	0	0	0	0	0	0	0
ABS Sisak d.o.o.	0	0	0	0	0	0	0	0	0	0	0	5E-07	0	0	0

Emissions	NOx	NM VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	PCDD/ PCDF	PAHs	HCB	PCBs
LPS	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
HLAP DATABASE															
HAIX Obuća d.o.o.	0	0.115	0	0	0	0	0	0	0	0	0	0	0	0	0
OMIAL NOVI d.o.o.	0	0.178	0	0	0	0	0	0	0	0	0	0	0	0	0
AQUAESTIL PLUS d.o.o.	0	0.283	0	0	0	0	0	0	0	0	0	0	0	0	0
ALUFLEXPACK NOVI d.o.o. Drniš	0	0.143	0	0	0	0	0	0	0	0	0	0	0	0	0
ALUFLEXPACK NOVI d.o.o. Umag	0	0.854	0	0	0	0	0	0	0	0	0	0	0	0	0
ROTOPLAST d.o.o.	0	0.103	0	0	0	0	0	0	0	0	0	0	0	0	0
SIPRO d.o.o.	0	0.282	0	0	0	0	0	0	0	0	0	0	0	0	0
COLLECTER DATABASE															
TE PLOMIN 2	0.512	0.042	0.215	0.004	0.004	8.6E-03	0.017	0.071	0.125	0.0031	0.110	0.139	1.9E-05	0.0086	2.359
HEP, TE SISAK	0.304	0.038	0.008	0.001	0.008	0.016	0.032	0.03	8E-06	0	1.4E-03	4.7E-03	2.9E-05	0	0
HEP, EL-TO ZAGREB	0.528	0.012	0	4.6E-04	3.6E-04	7.3E-04	0.002	0.02	0	0	4.3E-04	1.5E-03	9.1E-06	0	0
HEP, TE-TO ZAGREB	0.387	0.062	0.021	0.002	0.002	0.004	0.008	0.07	0.0034	4E-05	2.2E-03	8.0E-03	0.0003	0	0
PETROKEMIJA	0.16	0.005	0.033	0.423	0.031	0.042	0.08	7.3E-04	0	0	3.4E-05	1.7E-06	0	0	0
INA RAFINERIJA NAFTE RIJEKA	1.034	0.581	2.872	0.067	0.133	0.272	0.35	16.7	0.150	0.032	0.031	0.014	1.9E-03	0	0
NAŠICECEMENT	0.772	0.376	0.531	0	0.062	0.123	0.015	2.9	0.078	0.0064	0.0391	0.003	3.7E-04	0.0037	0.0821
CALUCEM	0.210	0.003	0.083	0	0.011	0.022	2.6E-03	0.32	0.014	0.0011	0.007	0.001	6.6E-05	6.5E-04	0.0146

Emissions	NOx	NM VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	PCDD/ PCDF	PAHs	HCB	PCBs
LPS	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
CEMEX Hrvatska-Tvornica cementa Sveti Juraj	0.072	0.002	0.00035	0	0.007	0.013	0.002	0.07	0.008	0.001	0.004	0.0003	3.9E-05	3.9E-04	0.0087
CEMEX Hrvatska-Tvornica cementa Sveti Kajo	0.699	0.015	0.003	0	0.064	0.172	0.015	0.70	0.109	0.009	0.055	0.0046	0.0005	0.005	0.1149
HOLCIM (Hrvatska)	0.391	0.022	0.009	0	0.031	0.062	0.007	0.79	0.039	0.003	0.020	0.0017	0.0002	0.0019	0.0415
ROCKWOOL ADRIATIC	0.060	0.024	0.206	0.064	0.029	0.033	0.038	0.001	0.069	0.0009	0.004	0.105	0.076	0.0003	0.0877
Knauf Insulation	0.016	0.025	1.3E-05	0.016	0.013	0.015	0.017	0.003	0	0	0	0	0	0	0
FARMS															
ZITO D.O.O. LUZANI	1.3E-04	0.010	0	0.065	1.3E-04	0.003124	NA	NA	NA	NA	NA	NA	NA	NA	NA
VUPIK D.D. BOBOTA	6.3E-05	0.005	0	0.031	6.5E-05	0.001511	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE D.D. DARDA 1	1.5E-04	0.012	0	0.075	1.6E-04	0.003632	NA	NA	NA	NA	NA	NA	NA	NA	NA
PIK VINKOVCI D.D. CERETINCI 1	9.2E-05	0.008	0	0.034	6.2E-05	0.001363	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE D.D. FARMA GRADEC	2.2E-04	0.017	0	0.090	1.7E-04	0.00392	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE D.D. FARMA KOZARAC	6.6E-05	0.005	0	0.033	6.8E-05	1.6E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
VUPIK D.D. PACETIN	6.6E-05	0.005	0	3.3E-02	6.8E-05	1.6E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE D.D. FARMA SOKOLOVAC	6.3E-05	0.005	0	3.1E-02	6.5E-05	1.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZITO D.O.O. FORKUSEVCI	6.1E-05	0.005	0	1.4E-02	1.6E-05	2.7E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE PLUS D.O.O. GAJ	4.7E-05	0.004	0	1.1E-02	1.2E-05	2.1E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZITO D.O.O. VUKA	7.4E-04	0.016	0	3.8E-02	6.0E-04	8.0E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA

Emissions	NOx	NM VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	PCDD/ PCDF	PAHs	HCB	PCBs
LPS	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
LUKAC D.O.O. IVANIC GRAD	3.3E-04	0.007	0	1.7E-02	2.7E-04	3.6E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
PERFA BIO D.O.O.	6.8E-04	0.014	0	3.5E-02	5.5E-04	7.3E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
LUNETA D.O.O. SVETI DURD	6.3E-04	0.013	0	3.3E-02	5.1E-04	6.8E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 1 JELKOVEC	1.1E-03	0.028	0	3.7E-02	6.8E-04	6.8E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 13 PETRIJANEC	7.1E-04	0.017	0	2.2E-02	4.2E-04	4.2E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 8 GORNJI KUCAN	7.6E-04	0.019	0	2.4E-02	4.5E-04	4.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 21 CAKOVEC	6.8E-04	0.017	0	2.2E-02	4.0E-04	4.0E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 9 GORNJI KUCAN	7.3E-04	0.018	0	2.3E-02	4.3E-04	4.3E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 17 PETRIJANEC	6.8E-04	0.017	0	2.2E-02	4.0E-04	4.0E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 19 OPCINA MARTIJANEC	6.4E-04	0.016	0	2.0E-02	3.8E-04	3.8E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 18 CAKOVEC	5.8E-04	0.014	0	1.9E-02	3.4E-04	3.4E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 20 PETRIJANEC	5.8E-04	0.014	0	1.9E-02	3.4E-04	3.4E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
VINDON D.O.O. BRODSKI STUPNIK	1.1E-03	0.024	0	4.7E-02	1.7E-03	9.2E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
VINDON D.O.O. DELOVI	8.7E-04	0.020	0	3.9E-02	1.4E-03	7.6E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 11 VINICA	7.2E-04	0.016	0	3.2E-02	1.1E-03	6.3E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA

Emissions	NOx	NM VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	PCDD/ PCDF	PAHs	HCB	PCBs
LPS	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
VINDON D.O.O. ZADUBRAVLJE	6.6E-04	0.015	0	2.9E-02	1.0E-03	5.7E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
VINDON D.O.O. KLOKOCEVIK	6.3E-04	0.014	0	2.8E-02	9.9E-04	5.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
VINDON D.O.O. BANOVCI	5.9E-04	0.013	0	2.6E-02	9.3E-04	5.1E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
KOKA D.D. FARMA 14 PETRIJANEC	3.6E-04	0.008	0	1.6E-02	5.7E-04	3.2E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BOVIS D.O.O. IVANKOVO	2.0E-04	0.084	0	6.2E-02	1.8E-03	2.8E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
FARMA TOMASANCI D.O.O.	1.5E-04	0.062	0	4.6E-02	1.4E-03	2.1E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE PLUS D.O.O. KARANAC	1.2E-04	0.052	0	3.8E-02	1.1E-03	1.7E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE PLUS D.O.O. MITROVAC	9.0E-05	0.037	0	2.7E-02	8.2E-04	1.3E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
FARMA MUZNIH KRAVA ANTUNOVAC	8.0E-05	0.033	0	2.4E-02	7.2E-04	1.1E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
VUPIK PLUS D.O.O. EKONOMIJA	6.8E-05	0.028	0	2.1E-02	6.2E-04	9.6E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
SLASCAK D.O.O. VISKOVCI	1.2E-04	0.048	0	3.5E-02	1.1E-03	1.6E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE PLUS D.O.O. DUGE MEDE	6.3E-05	0.026	0	1.9E-02	5.7E-04	8.8E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSATINA GRUPA D.O.O. PODGORAC	1.1E-04	0.044	0	3.3E-02	9.7E-04	1.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE PLUS D.D. KNEZEVI VINOGRADI	1.2E-04	0.052	0	3.8E-02	1.1E-03	1.7E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
BIO ADRIA D.O.O. KRSAN	4.8E-05	0.020	0	1.5E-02	4.3E-04	6.7E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA

Emissions	NOx	NM VOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg	PCDD/ PCDF	PAHs	HCB	PCBs
LPS	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
ZDENACKA FARMA D.O.O. VELIKI ZDENCI	5.2E-05	0.022	0	1.6E-02	4.7E-04	7.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSILOVAC D.O.O. FERICANCI	4.3E-05	0.018	0	1.3E-02	3.9E-04	6.1E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
VUPIK PLUS D.O.O. DALJ	3.7E-05	0.015	0	1.1E-02	3.4E-04	5.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
FARMA SALAS D.O.O. MARIJANCI	3.7E-05	0.015	0	1.1E-02	3.4E-04	5.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
STOCARSTVO RAIC, VUKOVINA	3.3E-05	0.031	0	9.8E-03	5.5E-04	8.3E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
BELJE PLUS D.O.O. POLJANSKI LUG	2.4E-05	0.023	0	7.3E-03	4.1E-04	6.1E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
PPK KARLOVACKA MESNA INDUSTRIJA	2.8E-05	0.027	0	8.3E-03	4.7E-04	7.0E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
NOVI AGRAR D.O.O. BIJELO BRDO	2.1E-05	0.020	0	6.2E-03	3.5E-04	5.3E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
MESNA INDUSTRIJA BRACA PIVAC D.O.O.	2.0E-05	0.020	0	6.1E-03	3.4E-04	5.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
STOCARSTVO RAIC, GUDOVAC	1.1E-05	0.011	0	3.3E-03	1.9E-04	2.8E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
LCP TOTAL	**6.50**	**4.85**	**4.45**	**1.99**	**0.43**	**1.01**	**0.61**	**21.59**	**0.60**	**0.06**	**0.27**	**0.28**	**0.08**	**0.02**	**2.71**
NATIONAL TOTAL	**45.75**	**61.11**	**5.561**	**26.916**	**26.2159**	**36.4632**	**53.007**	**206.79**	**8.36**	**0.791**	**0.3368**	**25.0066**	**13.326**	**0.3211**	**3.236**
SHARE LCP IN NATIONAL TOTAL	**14.2%**	**7.9%**	**80%**	**7.4%**	**1.6%**	**2.8%**	**1.1%**	**10.4%**	**7.2%**	**7.2%**	**81.2%**	**1.1%**	**0.6%**	**6.4%**	**83.7%**

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11. Adjustments

There are no adjustments in Croatia’s air pollutant emission inventory.

Photo by Kimberly Farmer, Kimberly Farmer (@kimberlyfarmer) | Unsplash Photo Community

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IIR Appendices

Appendix 1. Analysis of key sources

Appendix 2. Detailed methodological descriptions for individual source categories, if available including a table summarising whether source sectors use PM emission factors that include/exclude the condensable component

Appendix 3. Further elaboration of completeness, use of NE and IE and potential sources

Appendix 4. Energy balance of the Republic of Croatia - 2022.

Appendix 5. Additional information (QA/QC activities)

Appendix 6. Summary of information on the condensable component in PM (optional)

Appendix 7. Other appendices

- Uncertainty analysis,
- Impact of recalculations 1990-2021 by pollutant and NFR/SNAP97 sector

Appendix 1. Analysis of key sources

This appendix provides an analysis of key sources by pollutant for level assessment (L1) for the last historical year 2022 and trend assessment (T1) 1990-2022.

Tablica P1-1 Key categories for NOx emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A3bi	R.T., Passenger cars	NOX	11.33	24.8%	24.8%
1A3biii	R.T., Heavy duty vehicles	NOX	7.23	15.8%	40.6%
1A4bi	Residential: stationary	NOX	4.21	9.2%	49.8%
1A1a	Public electricity and heat production	NOX	3.50	7.6%	57.4%
1A2f	Non-metallic Minerals	NOX	2.82	6.2%	63.6%
1A3dii	National Navigation (Shipping)	NOX	2.51	5.5%	69.1%
3Da1	Inorganic N-fertilizers	NOX	2.30	5.0%	74.1%
1A3bii	R.T., Light duty vehicles	NOX	1.90	4.2%	78.3%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	NOX	1.79	3.9%	82.2%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A3biii	R.T., Heavy duty vehicles	NOX	10.31	7.23	0.130	13.7%	13.7%
1A4bi	Residential: stationary	NOX	4.31	4.21	0.113	11.9%	25.5%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	NOX	7.78	1.79	0.082	8.6%	34.1%
1A1a	Public electricity and heat production	NOX	11.49	3.50	0.079	8.3%	42.5%
1A3bii	R.T., Light duty vehicles	NOX	1.23	1.90	0.067	7.0%	49.5%
1A2f	Non-metallic Minerals	NOX	9.02	2.82	0.059	6.2%	55.6%
1A3dii	National Navigation (Shipping)	NOX	2.97	2.51	0.058	6.1%	61.7%
3Da1	Inorganic N-fertilizers	NOX	2.79	2.30	0.052	5.5%	67.2%
1A2c	Chemicals	NOX	2.56	0.12	0.050	5.3%	72.5%
1A2a	Iron and Steel	NOX	2.44	0.11	0.048	5.1%	77.5%
1A1b	Petroleum refining	NOX	3.51	0.82	0.036	3.8%	81.3%

Tablica P1-2 Key categories for NMVOC emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	NMVOC	17.76	29.1%	29.1%
2D3d	Coating applications	NMVOC	10.73	17.6%	46.6%
2D3a	Domestic solvent use including fungicides	NMVOC	4.29	7.0%	53.6%
2H2	Food and beverages industry	NMVOC	3.48	5.7%	59.3%
3B1b	Non-dairy cattle	NMVOC	3.44	5.6%	65.0%
2D3i	Other solvent use	NMVOC	2.77	4.5%	69.5%
3De	Cultivated crops	NMVOC	1.68	2.7%	72.3%
1B2av	Distribution of oil products	NMVOC	1.63	2.7%	74.9%
3B1a	Dairy cattle	NMVOC	1.51	2.5%	77.4%
5A	Solid waste disposal on land	NMVOC	1.43	2.3%	79.7%
1A3bv	R.T., Gasoline evaporation	NMVOC	1.41	2.3%	82.0%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	NMVOC	23.64	17.76	0.440	22.9%	22.9%
1A3bi	R.T., Passenger cars	NMVOC	24.51	1.23	0.344	17.9%	40.9%
2H2	Food and beverages industry	NMVOC	22.36	3.48	0.204	10.6%	51.5%
2D3e	Degreasing	NMVOC	10.50	0.06	0.169	8.8%	60.3%
2D3d	Coating applications	NMVOC	21.61	10.73	0.146	7.6%	67.9%
3B1b	Non-dairy cattle	NMVOC	1.70	3.44	0.132	6.9%	74.8%
2D3i	Other solvent use	NMVOC	11.53	2.77	0.059	3.1%	77.9%
5A	Solid waste disposal on land	NMVOC	0.59	1.43	0.057	3.0%	80.9%

Tablica P1-3 Key categories for SO_2 emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1B2aiv	Refining / Storage	SO2	1.49	26.8%	26.8%
1A1b	Petroleum refining	SO2	1.20	21.5%	48.3%
1A2f	Non-metallic Minerals	SO2	1.09	19.6%	68.0%
1A4bi	Residential: stationary	SO2	0.63	11.4%	79.4%
1A1a	Public electricity and heat production	SO2	0.42	7.6%	87.0%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A1a	Public electricity and heat production	SO2	76.63	0.42	11.446	35.1%	35.1%
1B2aiv	Refining / Storage	SO2	1.80	1.49	7.888	24.2%	59.3%
1A2f	Non-metallic Minerals	SO2	10.64	1.09	4.092	12.6%	71.9%
1A1b	Petroleum refining	SO2	22.49	1.20	2.539	7.8%	79.7%
1A2c	Chemicals	SO2	6.42	0.01	1.096	3.4%	83.0%

Tablica P1-4 Key categories for NH_3 emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
3Da1	Inorganic N-fertilizers	NH3	10.91	40.5%	40.5%
3Da2a	Animal manure	NH3	4.66	17.3%	57.9%
3B3	Swine	NH3	3.83	14.2%	72.1%
3B1b	Non-dairy cattle	NH3	1.56	5.8%	77.9%
3B1a	Dairy cattle	NH3	1.18	4.4%	82.3%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
3Da1	Inorganic N-fertilizers	NH3	10.26	10.91	0.378	35.5%	35.5%
3B1a	Dairy cattle	NH3	6.34	1.18	0.153	14.4%	49.9%
3Da2a	Animal manure	NH3	12.06	4.66	0.123	11.6%	61.5%
2B10a	Other chemical industry	NH3	3.48	0.42	0.100	9.4%	70.9%
3B1b	Non-dairy cattle	NH3	1.16	1.56	0.066	6.2%	77.1%
3B4gi	Laying Hens	NH3	2.07	0.49	0.043	4.0%	81.1%

Tablica P1-5 Key categories for $PM_{2.5}$ emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	PM2.5	20.57	78.5%	78.5%
1A1a	Public electricity and heat production	PM2.5	1.80	6.9%	85.3%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	PM2.5	29.26	20.57	0.079	18.3%	18.3%
1A1a	Public electricity and heat production	PM2.5	0.69	1.80	0.078	17.9%	36.2%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	PM2.5	0.86	0.06	0.029	6.7%	42.9%
1A2a	Iron and Steel	PM2.5	0.68	0.02	0.025	5.8%	48.7%
1A2f	Non-metallic Minerals	PM2.5	0.80	0.13	0.023	5.3%	54.0%
1A3bi	R.T., Passenger cars	PM2.5	0.17	0.44	0.019	4.4%	58.4%
1A3bvi	R.T., Automobile tyre and break wear	PM2.5	0.20	0.43	0.017	4.0%	62.4%
3F	Field burning of agricultural residues	PM2.5	0.43	0.00	0.016	3.8%	66.2%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	PM2.5	0.42	0.06	0.012	2.8%	69.0%
1A3biii	R.T., Heavy duty vehicles	PM2.5	0.44	0.12	0.010	2.2%	71.3%
2D3b	Road paving with asphalt	PM2.5	0.30	0.04	0.009	2.0%	73.3%
2B10a	Other chemical industry	PM2.5	0.28	0.03	0.009	2.0%	75.3%
1A1b	Petroleum refining	PM2.5	0.31	0.06	0.008	1.9%	77.3%
5C2	Open burning of waste	PM2.5	0.44	0.15	0.008	1.9%	79.2%
2A5b	Construction and demolition	PM2.5	0.91	0.46	0.008	1.8%	81.0%

Tablica P1-6 Key categories for PM_{10} emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	PM10	21.09	57.9%	57.9%
2A5b	Construction and demolition	PM10	4.58	12.6%	70.4%
3Dc	On-farm storage, handling and transport of agricultural products	PM10	2.26	6.2%	76.6%
1A1a	Public electricity and heat production	PM10	2.11	5.8%	82.4%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	PM10	30.01	21.09	0.116	20.6%	20.6%
1A1a	Public electricity and heat production	PM10	1.18	2.11	0.062	10.9%	31.5%
2A5b	Construction and demolition	PM10	9.08	4.58	0.045	8.0%	39.5%
2A5a	Quarrying and mining of minerals other than coal	PM10	1.35	1.53	0.031	5.5%	45.0%
3Dc	On-farm storage, handling and transport of agricultural products	PM10	4.77	2.26	0.030	5.4%	50.4%
2D3b	Road paving with asphalt	PM10	1.27	0.18	0.027	4.8%	55.1%
1A3bvi	R.T., Automobile tyre and break wear	PM10	0.40	0.85	0.027	4.7%	59.9%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	PM10	0.86	0.06	0.021	3.7%	63.6%
3B4giv	Other Poultry	PM10	0.94	0.12	0.021	3.6%	67.2%
1A2a	Iron and Steel	PM10	0.73	0.02	0.019	3.4%	70.6%
1A2f	Non-metallic Minerals	PM10	0.83	0.13	0.017	3.0%	73.6%
1A3bi	R.T., Passenger cars	PM10	0.17	0.44	0.015	2.7%	76.3%
3F	Field burning of agricultural residues	PM10	0.46	0.00	0.012	2.2%	78.5%
1B2aiv	Refining / Storage	PM10	0.70	0.19	0.011	1.9%	80.4%

Tablica P1-7 Key categories for TSP emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	TSP	22.15	41.8%	41.8%
2A5b	Construction and demolition	TSP	15.33	28.9%	70.7%
2A5a	Quarrying and mining of minerals other than coal	TSP	3.13	5.9%	76.6%
1A1a	Public electricity and heat produ	TSP	2.38	4.5%	81.1%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	TSP	31.61	22.15	0.139	22.7%	22.7%
2D3b	Road paving with asphalt	TSP	5.52	0.78	0.078	12.8%	35.5%
2A5b	Construction and demolition	TSP	30.38	15.33	0.064	10.4%	45.9%
2A5a	Quarrying and mining of minerals other than coal	TSP	2.76	3.13	0.052	8.5%	54.4%
1A1a	Public electricity and heat production	TSP	2.14	2.38	0.039	6.3%	60.7%
1A3bvi	R.T., Automobile tyre and break wear	TSP	0.50	1.07	0.026	4.2%	64.9%
3Dc	On-farm storage, handling and transport of agricultural products	TSP	4.77	2.26	0.015	2.4%	67.4%
1A3bvii	R.T., Automobile road abrasion	TSP	0.30	0.62	0.015	2.4%	69.8%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TSP	0.86	0.06	0.014	2.3%	72.1%
1A2a	Iron and Steel	TSP	0.78	0.02	0.014	2.3%	74.4%
3B4giv	Other Poultry	TSP	0.94	0.12	0.014	2.3%	76.7%
1A2f	Non-metallic Minerals	TSP	0.86	0.14	0.012	1.9%	78.6%
1A3bi	R.T., Passenger cars	TSP	0.17	0.44	0.012	1.9%	80.4%

Tablica P1-8 Key categories for BC emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	BC	2.49	68.5%	68.5%
1A3bi	R.T., Passenger cars	BC	0.35	9.5%	78.0%
2G	Other product manufacture and use	BC	0.10	2.8%	80.9%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	BC	3.18	2.49	0.163	23.0%	23.0%
1A3bi	R.T., Passenger cars	BC	0.08	0.35	0.121	17.1%	40.0%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	BC	0.47	0.04	0.113	16.0%	56.0%
1A2f	Non-metallic Minerals	BC	0.23	0.03	0.050	7.0%	63.1%
1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	BC	0.22	0.05	0.043	6.0%	69.1%
2D3b	Road paving with asphalt	BC	0.02	0.10	0.036	5.1%	74.2%
1A3biii	R.T., Heavy duty vehicles	BC	0.22	0.08	0.028	4.0%	78.1%
1A3bvi	R.T., Automobile tyre and break wear	BC	0.04	0.09	0.027	3.8%	82.0%

Tablica P1-9 Key categories for CO emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	CO	150.13	72.6%	72.6%
1A3bi	R.T., Passenger cars	CO	14.51	7.0%	79.6%
1B2aiv	Refining / Storage	CO	13.70	6.6%	86.2%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kt] $E_{x,0}$	Latest Year (2022) Estimate [kt] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	CO	191.34	150.13	1.055	44.8%	44.8%
1A3bi	R.T., Passenger cars	CO	215.01	14.51	0.848	36.0%	80.9%

Tablica P1-10 Key categories for Pb emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A3bvi	R.T., Automobile tyre and break wear	Pb	3.44	41.1%	41.1%
2G	Other product manufacture and use	Pb	1.72	20.6%	61.7%
1A4bi	Residential: stationary	Pb	1.14	13.7%	75.4%
2A3	Glass production	Pb	0.53	6.4%	81.8%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A3bi	R.T., Passenger cars	Pb	415.13	0.00	49.65	42.2%	42.2%
1A3bvi	R.T., Automobile tyre and break wear	Pb	1.69	3.44	25.82	22.0%	64.2%
2G	Other product manufacture and use	Pb	0.56	1.72	12.94	11.0%	75.2%
1A4bi	Residential: stationary	Pb	1.79	1.14	8.435	7.2%	82.4%

Tablica P1-11 Key categories for Cd emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	Cd	0.55	69.1%	69.1%
2G	Other product manufacture and use	Cd	0.05	6.2%	75.4%
2A3	Glass production	Cd	0.04	5.2%	80.5%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	Cd	0.56	0.55	0.348	37.1%	37.1%
2C1	Iron and Steel Production	Cd	0.24	0.03	0.234	24.9%	62.0%
3F	Field burning of agricultural residues	Cd	0.07	0.00	0.089	9.5%	71.5%
1B2aiv	Refining / Storage	Cd	0.08	0.02	0.060	6.3%	77.8%
1A1a	Public electricity and heat production	Cd	0.01	0.03	0.043	4.6%	82.4%

Tablica P1-12 Key categories for Hg emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A1a	Public electricity and heat production	Hg	0.12	36.2%	36.2%
1A2f	Non-metallic Minerals	Hg	0.12	35.1%	71.3%
1A4bi	Residential: stationary	Hg	0.03	7.8%	79.1%
1B2aiv	Refining / Storage	Hg	0.02	7.3%	86.4%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1B2b	Natural gas	Hg	0.70	0.00	2.081	47.1%	47.1%
1A1a	Public electricity and heat production	Hg	0.05	0.12	0.999	22.6%	69.7%
1A2f	Non-metallic Minerals	Hg	0.10	0.12	0.821	18.6%	88.2%

Tablica P1-13 Key categories for As emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A1a	Public electricity and heat production	As	0.16	43.1%	43.1%
1A2f	Non-metallic Minerals	As	0.06	17.4%	60.5%
2A3	Glass production	As	0.06	16.4%	76.9%
1A3bvi	R.T., Automobile tyre and break wear	As	0.04	10.8%	87.6%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
2C1	Iron and Steel Production	As	7.60	0.00	20.695	49.9%	49.9%
1A1a	Public electricity and heat production	As	0.71	0.16	8.291	20.0%	69.9%
1A2f	Non-metallic Minerals	As	0.06	0.06	3.971	9.6%	79.4%
2A3	Glass production	As	0.05	0.06	3.754	9.0%	88.5%

Tablica P1-14 Key categories for Cr emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A3bvi	R.T., Automobile tyre and break wear	Cr	1.29	44.9%	44.9%
1A4bi	Residential: stationary	Cr	0.97	33.8%	78.7%
1A1a	Public electricity and heat production	Cr	0.14	5.0%	83.7%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A3bvi	R.T., Automobile tyre and break wear	Cr	0.63	1.29	0.674	31.9%	31.9%
1A1a	Public electricity and heat production	Cr	1.78	0.14	0.522	24.7%	56.5%
2C1	Iron and Steel Production	Cr	1.08	0.02	0.365	17.3%	73.8%
1A4bi	Residential: stationary	Cr	1.03	0.97	0.316	14.9%	88.8%

Tablica P1-15 Key categories for Cu emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A3bvi	R.T., Automobile tyre and break wear	Cu	28.28	91.9%	91.9%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A3bvi	R.T., Automobile tyre and break wear	Cu	13.96	28.28	0.052	45.2%	45.2%
1A1a	Public electricity and heat production	Cu	0.73	0.34	0.018	15.4%	60.6%
1A4bi	Residential: stationary	Cu	0.36	0.25	0.007	6.3%	67.0%
2G	Other product manufacture and use	Cu	0.38	1.02	0.006	5.1%	72.1%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	Cu	0.35	0.32	0.006	5.0%	77.0%
1B2aiv	Refining / Storage	Cu	0.18	0.05	0.005	4.3%	81.3%

Tablica P1-16 Key categories for Ni emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A1b	Petroleum refining	Ni	1.25	42.9%	42.9%
1A1a	Public electricity and heat production	Ni	0.41	14.1%	57.0%
1B2aiv	Refining / Storage	Ni	0.21	7.4%	64.3%
1A3bvi	R.T., Automobile tyre and break wear	Ni	0.20	6.7%	71.1%
2A3	Glass production	Ni	0.15	5.3%	76.4%
1A4ai	Commercial/Institutional: Stationary	Ni	0.13	4.6%	80.9%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A1a	Public electricity and heat production	Ni	6.07	0.41	1.257	30.0%	30.0%
1A1b	Petroleum refining	Ni	5.33	1.25	0.681	16.3%	46.3%
2C1	Iron and Steel Production	Ni	2.65	0.12	0.673	16.1%	62.3%
1A3bvi	R.T., Automobile tyre and break wear	Ni	0.10	0.20	0.361	8.6%	71.0%
2A3	Glass production	Ni	0.13	0.15	0.264	6.3%	77.2%
1A2f	Non-metallic Minerals	Ni	0.12	0.12	0.203	4.9%	82.1%

Tablica P1-17 Key categories for Se emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
2A3	Glass production	Se	0.25	63.0%	63.0%
1A2f	Non-metallic Minerals	Se	0.06	14.8%	77.8%
1A4bi	Residential: stationary	Se	0.02	5.4%	83.2%

Trend Assessment								
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
2A3	Glass production	Se	0.22	0.25	0.178	36.2%	36.2%
1A1b	Petroleum refining	Se	0.04	0.01	0.080	16.2%	52.4%
1A2f	Non-metallic Minerals	Se	0.05	0.06	0.037	7.5%	59.9%
1A3bvi	R.T., Automobile tyre and break wear	Se	0.01	0.02	0.037	7.5%	67.4%
1A1a	Public electricity and heat production	Se	0.04	0.02	0.035	7.1%	74.5%
1B2aiv	Refining / Storage	Se	0.02	0.00	0.031	6.2%	80.7%

Tablica P1-18 Key categories for Zn emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	Zn	21.55	57.3%	57.3%
1A3bvi	R.T., Automobile tyre and break wear	Zn	8.63	23.0%	80.3%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A3bvi	R.T., Automobile tyre and break wear	Zn	4.07	8.63	0.142	31.1%	31.1%
2C1	Iron and Steel Production	Zn	2.68	0.61	0.054	11.8%	42.8%
1A1a	Public electricity and heat production	Zn	0.85	2.55	0.051	11.2%	54.0%
1A2f	Non-metallic Minerals	Zn	3.11	1.46	0.040	8.8%	62.9%
1A1b	Petroleum refining	Zn	1.83	0.33	0.039	8.6%	71.4%
5C2	Open burning of waste	Zn	1.85	0.58	0.032	7.1%	78.5%
1A2a	Iron and Steel	Zn	1.24	0.03	0.032	7.0%	85.5%

Tablica P1-19 Key categories for PCDD/PCDF (DIOX) emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [g I-TEQ] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	DIOX	20.68	82.7%	82.7%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [g I-TEQ] $E_{x,0}$	Latest Year (2022) Estimate [g I-TEQ] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
3F	Field burning of agricultural residues	DIOX	39.97	0.01	1.597	45.9%	45.9%
1A4bi	Residential: stationary	DIOX	33.73	20.68	1.421	40.9%	86.8%

Tablica P1-20 Key categories for PAH emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	PAH	12.10	90.8%	90.8%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [t] $E_{x,0}$	Latest Year (2022) Estimate [t] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A4bi	Residential: stationary	PAH	18.19	12.10	0.225	43.7%	43.7%
1A2a	Iron and Steel	PAH	0.94	0.03	0.067	13.0%	56.7%
5C2	Open burning of waste	PAH	1.32	0.36	0.052	10.0%	66.7%
2C1	Iron and Steel Production	PAH	0.61	0.08	0.035	6.8%	73.5%
1A2e	Food Processing, Beverages and Tobacco	PAH	0.42	0.06	0.023	4.4%	77.9%
1A3bvi	R.T., Automobile tyre and break wear	PAH	0.12	0.22	0.021	4.0%	81.9%

Tablica P1-21 Key categories for HCB emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kg] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A4bi	Residential: stationary	HCB	0.21	65.5%	65.5%
1A1a	Public electricity and heat production	HCB	0.08	23.4%	88.9%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kg] $E_{x,0}$	Latest Year (2022) Estimate [kg] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
3Df	Use of pesticides	HCB	6.82	0.01	20.552	49.9%	49.9%
1A4bi	Residential: stationary	HCB	0.21	0.21	13.809	33.5%	83.5%

Tablica P1-22 Key categories for PCBs emissions for the year 2022

Level Assessment					
NFR Category Code	NFR Category	Pollutant	Latest Year (2022) Estimate [kg] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1A1a	Public electricity and heat production	PCBs	2.41	74.3%	74.3%
2C1	Iron and Steel Production	PCBs	0.42	13.1%	87.4%

Trend Assessment							
NFR Category Code	NFR Category	Pollutant	Base Year (1990) Estimate [kg] $E_{x,0}$	Latest Year (2022) Estimate [kg] $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to the trend	Cumulative Total of $T_{x,t}$
1A1a	Public electricity and heat production	PCBs	1.08	2.41	0.81	50.1%	50.1%
1A2a	Iron and Steel	PCBs	1.00	0.02	0.30	18.5%	68.5%
1A4bi	Residential: stationary	PCBs	0.75	0.01	0.23	14.1%	82.6%

Appendix 2. Detailed methodological descriptions for individual source categories, if available including a table summarising whether source sectors use PM emission factors that include/exclude the condensable component

This appendix includes following informations:

- whether individual source categories use PM emission factors that include/exclude condensing components,
- detailed descriptions on national specifics for source category 3.B Manure management,
- Emission factors if they differ from those recommended in GB2023.

Detailed methodological descriptions for individual categories of sources are given in the relevant chapters 3-7 and summarized by sector and NFR categories with the source of the emission factors used in section 1.4.2.

Whether individual source categories use PM emission factors that include/exclude condensing components

Table A2-1 Inclusion/exclusion of the condensable component from PM_{10} and $PM_{2.5}$ emission factors by NFR source category

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A1a	Public electricity and heat production	no	yes	The emission factors used for TSP, PM10 and PM2.5, that are calculating from direct emission for large point sources (LPS) and yearly taken from the EPR database, exclude the condensable component. Method used for PM10 emission measurement is gravimetric method and samples for it, need to be dry. Gravimetric method is in Croatian law, reference method for determination of mass concentration of floating particles, described with HRN EN 12341 standard for PM10 fraction. For non LCP sources, the emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these PM factors represent filterable PM emissions and are based on an defined ash content.
1A1b	Petroleum refining	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these PM factors represent filterable PM emissions only (excluding any condensable fraction)
1A1c	Manufacture of solid fuels and other energy industries	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and the basis of these emission factors could not be determined in the reference.
1A2a	Stationary combustion in manufacturing industries and	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
	construction: Iron and steel			
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors represent total PM emissions (filterable and condensable fractions).
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A3ai(i)	International aviation LTO (civil)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2013 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3aii(i)	Domestic aviation LTO (civil)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2013 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A3bi	Road transport: Passenger cars	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from COPERT IV that is Tier 3 approach accordin to GB2023. According to GB2023, PM mass emission factors are considered to include both filterable and condensable material. The mass of particles collected on a filter kept below 52°C during diluted exhaust sampling. This corresponds to total (filterable and condensable) PM2.5. Coarse exhaust PM (i.e. >2.5µm diameter) is considered to be negligible, hence PM=PM2.5.
1A3bii	Road transport: Light duty vehicles	yes	no	
1A3biii	Road transport: Heavy duty vehicles and buses	yes	no	
1A3biv	Road transport: Mopeds & motorcycles	yes	no	
1A3bv	Road transport: Gasoline evaporation	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1A3bvi	Road transport: Automobile automobile tyre and brake wear	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3bvii	Road transport: Automobile road abrasion	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3c	Railways	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3di(ii)	International inland waterways	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3dii	National navigation (shipping)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1A3ei	Pipeline transport	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1A3eii	Other (please specify in the IIR)	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1A4ai	Commercial/institutional: Stationary	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A4aii	Commercial/institutional: Mobile	IE	IE	IE: 1A4aii
1A4bi	Residential: Stationary - using gaseous and liquid fuels	unclear	unclear	The Tier 1 emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A4bi	Residential: Stationary - using solid fuel (except biomass)	Stoves: Unclear Boilers: no	Stoves: Unclear Boilers: yas	The Tier 2 emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023. Tier 2 emission factors for stoves burning solid fuel (except biomass) have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
				Tier 2 emission factors for boilers burning solid fuel (except biomass) represent filterable PM emissions
1A4bi	Residential: Stationary - using biomass	yes	no	The Tier 2 methodology only provides total PM emission factors (including condensables) for all PM related pollutants (TSP, PM10 and PM2.5) (GB2023, page 76/187).
1A4bii	Residential: Household and gardening (mobile)	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors represent total PM emissions (filterable and condensable fractions).
1A4ci	Agriculture/Forestry/ Fishing: Stationary	unclear	unclear	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.
1A4cii	Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these emission factors represent total PM emissions (filterable and condensable fractions).
1A4ciii	Agriculture/Forestry/ Fishing: National fishing	IE	IE	IE: 1A3dii
1A5a	Other stationary (including military)	IE	IE	IE: 1A4a
1A5b	Other, Mobile (including military, land based and recreational boats)	IE	IE	IE: 1A4a, 1A3b(i-iv)
1B1a	Fugitive emission from solid fuels: Coal mining and handling	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B1c	Other fugitive emissions from solid fuels	NO	NO	This activity does not exist in Croatia.
1B2ai	Fugitive emissions oil: Exploration, production, transport	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B2aiv	Fugitive emissions oil: Refining / storage	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B2av	Distribution of oil products	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
1B2b	Fugitive emissions from natural gas (exploration, production,	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
	processing, transmission, storage, distribution and other)			
1B2c	Venting and flaring (oil, gas, combined oil and gas)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
1B2d	Other fugitive emissions from energy production	NO	NO	This activity does not exist in Croatia.
2A1	Cement production	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A2	Lime production	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A3	Glass production	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A5a	Quarrying and mining of minerals other than coal	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A5b	Construction and demolition	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2A5c	Storage, handling and transport of mineral products	IE	IE	IE: 2A1, 2A2, 2A3, 2A5a, 2A5b
2A6	Other mineral products (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
2B1	Ammonia production	NA/NE	NA/NE	There is no emission factor for PM2.5 in the GB2023, and this activity does not result with TSP and PM10 emissions.
2B2	Nitric acid production	NA/NE	NA/NE	There is no emission factor for PM2.5 in the GB2023, and this activity does not result with TSP and PM10 emissions.
2B3	Adipic acid production	NO	NO	This activity does not exist in Croatia.
2B5	Carbide production	NO	NO	This activity does not exist in Croatia.
2B6	Titanium dioxide production	NO	NO	This activity does not exist in Croatia.
2B7	Soda ash production	NO	NO	This activity does not exist in Croatia.
2B10a	Chemical industry: Other (please specify in the IIR)	NE	NE	There is no emission factor for TSP, PM10 and PM2.5 in the GB2023.
2B10b	Storage, handling and transport of chemical	IE	IE	IE: 2B10a

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
	products (please specify in the IIR)			
2C1	Iron and steel production	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these PM factors represent filterable PM emissions only (excluding any condensable fraction (European Commission, 2001)).
2C2	Ferroalloys production	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these PM factors represent filterable PM emissions only (excluding any condensable fraction).
2C3	Aluminium production	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these PM factors represent filterable PM emissions only (excluding any condensable fraction).
2C4	Magnesium production	NO	NO	This activity does not exist in Croatia.
2C5	Lead production	NO	NO	This activity does not exist in Croatia.
2C6	Zinc production	NO	NO	This activity does not exist in Croatia.
2C7a	Copper production	NO	NO	This activity does not exist in Croatia.
2C7b	Nickel production	NO	NO	This activity does not exist in Croatia.
2C7c	Other metal production (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
2C7d	Storage, handling and transport of metal products (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
2D3a	Domestic solvent use including fungicides	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
2D3b	Road paving with asphalt	yes	no	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and these PM factors represent filterable PM emissions with note that US EPA (2004) includes condensable PM emission factors and factors for controlled plant.
2D3c	Asphalt roofing	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2D3d	Coating applications	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
2D3e	Degreasing	NE	NE	There is no emission factor for PM2.5 in the GB2023.
2D3f	Dry cleaning	NE	NE	There is no emission factor for PM2.5 in the GB2023.
2D3g	Chemical products	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
2D3h	Printing	NE	NE	There is no emission factor for PM2.5 in the GB2023.
2D3i	Other solvent use (please specify in the IIR)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
2G	Other product use (please specify in the IIR)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2H1	Pulp and paper industry	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
2H2	Food and beverages industry	NE	NE	There is no emission factor for TSP, PM10 and PM2.5 in the GB2023.
2H3	Other industrial processes (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
2I	Wood processing	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2023.
2J	Production of POPs	NO	NO	This activity does not exist in Croatia.
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
3B1a	Manure management - Dairy cattle	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B1b	Manure management - Non-dairy cattle	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B2	Manure management - Sheep	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B3	Manure management - Swine	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4a	Manure management - Buffalo	NO	NO	This activity does not exist in Croatia.
3B4d	Manure management - Goats	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4e	Manure management - Horses	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
3B4f	Manure management - Mules and asses	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4gi	Manure mangement - Laying hens	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4gii	Manure mangement - Broilers	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4giii	Manure mangement - Turkeys	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4giv	Manure management - Other poultry	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3B4h	Manure management - Other animals (please specify in IIR)	NO	NO	This activity does not exist in Croatia.
3Da1	Inorganic N-fertilizers (includes also urea application)	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Da2a	Animal manure applied to soils	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Da2b	Sewage sludge applied to soils	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Da2c	Other organic fertilisers applied to soils (including compost)	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Da3	Urine and dung deposited by grazing animals	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Da4	Crop residues applied to soils	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Db	Indirect emissions from managed soils	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	no	yes	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is information that the processes which result in PM emissions are largely low-temperature mechanical activities, and emissions are unlikely to include substantial quantities of condensable particulate material.
3Dd	Off-farm storage, handling and transport of bulk agricultural products	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2023.
3De	Cultivated crops	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
3Df	Use of pesticides	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
3F	Field burning of agricultural residues	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
3I	Agriculture other (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
5A	Biological treatment of waste - solid waste disposal on land	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5B1	Biological treatment of waste - composting	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2023.
5B2	Biological treatment of waste - anaerobic digestion at biogas facilities	NA	NA	This activity does not result with TSP, PM10 and PM2.5 emissions.
5C1a	Municipal waste incineration	NO	NO	This activity does not exist in Croatia.
5C1bi	Industrial waste incineration	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5C1bii	Hazardous waste incineration	NO	NO	This activity does not exist in Croatia.
5C1biii	Clinical waste incineration	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5C1biv	Sewage sludge incineration	NO	NO	This activity does not exist in Croatia.
5C1bv	Cremation	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5C1bvi	Other waste incineration (please specify in the IIR)	NO	NO	This activity does not exist in Croatia.
5C2	Open burning of waste	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.
5D1	Domestic wastewater handling	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2023.
5D2	Industrial wastewater handling	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2023.
5D3	Other wastewater handling (please specify in IIR)	NE	NE	There is no emission factor for PM10 and PM2.5 in the GB2023.
5E	Other waste (please specify in IIR)	unknown	unknown	The emission factors used for TSP, PM10 and PM2.5 are default ones from GB2023 and there is no information on inclusion or exclusion of the condensable component in PM emission factors.

NFR	Source / sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
6A	Other (included in national total for entire territory) (please specify in IIR)	NO	NO	This activity does not exist in Croatia.

Detailed descriptions on national specifics for source category 3.B Manure management

Swine:

Currently in Croatia, swine production is based on the using of high producing breeds (landrace type breeds or hybreed such as PIC, Topics etc.) in housing system based on slurry manure type. The type of production is similar to that in Western European countries (Netherlands, Denmark, and Germany), from where are animals and equipment imported. Local characteristics (climate condition in each part of Croatia) should be also taken into account. In the period 2000 - 2010 there were changes which resulted in intensifying of the pig production. The number of sows, especially sows kept outdoors in partial or full time grazing system decrease (to the proportion of < 5 %), as well the number of sows in litter based housing (about 40% in 2012 and 2013, compared to > 80 % in the period 1990 - 2000). Intensive fattening of pigs makes > 90 % and takes place in housing system based on slatted floor and liquid/slurry manure type, which is a significant change in comparison to 1990 in which it is estimated that was less than 50 %. Increasing the number of piglets produced per sow per year, increasing the daily gain and the higher meatiness of pigs (52% in 1990 to 58 % in 2012), result in higher nutritional demand of pigs to protein (N) in feed. It is estimated that fattening pigs intake about 20.0 kg of N by feed, from which about 13.5 kg or 70 % is excreted with excrements (feces and urine; IPCC, 2006; SN, 2012). For breeding sows N intake is estimated to 48.7 kg animal from which about 30.8 kg per animal per year is excreted with excrements. This amount of N is the basis for the TAN content in manure and ammonia emission, depending on the method of manure removal (4.5 kg N), storage (0.85 kg N per m2 per year) and the application of manure (> 15 % TAN). For grazing sows (outdoor production system) N loss is < 3.0 kg per animal (Misselbrook et al., 2000).

Cattle dairy:

In the 1990s the milk production was based on keeping the double purpose dairy cows (milk and meat) in extensive production system. The average milk production amounted to 1,930.0 kg cow-1 year-1 in 1990 and 2307.0 kg in 2000 (CBS, 1990-2000). Because the average milk production per cow was relatively low during this time period, N excretion by manure was low due to the low nutritional demand of cow to protein (N) content in the feed. Increase in milk production per cow is closely associated with increase in DMI and the protein (N) content. Assuming that about 20% of N intake with feed is retained in the organism of the cow for milk synthesis and demands of their own tissues, the rest (80%) is excreted with faeces and urine and makes a pool for the emission of ammonia (IPCC, 2006). In the 1990s more than 80% of the dairy cows were in production system which was based on a combination of grazing (6 months) and housing (6 months) system or only housing system with the use of large amounts of litter (> 7.0 kg head day). Only about 20% of dairy cows were in the housing system based on liquid manure type. In the last 15 years significant changes in the structure of milk production could be observed. The number of cows was reduced, but the average production of milk per cow has significantly increased. In 2010 milk production per cow amounted to 4370 kg and for 2013 it is estimated to approach 5000 kg per cow per year. Above mentioned results in significantly greater demands to feed protein (N) intake and consequently a greater amount of N excreted with feces and urine as the basis for the emission of ammonia. In spite of this the nutritional protein demands risen more than twice and despite of higher efficiency of protein digestion increase the amount of N excreted in faeces and urine. Recently, milk production is based on a smaller number of specialized dairy farms in comparison to 15 years ago. The share of dairy cows kept in housing system based on liquid/slurry manure type (slatted floor or solid floor) increased. This is particularly evident after the adoption of the “Operative program for development of cattle production in Croatia” by the Croatian government that has resulted in building of new and reconstruction of existing farms dairy modelled on a farm in western European countries (Germany, Netherlands and Austria) that are based on the liquid manure. Milk production based on using of large amounts of litter and pasture as the favourable production systems from the point of ammonia emissions, are gradually reduced (currently their share is less than 30%) and are retained mainly on smaller farms with lower milk production per cow. In housing systems based on liquid manure, excrements are collected in lagoons (above ground level, open plan, solid floor) or in the pit storage (closed type, below the ground level, slatted floor). Housing system based on liquid manure and solid floor (the use of scrapers) as well the manure storage in lagoons is significantly less favourable from the point of ammonia emissions in comparison to previous using grazing system or housing system based on high amount of bedding material. Change from the grazing to the housing system has resulted in average increase of ammonia emission, while the move from the litter based to liquid/slurry based housing has resulted in additional increase of ammonia emission. In addition, the amount of ammonia which is lost during storage and during the application of manure should also be accounted for (Misselbrook et al., 2000).

Cattle non-dairy:

The category of non-dairy cattle represents the ammonia emission from the beef and/or suckling cows and finishing cattle (calves, bulls, heifers). Beef cows make up 5% of the total number of cows in Croatia and are characterized by full time grazing with feed supplement during winter season and use of poor pasture in relation to crude protein content (N). The fattening of cattle takes place in housing with predominantly slurry based system (slatted) or more rarely with litter. Intensive fattening is based on using of high amounts of grains and maize silage, which brings about 45 kg N per animal per year of which 36 kg N per animal per year is excreted with the faeces and urine as a basis of TAN and the ammonia emissions from manure (SN, 2012). In the period 1990 - 2013 there were no significant changes in beef cattle production systems and manure management.

Poultry:

Average annual N feed intake and in excretion is dependent on the type of poultry and their purpose (production of eggs, meat, and breeding flocks). The N intake in broilers is about 1.05 kg per animal per year, from which around 0.55 kg N is excreted with excrements as uric acid. In laying hens the amount of excreted N is about 0.75 kg animal per year, in ducks 0.76 kg animal per year and in turkey 1.71 kg animal per year (SN, 2012). The above mentioned is resulting with different emission of ammonia for different animal category. It should be noted that the production of poultry meat and eggs in Croatia in their characteristics are compatible with the same production in Western European countries (Netherlands, Germany, the same genetic basis of animal, housing and feeding, manure management).

Emission factors if they differ from those recommended in GB2023

Table A2-2 Tier 2 emission factors for NMVOC for NFR 1.B.2.b.ii Gas transport and distribution, 1990 - 2022

Year	g NMVOC / 1000 m^3
1990	3.95
1991	4.26
1992	4.11
1993	3.89
1994	4.14
1995	4.48
1996	3.99
1997	3.85
1998	3.51
1999	3.53
2000	3.44
2001	4.15
2002	4.55
2003	7.02
2004	4.83
2005	3.68
2006	3.51
2007	3.59
2008	3.84
2009	4.91
2010	2.47
2011	5.40
2012	15.58
2013	10.35
2014	20.49
2015	4.27
2016	4.36
2017	2.86
2018	15.29
2019	19.92
2020	12.45
2021	9.20
2022	3.71

Table A2-3: NMVOC emission factors for category Other solvent use (NFR 2.D.3.i), activity Application of glues and adhesives

Year	g NMVOC/Mg glue
1990	522,000
1991	502,212
1992	482,424
1993	462,635
1994	442,847
1995	423,059
1996	403,271
1997	383,483
1998	363,695
1999	343,906
2000	324,118
2001	304,330

Year	g NMVOC/Mg glue
2002	284,542
2003	264,754
2004	244,966
2005	225,177
2006	216,533
2007	207,889
2008	199,245
2009	190,600
2010	181,956
2011	176,665
2012	171,375
2013	166,084
2014	160,794
2015	155,503
2016	150,213
2017	144,922
2018	139,632
2019	134,341
2020	129,051
2021	123,760
2022	118,469

Tablica A2-4 National emision factors for SO_2 and NCV velues by fuel type

FE SO_2 (g/GJ)		**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Fuel oil	FE SO_2, g/GJ	1522.77	995.27	1169.45	1592.44	1791.49	1015.18	636.97	781.29	1025.13	1059.97	995.27	1054.99	1259.02	1089.82	935.56
	NCV, MJ/kg	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19
Extra light fuel oil	FE SO_2, g/GJ	224.77	313.74	285.65	285.65	168.58	149.85	117.07	191.99	131.12	149.85	206.04	177.94	187.31	159.21	191.99
	NCV, MJ/kg	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71
Diesel	FE SO_2, g/GJ	234.14	213.06	220.09	274.88	188.71	145.17	234.14	154.53	168.58	173.26	196.68	145.17	168.58	177.94	177.94
	NCV, MJ/kg	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71
Motor gasoline	FE SO_2, g/GJ	22.43	23.77	74.46	23.77	19.74	13.46	22.43	22.43	14.35	16.15	22.43	17.94	13.46	13.46	17.94
	NCV, MJ/kg	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60

FE SO_2 (g/GJ)		**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Fuel oil	FE SO_2, g/GJ	1062.74	986.75	1013.83	1030.11	967.07	1003.57	780.29	852.04	472.75	472.75	430.46	445.38	437.42	445.38	423.24
	NCV, MJ/kg	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19
Extra light fuel oil	FE SO_2, g/GJ	206.04	210.72	166.24	177.94	187.31	166.24	131.12	142.64	39.10	37.46	37.46	37.46	40.27	34.65	34.42
	NCV, MJ/kg	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71
Diesel	FE SO_2, g/GJ	157.255	150.725	102.52	149.93	73.26	73.89	26.30	0.22	0.27	0.30	0.29	0.30	0.34	0.35	0.29
	NCV, MJ/kg	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71
Gasoline	FE SO_2, g/GJ	11.11	10.50	5.89	3.96	3.38	0.939	0.242	0.211	0.236	0.209	0.236	0.207	0.269	0.152	0.204
	NCV, MJ/kg	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60	44.60

FE SO_2 (g/GJ)		**2020**	**2021**	**2022**
Fuel oil	FE SO2, g/GJ	385.67	413.04	378.20
	NCV, MJ/kg	40.19	40.19	40.19
Extra light fuel oil	FE SO2, g/GJ	37.46	23.41	23.41
	NCV, MJ/kg	42.71	42.71	42.71
Diesel	FE SO2, g/GJ	0.28	0.26	0.28
	NCV, MJ/kg	42.71	42.71	42.71
Gasoline	FE SO_2, g/GJ	0.153	0.202	0.173
	NCV, MJ/kg	44.60	44.60	44.60

Table A2-5. Emission factors for SO_2 from gasoline and kerosene combustion for NFR codes 1.A.3.a.i(i), 1.A.3.a.ii(i), 1.A.3.a.i(ii), 1.A .3.a.ii(ii)

	EF in g/GJ	
Year	**gasoline**	**kerosene**
1990	22.43	18.18
1991	23.77	20.02
1992	74.46	27.30
1993	23.77	38.67
1994	19.74	37.76
1995	13.46	20.47
1996	22.43	90.99
1997	22.43	90.99
1998	14.35	77.34
1999	16.15	40.95
2000	22.43	31.85
2001	17.94	54.60
2002	13.46	72.79
2003	13.46	59.14
2004	17.94	77.34
2005	11.11	45.00
2006	10.50	103.98
2007	5.89	62.40
2008	3.96	91.98
2009	3.38	80.87
2010	0.94	69.14
2011	0.24	60.24
2012	0.21	64.69
2013	0.24	63.02
2014	0.21	72.43
2015	0.24	66.12
2016	0.21	57.38
2017	0.27	16.11
2018	0.15	10.99
2019	0.20	30.60
2020	0.15	4.66
2021	0.20	8.31
2022	0.17	13.56

Table A2-6. Emission factors for SO_2 from gasoline and diesel combustion for NFR codes 1.A.4.ii i 1.A.2.g.vii

	EF in g/GJ	
Year	**gasoline**	**diesel**
1990	22.43	234.14
1991	23.77	213.96
1992	74.46	220.09
1993	23.77	274.88
1994	19.74	188.71
1995	13.46	145.17
1996	22.43	234.14
1997	22.43	154.53
1998	14.35	168.58
1999	16.15	173.26
2000	22.43	196.68
2001	17.94	145.17
2002	13.46	168.58
2003	13.46	177.94
2004	17.94	177.94

	EF in g/GJ	
Year	gasoline	diesel
2005	11.11	157.26
2006	10.50	150.73
2007	5.89	102.52
2008	3.96	149.93
2009	3.38	73.26
2010	0.94	73.89
2011	0.24	26.30
2012	0.21	0.22
2013	0.24	0.27
2014	0.21	0.30
2015	0.24	0.29
2016	0.21	0.30
2017	0.27	0.34
2018	0.15	0.35
2019	0.20	0.29
2020	0.15	0.28
2021	0.20	0.26
2022	0.17	0.28

Table A2-7: NMVOC emission factors for Solid waste disposal on land (NFR 5.A)

Year	kg NMVOC/Mg waste
1990	0.577430
1991	0.604209
1992	0.623504
1993	0.622750
1994	0.607446
1995	0.610652
1996	0.604180
1997	0.605830
1998	0.605454
1999	0.619822
2000	0.614877
2001	0.609457
2002	0.597633
2003	0.595660
2004	0.597433
2005	0.574104
2006	0.533071
2007	0.497263
2008	0.495720
2009	0.617482
2010	0.719875
2011	0.747708
2012	0.813976
2013	0.815473
2014	0.918601
2015	0.900188
2016	0.986075
2017	1.053281
2018	1.102551
2019	1.041366
2020	1.084666
2021	0.907157
2022	0.780961

Appendix 3. Further elaboration of completeness, use of NE and IE and potential sources of air pollutant emissions excluded

It is qualitatively assessed that the current and future inclusion of pollutant emission estimated for source categories for which they are not estimated (NE) would lead to an increase in the emissions of these pollutants. However, a significant impact could only be in the case of national key categories, such as, for example, source categories in the agriculture sector or in road transport.

It is qualitatively assessed that current and future inclusion of pollutant emission estimates for source categories for which emissions are included elsewhere (IE) would not lead to significant changes in total emission levels.

Appendix 4. The Energy balance of the Republic of Croatia for the most recent inventory year

This attachment provides a tabular presentation of the energy balance of the Republic of Croatia for the year 2022, in table A4-1 in natural units, and in table A4-2 in energy units (PJ). Table A4-3 additionally shows a detailed view for the 2022 Industry Analysis, natural units.

Table A4-1: National Energy balance for 2022, natural units

ENERGY BALANCE 2021 *natural units*	Anthracite	Hard coal	Brown coal	Lignite	Crude oil	Natural gas
	103 t	103 t	103 t	103 t	103 t	106 m3
Production					584.0	745.0
Import	4.4	643.9	4.2	3.7	1473.9	3021.5
Export		4.2			202.4	1062.0
Import-processing						
Export-processing						
Stock change		-8.1			-61.7	-174.8
Bunkers						
Energy supplied	**4.4**	**631.6**	**4.2**	**3.7**	**1793.8**	**2529.7**
Production						
hydro power plants						
– small HPP						
Wind power plants						
Solar power plants						
Geothermal power plants						
thermal power plants						
public cogeneration plants						
public heating plants						
industrial cogeneration plants						
– in rafineries						
– in gas production						
Industrial heating plants						
Petroleum refineries						
NGL-plant						
Coke plant						
Gas works						
Total production						
Transformation sector						
hydro power plants						
– small HPP						
Wind power plants						
Solar power plants						
Geothermal power plants						
thermal power plants		550.4				7.6
public cogeneration plants						833.3
public heating plants						45.2
industrial cogeneration plants						145.7
– in rafineries						25.9
– in gas production						52.3
Industrial heating plants						86.7
Petroleum refineries					1757.8	65.1
NGL-plant					36.0	7.2
Coke plant						
Gas works						
Total transformation sector		**550.4**			**1793.8**	**1190.8**
Energy sector own use						
Oil and gas extraction						59.7
Coal production						
Electric energy supply industry						
hydro power plants						
thermal power plants						
public cogeneration plants						
industrial cogeneration plants						
Wind power						
Petroleum refineries						25.7
NGL-plant						42.8
Gas works						
Total energy sector own use						**128.2**
Losses						**45.2**
Final energy demand	**4.4**	**81.2**	**4.2**	**3.7**		**1165.5**
Non energy use						**61.5**
Energy sector						
Petrochemical industry						61.5
Other industry						
Construction						
Transport						
Agriculture						
Energy consumption	**4.4**	**81.2**	**4.2**	**3.7**		**1104.0**
Industry	**4.4**	**81.2**	**3.1**	**0.6**		**257.2**
Iron and steel	4.3					19.6
Non-ferrous metals						13.6
Non-metallic minerals						51.6
Chemical			0.5			8.7
Construction materials		81.2	2.6			62.5
Pulp and paper						10.1
Food production	0.1			0.6		48.8
Not elsewhere specified						42.3
Transport						**4.3**
Rail						
Road						
Air						
– international						
– domestic						
Sea and River						
Public transport						4.3
Not elsewhere specified						
Other sectors			**1.1**	**3.1**		**842.5**
Households			1.1	3.1		580.2
Services						232.0
Agriculture						30.3
Construction						

ENERGY BALANCE 2021 *natural units*	Hydro energy TJ	Fuel wood 103 m3	Wind energy TJ	Solar energy TJ	Geothermal energy TJ	Landfill gas 103 m3	Biofuels 103 t	Other biomass TJ
Production	49312.0	4883.6	18913.7	2016.3	1726.1	199395.0	0.4	24184.1
Import		97.2					14.8	909.9
Export		567.8						5582.9
Import-processing								
Export-processing								
Stock change							8.9	-160.5
Bunkers								
Energy supplied	**49312.0**	**4413.0**	**18913.7**	**2016.3**	**1726.1**	**199395.0**	**24.1**	**19350.6**
Production								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants								
– in rafineries								
– in gas production								
Industrial heating plants								
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total production								
Transformation sector								
hydro power plants	49312.0							
– small HPP	1092.6							
Wind power plants			18913.7					
Solar power plants				1343.9				
Geothermal power plants					1527.8			
thermal power plants						19620.0		
public cogeneration plants						172001.0		13289.3
public heating plants								17.0
industrial cogeneration plants						7774.0		
– in rafineries								
– in gas production								
Industrial heating plants								154.1
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**49312.0**		**18913.7**	**1343.9**	**1527.8**	**199395.0**		**13460.4**
Energy sector own use								
Oil and gas extraction								
Coal production								
Electric energy supply industry								
hydro power plants								
thermal power plants								
public cogeneration plants								
industrial cogeneration plants								
Wind power								
Petroleum refineries								
NGL-plant								
Gas works								
Total energy sector own use								
Losses								
Final energy demand		**4413.0**		**672.4**	**198.3**		**24.1**	**5890.2**
Non energy use								
Energy sector								
Petrochemical industry								
Other industry								
Construction								
Transport								
Agriculture								
Energy consumption		**4413.0**		**672.4**	**198.3**		**24.1**	**5890.2**
Industry		**33.8**					**0.2**	**2657.7**
Iron and steel		0.1						9.9
Non-ferrous metals								
Non-metallic minerals								0.5
Chemical								0.3
Construction materials		5.7						2018.5
Pulp and paper		4.3						65.4
Food production		1.9						228.9
Not elsewhere specified		21.8					0.2	334.2
Transport							**23.9**	
Rail								
Road							23.9	
Air								
– international								
– domestic								
Sea and River								
Public transport								
Not elsewhere specified								
Other sectors		**4379.2**		**672.4**	**198.3**			**3232.5**
Households		4367.0		470.7				2768.6
Services		12.2		201.7	108.3			463.9
Agriculture					90.0			
Construction								

ENERGY BALANCE 2021 *natural units*	Coke oven coke	Liquefied petroleum	Unleaded motor	Standard motor	Petroleum	Jet fuel	Diesel oil	Light heating oil	Low sulphur fuel	Standard fuel oil
	103 t	103 t	103 t	103 t	103 t	103 t	103 t	103 t	103 t	103 t
Production		150.9	498.8			149.7	813.1	151.5	128.8	145.2
Import	31.1	169.5	186.1	0.5	1.0	36.1	2053.8	8.3	4.4	
Export		215.7	217.1	0.1		1.4	871.0	22.6	118.6	80.9
Import-processing										
Export-processing										
Stock change	1.6	-0.8	7.4			0.5	-76.6	2.5	-1.0	3.1
Bunkers							11.9		7.0	
Energy supplied	**32.7**	**103.9**	**475.2**	**0.4**	**1.0**	**184.9**	**1907.4**	**139.7**	**6.6**	**67.4**
Production										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants										
public cogeneration plants										
public heating plants										
industrial cogeneration plants										
– in rafineries										
– in gas production										
Industrial heating plants										
Petroleum refineries		120.6	498.8			149.7	813.1	151.5	128.8	145.2
NGL-plant		30.3								
Coke plant										
Gas works										
Total production		**150.9**	**498.8**			**149.7**	**813.1**	**151.5**	**128.8**	**145.2**
Transformation sector										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants								9.9		
public cogeneration plants								5.4		
public heating plants								4.3	0.6	
industrial cogeneration plants										53.6
– in rafineries										53.6
– in gas production										
Industrial heating plants										7.0
Petroleum refineries										
NGL-plant										
Coke plant										
Gas works										
Total transformation sector								**19.6**	**0.6**	**60.6**
Energy sector own use										
Oil and gas extraction										
Coal production										
Electric energy supply industry										
hydro power plants										
thermal power plants										
public cogeneration plants										
industrial cogeneration plants										
Wind power										
Petroleum refineries										5.5
NGL-plant										
Gas works										
Total energy sector own use										**5.5**
Losses										
Final energy demand	**32.7**	**103.9**	**475.2**	**0.4**	**1.0**	**184.9**	**1907.4**	**120.1**	**6.0**	**1.3**
Non energy use										
Energy sector										
Petrochemical industry										
Other industry										
Construction										
Transport										
Agriculture										
Energy consumption	**32.7**	**103.9**	**475.2**	**0.4**	**1.0**	**184.9**	**1907.4**	**120.1**	**6.0**	**1.3**
Industry	**32.7**	**6.2**	**0.2**		**1.0**		**9.9**	**22.3**	**6.0**	**1.3**
Iron and steel	0.2	2.3					0.3	1.0		
Non-ferrous metals		0.8					0.2	0.4		
Non-metallic minerals		0.3					0.1			
Chemical					1.0			0.9		
Construction materials	30.2	0.6	0.1				7.5	5.0	2.1	0.4
Pulp and paper		0.1						0.1		
Food production	2.3	1.3					0.2	10.3	3.9	0.9
Not elsewhere specified		0.8	0.1				1.6	4.6		
Transport		**46.4**	**464.1**	**0.4**		**184.9**	**1598.2**			
Rail							14.7			
Road		46.4	464.1				1514.7			
Air				0.4		184.9				
– international						177.1				
– domestic				0.4		7.8				
Sea and River							48.3			
Public transport							20.5			
Not elsewhere specified										
Other sectors		**51.3**	**10.9**				**299.3**	**97.8**		
Households		37.5						56.1		
Services		8.6						24.7		
Agriculture		2.3	7.5				186.4	11.5		
Construction		2.9	3.4				112.9	5.5		

ENERGY BALANCE 2021 *natural units*	Naphta	White spirit	Bitumen	Other oils	Lubricants	Petroleum coke	Etan	Other derivates
	103 t	103 t	103 t	103 t	103 t	103 t	103 t	103 t
Production	29.6			9.0		20.1		117.9
Import		4.0	131.1	43.6	7.2	139.4		
Export	18.2	1.7	3.6	14.0	0.3	10.0		95.8
Import-processing								
Export-processing								
Stock change	-2.6			-0.5		-19.9		-22.1
Bunkers								
Energy supplied	**8.8**	**2.3**	**127.5**	**38.1**	**6.9**	**129.6**		**0.0**
Production								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants								
– in rafineries								
– in gas production								
Industrial heating plants								
Petroleum refineries	14.0			9.0		20.1		117.9
NGL-plant	15.6							
Coke plant								
Gas works								
Total production	**29.6**			**9.0**		**20.1**		**117.9**
Transformation sector								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants								
– in rafineries								
– in gas production								
Industrial heating plants								
Petroleum refineries	8.8							
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**8.8**							
Energy sector own use								
Oil and gas extraction								
Coal production								
Electric energy supply industry								
hydro power plants								
thermal power plants								
public cogeneration plants								
industrial cogeneration plants								
Wind power								
Petroleum refineries						19.7		
NGL-plant								
Gas works								
Total energy sector own use						**19.7**		
Losses								
Final energy demand	**0.0**	**2.3**	**127.5**	**38.1**	**6.9**	**109.9**		**0.0**
Non energy use		**2.3**	**127.5**	**37.8**	**6.9**			
Energy sector				1.8				
Petrochemical industry					0.2			
Other industry		2.3	14.5	9.8	6.7			
Construction			113.0	1.3				
Transport				23.8				
Agriculture				1.1				
Energy consumption	**0.0**			**0.3**		**109.9**		**0.0**
Industry						**109.9**		
Iron and steel								
Non-ferrous metals						0.1		
Non-metallic minerals								
Chemical								
Construction materials						109.8		
Pulp and paper								
Food production								
Not elsewhere specified								
Transport				**0.3**				
Rail								
Road				0.2				
Air								
– international								
– domestic								
Sea and River				0.1				
Public transport								
Not elsewhere specified								
Other sectors								
Households								
Services								
Agriculture								
Construction								

ENERGY BALANCE 2021 *natural units*	Refinery gas	Refinery semiproducts	Aditives	Gas works gas	Electricity	Steam and hot water	Industrial waste, non
	103 t	103 t	103 t	103 m3	GWh	TJ	TJ
Production	87.6				14220.5	22971.9	1935.0
Import		454.9	43.4		5336.2		
Export					641.4		
Import-processing							
Export-processing							
Stock change		-2.8					
Bunkers							
Energy supplied	**87.6**	**452.1**	**43.4**		**18915.3**	**22971.9**	**1935.0**
Production							
hydro power plants					5573.7		
– small HPP					123.5		
Wind power plants					2137.8		
Solar power plants					151.9		
Geothermal power plants					72.7		
thermal power plants					1658.3		
public cogeneration plants					4345.1	12857.7	
public heating plants						1556.3	
industrial cogeneration plants					281.0	5027.3	
– in rafineries					62.7	2730.0	
– in gas production					133.2	520.0	
Industrial heating plants						2939.4	
Petroleum refineries	87.6						
NGL-plant							
Coke plant							
Gas works							
Total production	**87.6**				**14220.5**	**22380.7**	
Transformation sector							
hydro power plants							
– small HPP							
Wind power plants							
Solar power plants							
Geothermal power plants							
thermal power plants							
public cogeneration plants							
public heating plants							
industrial cogeneration plants	10.8						
– in rafineries	10.8						
– in gas production							
Industrial heating plants							
Petroleum refineries		452.1	43.4				
NGL-plant							
Coke plant							
Gas works							
Total transformation sector	**10.8**	**452.1**	**43.4**				
Energy sector own use							
Oil and gas extraction					114.0	427.0	
Coal production						343.0	
Electric energy supply industry					15.4		
hydro power plants					210.3		
thermal power plants					147.6		
public cogeneration plants					292.7	1612.2	
industrial cogeneration plants							
Wind power					22.3		
Petroleum refineries	76.8				163.4	3155.5	
NGL-plant					56.7	93.0	
Gas works							
Total energy sector own use	**76.8**				**1022.4**	**5630.7**	
Losses					**1659.3**	**1683.5**	
Final energy demand		**0.0**			**16233.6**	**15657.7**	**1935.0**
Non energy use							
Energy sector							
Petrochemical industry							
Other industry							
Construction							
Transport							
Agriculture							
Energy consumption		**0.0**			**16233.6**	**15657.7**	**1935.0**
Industry					**3330.6**	**8104.4**	**1935.0**
Iron and steel					442.0	31.3	6.0
Non-ferrous metals					108.0		
Non-metallic minerals					151.7	8.8	
Chemical					186.9	1238.2	
Construction materials					581.5	0.5	1929.0
Pulp and paper					115.1	1253.2	
Food production					657.8	2478.3	
Not elsewhere specified					1087.6	3094.1	
Transport					**343.4**		
Rail					183.8		
Road					12.2		
Air					35.2		
– international							
– domestic					35.2		
Sea and River					19.6		
Public transport					58.2		
Not elsewhere specified					34.4		
Other sectors					**12559.6**	**7553.3**	
Households					6464.3	5212.1	
Services					5851.1	2022.9	
Agriculture					148.5	318.3	
Construction					95.7		

Table A4-2: National Energy balance for 2022, energy units

PJ	Anthracite	Hard coal	Brown coal	Lignite	Crude oil	Natural gas
Production					24.820	26.633
Import	0.129	16.127	0.078	0.043	62.641	106.659
Export		0.105			8.602	37.489
Import-processing						
Export-processing						
Stock change		-0.203			-2.622	-6.170
Bunkers						
Energy supplied	**0.129**	**15.819**	**0.078**	**0.043**	**76.237**	**89.632**
Production						
hydro power plants						
– small HPP						
Wind power plants						
Solar power plants						
Geothermal power plants						
thermal power plants						
public cogeneration plants						
public heating plants						
industrial cogeneration plants						
– in rafineries						
– in gas production						
Industrial heating plants						
Petroleum refineries						
NGL-plant						
Coke plant						
Gas works						
Total production						
Gross production	**0.129**	**15.819**	**0.078**	**0.043**	**76.237**	**89.632**
Transformation sector						
hydro power plants						
– small HPP						
Wind power plants						
Solar power plants						
Geothermal power plants						
thermal power plants		13.644				0.268
public cogeneration plants						29.415
public heating plants						1.596
industrial cogeneration plants						5.143
– in rafineries						0.914
– in gas production						1.846
Industrial heating plants						3.061
Petroleum refineries					74.707	2.298
NGL-plant					1.530	0.588
Coke plant						
Gas works						
Total transformation sector		**13.644**			**76.237**	**42.369**
Energy sector own use						
Oil and gas extraction						2.107
Coal production						
Electric energy supply industry						
hydro power plants						
thermal power plants						
public cogeneration plants						
industrial cogeneration plants						
Industrial heating plants						
Petroleum refineries						0.907
NGL-plant						1.511
Gas works						
Total energy sector own use						**4.525**
Losses						**1.596**
Final energy demand	**0.129**	**2.175**	**0.078**	**0.043**		**41.142**
Non energy use						**2.171**
Energy sector						
Petrochemical industry						2.171
Other industry						
Construction						
Transport						
Agriculture						
Energy consumption	**0.129**	**2.175**	**0.078**	**0.043**		**38.971**
Industry	**0.129**	**2.175**	**0.057**	**0.007**		**9.079**
Iron and steel	0.126					0.692
Non-ferrous metals						0.480
Non-metallic minerals						1.821
Chemical			0.009			0.307
Construction materials		2.175	0.048			2.206
Pulp and paper						0.357
Food production	0.003			0.007		1.723
Not elsewhere specified						1.493
Transport						**0.152**
Rail						
Road						
Air						
– international						
– domestic						
Sea and River						
Public transport						0.152
Not elsewhere specified						
Other sectors			**0.020**	**0.036**		**29.740**
Households			0.020	0.036		20.481
Services						8.190
Agriculture						1.070
Construction						

PJ	Hydro energy	Fuel wood	Wind energy	Solar energy	Geothermal energy	Landfill gas	Biofuels	Other biomass
Production	49.312	43.952	18.914	2.016	1.726	3.799	0.015	24.184
Import		0.875					0.544	0.910
Export		5.110						5.583
Import-processing								
Export-processing								
Stock change							0.327	-0.161
Bunkers								
Energy supplied	**49.312**	**39.717**	**18.914**	**2.016**	**1.726**	**3.799**	**0.886**	**19.351**
Production								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants								
– in rafineries								
– in gas production								
Industrial heating plants								
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total production								
Gross production	**49.312**	**39.717**	**18.914**	**2.016**	**1.726**	**3.799**	**0.886**	**19.351**
Transformation sector								
hydro power plants	49.312							
– small HPP	1.093							
Wind power plants			18.914					
Solar power plants				1.344				
Geothermal power plants					1.528			
thermal power plants						0.336		
public cogeneration plants						3.305		13.289
public heating plants								0.017
industrial cogeneration plants						0.158		
– in rafineries								
– in gas production								
Industrial heating plants								0.154
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**49.312**		**18.914**	**1.344**	**1.528**	**3.799**		**13.460**
						335.900		
Energy sector own use								
Oil and gas extraction								
Coal production								
Electric energy supply industry								
hydro power plants								
thermal power plants								
public cogeneration plants								
industrial cogeneration plants								
Industrial heating plants								
Petroleum refineries								
NGL-plant								
Gas works								
Total energy sector own use								
Losses								
Final energy demand		**39.717**		**0.672**	**0.198**	**0.000**	**0.886**	**5.890**
Non energy use								
Energy sector								
Petrochemical industry								
Other industry								
Construction								
Transport								
Agriculture								
Energy consumption		**39.717**		**0.672**	**0.198**	**0.000**	**0.886**	**5.890**
Industry		**0.304**					**0.007**	**2.658**
Iron and steel		0.001						0.010
Non-ferrous metals								
Non-metallic minerals								0.001
Chemical								0.000
Construction materials		0.051						2.019
Pulp and paper		0.039						0.065
Food production		0.017						0.229
Not elsewhere specified		0.196					0.007	0.334
Transport							**0.879**	
Rail								
Road							0.879	
Air								
– international								
– domestic								
Sea and River								
Public transport								
Not elsewhere specified								
Other sectors		**39.413**		**0.672**	**0.198**			**3.233**
Households		39.303		0.471				2.769
Services		0.110		0.202	0.108			0.464
Agriculture					0.090			
Construction								

PJ	Coke oven coke	Liquefied petroleum gases	Unleaded motor gasoline	Standard motor gasoline	Petroleum	Jet fuel	Diesel oil	Light heating oil	Low sulphur fuel oil	Standard fuel oil
Production	195.371									
Import	188.005	0.912	7.948	8.298	0.022	0.044	1.587	87.718	0.354	0.177
Export	56.889		10.114	9.680	0.004		0.062	37.200	0.965	4.767
Import-processing										
Export-processing										
Stock change	-8.829	0.047	-0.038	0.330			0.022	-3.272	0.107	-0.040
Bunkers								0.508		0.281
Energy supplied	**317.659**	**0.958**	**-2.204**	**-1.052**	**0.018**	**0.044**	**1.547**	**46.738**	**-0.504**	**-4.911**
Production										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants										
public cogeneration plants										
public heating plants										
industrial cogeneration plants										
– in rafineries										
– in gas production										
Industrial heating plants										
Petroleum refineries			5.655	22.241			6.581	34.728	6.471	5.176
NGL-plant			1.421							
Coke plant										
Gas works										
Total production			**7.076**	**22.241**			**6.581**	**34.728**	**6.471**	**5.176**
Gross production	**317.659**	**0.958**	**4.872**	**21.189**	**0.018**	**0.044**	**8.128**	**81.465**	**5.967**	**0.265**
Transformation sector										
hydro power plants	49.312									
– small HPP	1.093									
Wind power plants	18.914									
Solar power plants	1.344									
Geothermal power plants	1.528									
thermal power plants	14.249								0.423	
public cogeneration plants	46.010								0.231	
public heating plants	1.613								0.184	0.024
industrial cogeneration plants	5.301									
– in rafineries	0.914									
– in gas production	1.846									
Industrial heating plants	3.215									
Petroleum refineries	77.005									
NGL-plant	2.118									
Coke plant										
Gas works										
Total transformation sector	**220.607**								**0.837**	**0.024**
Energy sector own use										
Oil and gas extraction	2.107									
Coal production										
Electric energy supply industry										
hydro power plants										
thermal power plants										
public cogeneration plants										
industrial cogeneration plants										
Industrial heating plants										
Petroleum refineries	0.907									
NGL-plant	1.511									
Gas works										
Total energy sector own use	**4.525**									
Losses	**1.596**									
Final energy demand	**90.930**	**0.958**	**4.872**	**21.189**	**0.018**	**0.044**	**8.128**	**81.465**	**5.129**	**0.241**
Non energy use	**2.171**									
Energy sector										
Petrochemical industry	2.171									
Other industry										
Construction										
Transport										
Agriculture										
Energy consumption	**88.759**	**0.958**	**4.872**	**21.189**	**0.018**	**0.044**	**8.128**	**81.465**	**5.129**	**0.241**
Industry	**14.416**	**0.958**	**0.291**	**0.009**		**0.044**		**0.423**	**0.952**	**0.241**
Iron and steel	0.829	0.006	0.108					0.013	0.043	
Non-ferrous metals	0.480		0.038					0.009	0.017	
Non-metallic minerals	1.822		0.014					0.004		
Chemical	0.317					0.044			0.038	
Construction materials	6.499	0.885	0.028	0.004				0.320	0.214	0.084
Pulp and paper	0.461		0.005						0.004	
Food production	1.978	0.067	0.061					0.009	0.440	0.157
Not elsewhere specified	2.031		0.038	0.004				0.068	0.196	
Transport	**1.031**		**2.176**	**20.694**	**0.018**		**8.128**	**68.259**		
Rail								0.628		
Road	0.879		2.176	20.694				64.693		
Air					0.018		8.128			
– international							7.785			
– domestic					0.018		0.343			
Sea and River								2.063		
Public transport	0.152							0.876		
Not elsewhere specified										
Other sectors	**73.312**		**2.405**	**0.486**				**12.783**	**4.177**	
Households	63.079		1.758						2.396	
Services	9.073		0.403						1.055	
Agriculture	1.160		0.108	0.334				7.961	0.491	
Construction			0.136	0.152				4.822	0.235	

PJ	Naphta	White spirit	Bitumen	Lubricants	Paraffin and wax	Petroleum coke	Etan	Other derivates
Production								
Import			0.134	4.392	1.461	0.241	4.321	
Export	3.251	0.812	0.057	0.121	0.469	0.010	0.310	
Import-processing								
Export-processing								
Stock change	0.125	-0.116			-0.017		-0.617	
Bunkers								
Energy supplied	**-3.127**	**-0.927**	**0.077**	**4.271**	**0.975**	**0.231**	**3.395**	
Production								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants								
– in rafineries								
– in gas production								
Industrial heating plants								
Petroleum refineries	5.836	0.624			0.302		0.623	
NGL-plant		0.696						
Coke plant								
Gas works								
Total production	**5.836**	**1.320**			**0.302**		**0.623**	
Gross production	**2.709**	**0.392**	**0.077**	**4.271**	**1.276**	**0.231**	**4.018**	
Transformation sector								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants	2.154							
– in rafineries	2.154							
– in gas production								
Industrial heating plants	0.281							
Petroleum refineries		0.392						
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**2.436**	**0.392**						
Energy sector own use								
Oil and gas extraction								
Coal production								
Electric energy supply industry								
hydro power plants								
thermal power plants								
public cogeneration plants								
industrial cogeneration plants								
Industrial heating plants								
Petroleum refineries	0.221						0.611	
NGL-plant								
Gas works								
Total energy sector own use	**0.221**						**0.611**	
Losses								
Final energy demand	**0.052**	**0.000**	**0.077**	**4.271**	**1.276**	**0.231**	**3.407**	
Non energy use			**0.077**	**4.271**	**1.266**	**0.231**		
Energy sector					0.060			
Petrochemical industry						0.007		
Other industry			0.077	0.486	0.328	0.224		
Construction				3.786	0.044			
Transport					0.797			
Agriculture					0.037			
Energy consumption	**0.052**	**0.000**			**0.010**		**3.407**	
Industry	**0.052**						**3.407**	
Iron and steel								
Non-ferrous metals							0.003	
Non-metallic minerals								
Chemical								
Construction materials	0.016						3.404	
Pulp and paper								
Food production	0.036							
Not elsewhere specified								
Transport					**0.010**			
Rail								
Road					0.007			
Air								
– international								
– domestic								
Sea and River					0.003			
Public transport								
Not elsewhere specified								
Other sectors								
Households								
Services								
Agriculture								
Construction								

PJ	Refinery gas	Refinery semiproducts	Aditives	Gas works gas	Electricity	Steam and hot water	Industrial waste, non renewable
Production							0.591
Import			19.424	1.853		19.210	
Export	3.850					2.309	
Import-processing							
Export-processing							
Stock change	-0.888		-0.120				
Bunkers							
Energy supplied	**-4.738**		**19.305**	**1.853**		**16.901**	**0.591**
Production							
hydro power plants						20.065	
– small HPP						0.445	
Wind power plants						7.696	
Solar power plants						0.547	
Geothermal power plants						0.262	
thermal power plants						5.970	
public cogeneration plants						15.642	12.858
public heating plants							1.556
industrial cogeneration plants						1.012	5.027
– in rafineries						0.226	2.730
– in gas production						0.480	0.520
Industrial heating plants							2.939
Petroleum refineries	4.738	3.732					
NGL-plant							
Coke plant							
Gas works							
Total production	**4.738**	**3.732**				**51.194**	**22.381**
Gross production		**3.732**	**19.305**	**1.853**		**68.095**	**22.972**
Transformation sector							
hydro power plants							
– small HPP							
Wind power plants							
Solar power plants							
Geothermal power plants							
thermal power plants							
public cogeneration plants							
public heating plants							
industrial cogeneration plants		0.460					
– in rafineries		0.460					
– in gas production							
Industrial heating plants							
Petroleum refineries			19.305	1.853			
NGL-plant							
Coke plant							
Gas works							
Total transformation sector		**0.460**	**19.305**	**1.853**			
Energy sector own use							
Oil and gas extraction						0.410	0.427
Coal production							0.343
Electric energy supply industry						0.055	
hydro power plants						0.757	
thermal power plants						0.531	
public cogeneration plants						1.054	1.612
industrial cogeneration plants							
Industrial heating plants						0.080	
Petroleum refineries		3.272				0.588	3.156
NGL-plant						0.204	0.093
Gas works							
Total energy sector own use		**3.272**				**3.681**	**5.631**
Losses						**5.973**	**1.684**
Final energy demand			**0.000**			**58.441**	**15.658**
Non energy use							
Energy sector							
Petrochemical industry							
Other industry							
Construction							
Transport							
Agriculture							
Energy consumption			**0.000**			**58.441**	**15.658**
Industry						**11.990**	**8.104**
Iron and steel						1.591	0.031
Non-ferrous metals						0.389	
Non-metallic minerals						0.546	0.009
Chemical						0.673	1.238
Construction materials						2.093	0.001
Pulp and paper						0.414	1.253
Food production						2.368	2.478
Not elsewhere specified						3.915	3.094
Transport						**1.236**	
Rail						0.662	
Road						0.044	
Air						0.127	
– international							
– domestic						0.127	
Sea and River						0.071	
Public transport						0.210	
Not elsewhere specified						0.124	
Other sectors						**45.215**	**7.553**
Households						23.271	5.212
Services						21.064	2.023
Agriculture						0.535	0.318
Construction						0.345	

Table A4-3: Industry analisys balance for 2022, energy units

ENERGY CONSUMPTION		Industrial cogenerations				Industrial heating plants	Own use (production of oil and gas)	Own use (refineries)	Own use (biogas production)	Industry									Commertial sector
		Rafineries	Production of oil and gas	Other sectors	Total					Total	Iron and Steal	Non-Ferrous metals	Non-Metalic Minerals	Chemicals	Construction	Paper	Food	Other	
Anthracite					0.0					4.4	4.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Coking coal (kameni ugljen)	10^3 t				0.0					81.2	0.0	0.0	0.0	0.0	81.2	0.0	0.0	0.0	0.0
Sub-Bituminous Coal (Mrki u	10^3 t				0.0					3.1	0.0	0.0	0.0	0.5	2.6	0.0	0.0	0.0	0.0
Lignite	10^3 t				0.0					0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
Natural gas	10^6 m^3				0.0		154.8	51.6		411.4	20.2	13.6	51.9	33.1	62.5	58.1	122.0	50.0	232.0
Wood	10^3 m^3				0.0					33.8	0.1	0.0	0.0	0.0	5.7	4.3	1.9	21.8	12.2
Biogas	TJ				0.0				44.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.8
Wood waste	TJ				0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	201.7
Briketi ugljena	TJ				0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108.3
Coke oven coke	TJ				0.0					876.8	3.9	0.0	0.5	0.3	89.5	73.2	313.5	395.9	463.9
Liquified petroleum gas	TJ				0.0					1935.0	6.0	0.0	0.0	0.0	1929.0	0.0	0.0	0.0	0.0
Motor Gasoline	10^3 t				0.0					32.7	0.2	0.0	0.0	0.0	30.2	0.0	2.3	0.0	0.0
Petroleum	10^3 t				0.0			0.0		6.2	2.3	0.8	0.3	0.0	0.6	0.1	1.3	0.8	8.6
Diesel	10^3 t				0.0					0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Gas/Diesel oil	10^3 t				0.0					1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Residual fuel oil	10^3 t				0.0					9.9	0.3	0.2	0.1	0.0	7.5	0.0	0.2	1.6	0.0
Petroleum coke	10^3 t				0.0			0.0		22.3	1.0	0.4	0.0	0.9	5.0	0.1	10.3	4.6	24.7
Refinery gas	10^3 t				0.0			59.1		14.3	0.0	0.0	0.0	0.0	2.5	0.8	9.1	1.9	0.0
Other oil derivates	10^3 t				0.0			19.7		109.9	0.0	0.1	0.0	0.0	109.8	0.0	0.0	0.0	0.0
Visokopećni plin	10^3 t				0.0			87.6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Koksni plin	10^3 t				0.0			0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas works gas	10^3 m^3				0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	GWh				0.0		37.5	100.7	0.0	3262.3	442.0	108.0	151.7	186.9	581.5	66.9	637.7	1087.6	5834.3
Steam and hot water	TJ				0.0			425.5	300.9	3453.0	13.9	0.0	0.0	497.1	0.0	0.0	195.2	2746.8	1999.7

Appendix 5. Additional information (QA/QC activities)

Table A1-1 QA/QC activities

Activity	QC checks / reviews		QC others (Correction)	
	Expert name	Period / deadline	QA / QC manager	Deadline
DATA COLLECTION ACTIVITIES				
Checks all input data for emission calculations properly referenced	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check availability of literature material	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Confirm that bibliographical data references are properly cited	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
ACTIVITY DATA ENTRY IN DATABASES AND EMISSION CALCULATION				
Check whether the documented assumptions and criteria for selection of activity data, emission factors and other necessary parameters for emissions calculation	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Cross-check descriptions of input data and the emission factors with information about categories	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check the correctness of interpretation and use of activity data and emission factors	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check that the parameters and units are accurately recorded	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check that used appropriate conversion factors	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check whether the unit is properly marked in the worksheets	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check the consistency of data between the categories	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Identified e.g. activity data common to several categories	Mirela Poljanac	November	Vladimir Jelavić, Valentina Delija-Ružić	December
Check the consistency of the activity data	Mirela Poljanac	December	Vladimir Jelavić, Valentina Delija-Ružić	December
Check the consistency of time series of input activity data for each category	Mirela Poljanac	December	Vladimir Jelavić, Valentina Delija-Ružić	January
DATABASES ITEMS				
Check whether all the categories covered by the emission sources that exist in the country, if not whether there are marked with the appropriate notation key („NO“)	Mirela Poljanac	December	Vladimir Jelavić, Valentina Delija-Ružić	January
Check whether there is double counting, i.e. duplication of entries	Mirela Poljanac	January	Vladimir Jelavić, Valentina Delija-Ružić	January

Activity	QC checks / reviews		QC others (Correction)	
	Expert name	Period / deadline	QA / QC manager	Deadline
Check out the use of units and all necessary conversions of the same	Mirela Poljanac	January	Vladimir Jelavić, Valentina Delija-Ružić	January
Used to check the consistency of data on activities for each pollutant within each category.	Mirela Poljanac	January	Vladimir Jelavić, Valentina Delija-Ružić	January
Check the correctness of the emissions calculation	Mirela Poljanac	January	Vladimir Jelavić, Valentina Delija-Ružić	January
Check the consistency of trends	Mirela Poljanac	January	Vladimir Jelavić, Valentina Delija-Ružić	January
Check *Tier 2* method for emissions calculation by using *Tier 1*	Mirela Poljanac	January	Vladimir Jelavić, Valentina Delija-Ružić	January
FILLING THE REPORTING TAMPLATES (ANNEXES TABLES)				
Check pollutants emission totals by pollutants and by sectors	Mirela Poljanac	January	Hana Mesić, Vladimir Jelavić	January
Check NFR national totals	Mirela Poljanac	January	Hana Mesić, Vladimir Jelavić	January
Check for major changes compared to previous year	Mirela Poljanac	January	Hana Mesić, Vladimir Jelavić	January
Check totals in NFR codes with totals in SNAP codes	Mirela Poljanac	January	Hana Mesić, Vladimir Jelavić	January
Check longitude, latitude and height class of LPSs	Mirela Poljanac	-	Mirela Poljanac	-
Automate work due to avoid errors by linking working Excels	Mirela	January	Mirela Poljanac	January
PREPARING IIR (INFORMATIVE INVENTORY REPORT)				
Check the values in the text and excel tables	Mirela Poljanac	February	Hana Mesić Vladimir Jelavić	February
Check out the Figures	Mirela Poljanac	February	Hana Mesić, Vladimir Jelavić	February
Check the written text	Mirela Poljanac	February	Hana Mesić, Vladimir Jelavić	February
ARCHIVING				
Production of *"hard"* copies of the database	Mirela Poljanac	December	-	-
Archiving Excel Table	Mirela Poljanac	December	-	-
Archiving of data sources	Mirela Poljanac	December	-	-
Archiving of all manuals	Mirela Poljanac	December	-	-
Archiving IIR	Mirela Poljanac	December	-	-

Appendix 6. Summary of information on the condensable component in PM

This appendix summarizes the source categories that include the condensable component in PM. Those categories for which according to GB2023 it is unknown or unclear whether the emission factor includes the condensing component were not considered.

The categories of sources where the emission factor includes the condensing component are as follows:

- **1A2gvii Mobile Combustion in manufacturing industries and construction** – The emission factors used for TSP, PM_{10} and $PM_{2.5}$ are given by GB2023 and these emission factors represent total PM emissions (filterable and condensable fractions).
- **1A3bi-iv Road transport: (Passenger cars, Light duty vehicles, Heavy duty vehicles and buses, Mopeds & motorcycles)** – The emission factors used for TSP, PM10 and PM2.5 are given from COPERT V which is a Tier 3 approach in in accordance with GB2023. According to GB2023, PM emission mass factors are considered to include filterable and condensable material. The mass of particles collected on the filter was maintained below 52 °C during sampling of the diluted exhaust gases. This corresponds to total (filterable and condensable) $PM_{2.5}$. Coarse exhaust PM (ie diameter >2.5 µm) is considered to be negligible, therefore PM = $PM_{2.5}$.
- **1A4bi Residential: Stationary - using biomass** – Tier 2 methodology only provides emission factors for total PM (including condensable) for all PM related pollutants (TSP, PM10 and PM2.5) (GB 2023, p. 76/187).
- **1A4bii Residential: Household and gardening (mobile)** – The emission factors used for TSP, PM_{10} and $PM_{2.5}$ are given by GB2023 and these emission factors represent total PM emissions (filterable and condensable fractions).
- **1A4cii Agriculture/Forestry/ Fishing: Off-road vehicles and other machinery** – The emission factors used for TSP, PM_{10} and $PM_{2.5}$ are given by GB2023 and these emission factors represent total PM emissions (filterable and condensable fractions).

Appendix 7. Other appendices

Other appendices to the IIR are as follows:

- Uncertainty analysis,
- Impact of recalculations 1990-2021 by pollutant and NFR/SNAP97 sector

Uncertainty analysis

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	SO2	99.3234264	1.62391886	2.0	10.0	10.20	2.99703	-0.00935	0.00954	-0.09349	0.02699	0.09731
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	SO2	34.4602758	1.46371916	2.0	10.0	10.20	2.70137	0.00202	0.00860	0.02023	0.02432	0.03163
1 A 3 b Road Transport	1 A 3 b Cestovni promet	SO2	4.4309695	0.00118726	2.0	20.0	20.10	0.00432	-0.00084	0.00001	-0.01676	0.00002	0.01676
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	SO2	0.75893077	0.01641339	2.0	20.0	20.10	0.05970	-0.00005	0.00010	-0.00097	0.00027	0.00100
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	SO2	0.51704634	0.00134	2.0	20.0	20.10	0.00487	-0.00009	0.00001	-0.00181	0.00002	0.00182
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	SO2	6.89342072	0.03684022	5.0	20.0	20.62	0.13744	-0.00110	0.00022	-0.02196	0.00153	0.02201
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	SO2	20.1533315	0.64972347	2.0	20.0	20.10	2.36336	-0.00003	0.00382	-0.00053	0.01080	0.01081
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	SO2	0.61496454	0.18432634	10.0	50.0	50.99	1.70092	0.00097	0.00108	0.04828	0.01532	0.05065
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	SO2	1.80036063	1.49185288	2.0	50.0	50.04	13.50992	0.00842	0.00876	0.42103	0.02479	0.42176
2 B 10 a, 2 H Chemical industry: Other, Pulp and Paper industry	2 B 10 a Kemijska industrija: ostalo i 2H Industrija papira	SO2	0.81755473	0.03322966	2.0	20.0	20.10	0.12087	0.00004	0.00020	0.00079	0.00055	0.00096
2 C Metal production	2 C Industrija metala	SO2	0.38150828	0.01014811	7.5	20.0	21.36	0.03923	-0.00001	0.00006	-0.00026	0.00063	0.00068
2 G Other product use	2 G Ostala uporaba proizvoda	SO2	0.00214118	0.00661984	10.0	20.0	22.36	0.02679	0.00004	0.00004	0.00077	0.00055	0.00095
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	SO2	0.03997349	1.0447E-05	65.0	50.0	82.01	0.00016	-0.00001	0.00000	-0.00038	0.00001	0.00038
5 C Waste incineration	5 C Termička obrada otpada	SO2	0.01	0.00558206	5.0	20.0	20.62	0.02083	0.00003	0.00003	0.00061	0.00023	0.00065
5 C 1 b v Cremation	5 C 1 b v Kremiranje	SO2	0.00016543	0.00082569	65.0	20.0	68.01	0.01016	0.00000	0.00000	0.00010	0.00045	0.00046
TOTAL	TOTAL		170.21	5.53	% Uncertainty in total inventory			14.40			Trend uncertainty:		0.44

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	NO2	16.6402352	4.72519983	2.0	20.0	20.10	2.07663	-0.02590	0.04591	-0.51801	0.12987	0.53405
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	NO2	20.9731198	5.45748973	2.0	20.0	20.10	2.39846	-0.03746	0.05303	-0.74922	0.14999	0.76409
1 A 3 b Road Transport	1 A 3 b Cestovni promet	NO2	35.9233142	20.6138291	2.0	20.0	20.10	9.05936	0.04502	0.20030	0.90039	0.56654	1.06380
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	NO2	2.27590465	1.04580388	2.0	100.0	100.02	2.28710	0.00033	0.01016	0.03340	0.02874	0.04406
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	NO2	2.97107575	2.50694294	2.0	200.0	200.01	10.96337	0.01153	0.02436	2.30531	0.06890	2.30634
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	NO2	2.48002058	1.01930848	5.0	50.0	50.25	1.11991	-0.00080	0.00990	-0.04023	0.07004	0.08077
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	NO2	12.6905509	6.28000559	2.0	50.0	50.04	6.87108	0.00621	0.06102	0.31067	0.17260	0.35540
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	NO2	0.07078659	0.01520096	10.0	50.0	50.99	0.01695	-0.00016	0.00015	-0.00790	0.00209	0.00817
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	NO2	0.25627738	0.0701542	2.0	50.0	50.04	0.07676	-0.00042	0.00068	-0.02125	0.00193	0.02134
2 B 10 a Chemical industry: Other; H Pulp and Paper industry	2 B 10 a Kemijska industrija: ostalo i 2H Industrija papira	NO2	0.56044803	0.00526002	2.0	50.0	50.04	0.00576	-0.00237	0.00005	-0.11845	0.00014	0.11845
2 B 1, 2 B 2 Ammonia and Nitric acid production	3 B 1, 2 B 2 Proizvodnja amonijaka i nitratne kiseline	NO2	2.09103104	0.11978997	2.0	50.0	50.04	0.13106	-0.00786	0.00116	-0.39320	0.00329	0.39322
2 C Metal production	2 C Industrija metala	NO2	0.09649594	0.02198758	7.5	50.0	50.56	0.02431	-0.00020	0.00021	-0.01015	0.00227	0.01040
2 G Other product use	2 G Ostala uporaba proizvoda	NO2	0.02194814	0.01585696	10.0	50.0	50.99	0.01768	0.00006	0.00015	0.00297	0.00218	0.00368
3 D a, b, c, d, e	3 D a, b, c, d, e	NO2	5.13464869	3.60933311	5.0	100.0	100.12	7.90164	0.01289	0.03507	1.28924	0.24799	1.31287
3B1, 3B2, 3B4d, 3B4e, 3B4f,	3B1, 3B2, 3B4d, 3B4e, 3B4f,	NO2	0.07430705	0.02158811	10.0	100.0	100.50	0.04744	-0.00011	0.00021	-0.01111	0.00297	0.01150
3B3, 3B4g	3B3, 3B4g	NO2	0.12025327	0.05267299	50.0	100.0	111.80	0.12876	-0.00001	0.00051	-0.00075	0.03619	0.03620
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	NO2	0.18387804	4.8057E-05	65.0	50.0	82.01	0.00009	-0.00079	0.00000	-0.03968	0.00004	0.03968
5 C 1 b v Cremation	5 C 1 b v Kremiranje	NO2	0.0012078	0.00602828	65.0	20.0	68.01	0.00896	0.00005	0.00006	0.00107	0.00538	0.00549
5 C Waste incineration	5 C Termička obrada otpada	NO2	0.3476795	0.14884417	5.0	20.0	20.62	0.06709	-0.00006	0.00145	-0.00110	0.01023	0.01029
TOTAL			102.91	45.74	% Uncertainty in total inventory			18.12			Trend uncertainty:		3.06

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	NMVOC	0.96061597	0.52631471	2.0	50.0	50.04	0.43097	0.00109	0.00303	0.05427	0.00856	0.05494
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	NMVOC	4.91472654	1.35205989	2.0	50.0	50.04	1.10714	-0.00216	0.00777	-0.10779	0.02199	0.11001
1 A 3 b Road Transport	1 A 3 b Cestovni promet	NMVOC	34.2461956	4.33183465	2.0	20.0	20.10	1.42479	-0.04421	0.02491	-0.88410	0.07046	0.88691
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	NMVOC	0.23044804	0.09245792	2.0	100.0	100.02	0.15133	0.00007	0.00053	0.00660	0.00150	0.00677
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	NMVOC	0.26723934	0.09876308	2.0	200.0	200.01	0.32325	0.00003	0.00057	0.00558	0.00161	0.00581
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	NMVOC	0.28713358	0.39346137	5.0	50.0	50.25	0.32353	0.00168	0.00226	0.08412	0.01600	0.08562
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	NMVOC	25.3678198	18.1608234	2.0	50.0	50.04	14.87103	0.05309	0.10443	2.65466	0.29538	2.67104
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	NMVOC	4.25736175	1.78575635	10.0	50.0	50.99	1.49004	0.00167	0.01027	0.08327	0.14522	0.16740
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	NMVOC	1.56195073	0.44735473	2.0	50.0	50.04	0.36632	-0.00058	0.00257	-0.02919	0.00728	0.03008
2 B 1, 2 B 10 a, 2 H 1, 2 H 2 Ammonia production, Chemical industry: Other, Pulp and Paper industry, Food and beverages industry	2 B 1, 2 B 10 a, 2 H 1, 2 H 2 Proizvodnja amonijaka, Kemijska industrija: ostalo, Industrija papira, Industrija hrane i pića	NMVOC	23.3997289	3.48833919	2.0	50.0	50.04	2.85643	-0.02719	0.02006	-1.35942	0.05674	1.36061
2 A 3 Glass production	2 A 3 Proizvodnja stakla	NMVOC	0.00975	0.049388	2.0	200.0	200.01	0.16164	0.00026	0.00028	0.05286	0.00080	0.05287
2 C Metal production	2 C Industrija metala	NMVOC	0.00963595	0.00783894	7.5	50.0	50.56	0.00649	0.00003	0.00005	0.00128	0.00048	0.00137
2D3b	2D3b	NMVOC	0.00891213	0.03855	15.5	200.0	200.60	0.12654	0.00020	0.00022	0.04073	0.00486	0.04102
2D3c,2D3h	2D3c,2D3h	NMVOC	5.69632884	1.33521145	30	50.0	58.31	1.27402	-0.00383	0.00768	-0.19157	0.32575	0.37791
2D3g	2D3g	NMVOC	3.00864106	0.63224127	32.5	200.0	202.62	2.09634	-0.00244	0.00364	-0.48871	0.16710	0.51649
2D3a, 2D3i, 2G, 2D3e, 2D3f, 2D3d	2D3a, 2D3i, 2G, 2D3e, 2D3f, 2D3d	NMVOC	58.0831497	18.5045661	10	50.0	50.99	15.44024	-0.01092	0.10641	-0.54624	1.50484	1.60092
3B	3B	NMVOC	9.140066	6.71831072	10.0	100	100.50	11.04865	0.02015	0.03863	2.01528	0.54635	2.08803
3 D a, b, c, d, e	3 D a, b, c, d, e	NMVOC	1.68589051	1.67850016	5	100.0	100.12	2.75012	0.00624	0.00965	0.62447	0.06825	0.62819
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	NMVOC	0.03997349	1.0447E-05	65.0	50.0	82.01	0.00001	-0.00008	0.00000	-0.00404	0.00001	0.00404
5 A Biological treatment of waste - Solid waste disposal on land	5 A Biološka obrada otpada - Odlagališta otpada	NMVOC	0.5930031	1.42896531	65	50	82.01	1.91759	0.00702	0.00822	0.35093	0.75535	0.83289
5 C 1 b v Cremation	5 C 1 b v Kremiranje	NMVOC	1.9032E-05	9.4991E-05	5.0	50	50.25	0.00008	0.00000	0.00000	0.00003	0.00000	0.00003
5 C Waste incineration	5 C Termička obrada otpada	NMVOC	0.13	0.03439369	5.0	50	50.25	0.02828	-0.00007	0.00020	-0.00327	0.00140	0.00356
5 D Wastewater handling	5 D Rukovanje otpadnim vodama	NMVOC	2.38E-03	4.66E-03	5.0	50	50.25	0.00383	0.00002	0.00003	0.00110	0.00019	0.00112
TOTAL			173.90	61.11	% Uncertainty in total inventory			24.76			Trend uncertainty:		4.27

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	CO	2.66710433	1.88162985	2.0	20.0	20.10	0.18292	0.00160	0.00334	0.03205	0.00943	0.03341
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	CO	29.1012503	8.90225373	2.0	20.0	20.10	0.86540	-0.00312	0.01578	-0.06245	0.04463	0.07675
1 A 3 b Road Transport	1 A 3 b Cestovni promet	CO	226.924141	20.859973	2.0	20.0	20.10	2.02783	-0.10998	0.03697	-2.19963	0.10457	2.20212
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	CO	2.38130973	1.02671637	2.0	100.0	100.02	0.49667	0.00027	0.00182	0.02730	0.00515	0.02778
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	CO	0.70042502	0.35742097	2.0	200.0	200.01	0.34575	0.00018	0.00063	0.03571	0.00179	0.03575
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	CO	1.55960095	0.67761058	5.0	50.0	50.25	0.16468	0.00019	0.00120	0.00940	0.00849	0.01267
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	CO	198.341765	156.520529	2.0	50.0	50.04	37.88051	0.14807	0.27742	7.40343	0.78466	7.44490
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	CO	0.57464789	0.06887259	10.0	50.0	50.99	0.01698	-0.00025	0.00012	-0.01256	0.00173	0.01268
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	CO	50.0414877	13.6968005	2.0	50.0	50.04	3.31485	-0.00822	0.02428	-0.41101	0.06866	0.41671
2 B 10 a, 2 H Chemical industry: Other, Pulp and Paper industry, 2 B 1 Ammonia production	2 B 10 a Kemijska industrija: ostalo i 2H Industrija papira, 2 B 1 Proizvodnja amonijaka	CO	30.7682401	0.00034937	2.0	50.0	50.04	0.00008	-0.01997	0.00000	-0.99869	0.00000	0.99869
2 C Metal production	2 C Industrija metala	CO	9.2006946	0.28752991	7.5	50.0	50.56	0.07031	-0.00547	0.00051	-0.27329	0.00541	0.27334
2D3b, 2D3c, 2D3d, 2D3g, 2D3h	2D3b, 2D3c, 2D3d, 2D3g, 2D3h	CO	0.00023289	0.0002043	15.5	50.0	52.35	0.00005	0.00000	0.00000	0.00001	0.00001	0.00001
2 G Other product use	2 G Ostala uporaba proizvoda	CO	0.67128345	0.48362601	5	100.0	100.12	0.23420	0.00042	0.00086	0.04212	0.00606	0.04255
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	CO	5.33246327	0.00139364	65.0	17.0	67.19	0.00045	-0.00346	0.00000	-0.05883	0.00023	0.05884
5 C Waste incineration	5 C Termička obrada otpada	CO	5.93	1.99698574	5.0	100.0	100.12	0.96704	-0.00032	0.00354	-0.03155	0.02503	0.04027
5 C 1 b v Cremation	5 C 1 b v Kremiranje	CO	0.00020496	0.00102298	5.0	50.0	50.25	0.00025	0.00000	0.00000	0.00008	0.00001	0.00008
TOTAL			564.20	206.76	% Uncertainty in total inventory			38.11			Trend uncertainty:		7.84

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	NH3	0.00893257	0.01015944	2.0	1000.00	1000.00	0.37746	0.00011	0.00020	0.10691	0.00057	0.10691
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	NH3	0.13392061	0.04301755	2.0	1000.00	1000.00	1.59824	-0.00056	0.00085	-0.56299	0.00241	0.56300
1 A 3 b Road Transport	1 A 3 b Cestovni promet	NH3	0.05670472	0.4367936	2.0	400	400.00	6.49139	0.00806	0.00866	3.22248	0.02448	3.22258
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	NH3	0.00071282	0.00022602	2.0	1000.00	1000.00	0.00840	0.00000	0.00000	-0.00306	0.00001	0.00306
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	NH3	0.00073058	0.0225329	5.0	1000.00	1000.01	0.83718	0.00044	0.00045	0.43880	0.00316	0.43881
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	NH3	0.34040647	0.3007405	2.0	1000.00	1000.00	11.17349	0.00236	0.00596	2.36152	0.01686	2.36158
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	NH3	0.0020572	0	10.0	1000.00	1000.05	0.00000	-0.00002	0.00000	-0.02174	0.00000	0.02174
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	NH3	0.2050219	0.05612336	2.0	1000.00	1000.00	2.08517	-0.00105	0.00111	-1.05475	0.00315	1.05476
2 B 10 a Chemical industry: Other, 2 H 1 Pulp and Paper industry, 2 H 2 Food and beverages industry	2 B 10 a Kemijska industrija: ostalo, 2 H 1 Industrija papira, 2 H 2 Industrija hrane i pića	NH3	3.48320198	0.4204402	2.0	400	400.00	6.24835	-0.02846	0.00833	-11.38562	0.02357	11.38564
2 A 3 Glass production	2 A 3 Proizvodnja stakla	NH3	0.03	0.07964883	2.0	60	60.03	0.17765	0.00130	0.00158	0.07796	0.00446	0.07809
2 B 1 Ammonia production	2 B 1 Proizvodnja amonijaka	NH3	0.02	0.00276138	2.0	400	400.00	0.04104	-0.00013	0.00005	-0.05103	0.00015	0.05103
2D3a, 2D3i, 2G	2D3a, 2D3i, 2G	NH3	0.05017765	0.03524511	10	400	400.12	0.52395	0.00017	0.00070	0.06723	0.00988	0.06795
3B1, 3B2, 3B4d, 3B4e, 3B4f	3B1, 3B2, 3B4d, 3B4e, 3B4f	NH3	8.0259234	3.13853725	10.0	100	100.50	11.71882	-0.02260	0.06219	-2.25988	0.87956	2.42501
3B3, 3B4g	3B3, 3B4g	NH3	11.9713892	5.47996345	50.0	100	111.80	22.76295	-0.01790	0.10859	-1.78950	7.67866	7.88442
3 D a, b, c, d, e	3 D a, b, c, d, e	NH3	24.70	16.73	5	100	100.12	62.22523	0.07002	0.33148	7.00198	2.34388	7.38386
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	NH3	0.19187274	5.0146E-05	65.0	100	119.27	0.00022	-0.00203	0.00000	-0.20269	0.00009	0.20269
5 B Biological treatment of waste	5 B Biološka obrada otpada	NH3	0.00	0.03868277	5	400	400.03	0.57492	0.00077	0.00077	0.30662	0.00542	0.30667
5 D Wastewater handling	5 D Rukovanje otpadnim vodama	NH3	1.24	0.12	30.0	1000.00	1000.45	4.58230	-0.01070	0.00244	-10.70446	0.10365	10.70497
TOTAL			50.46	26.92	% Uncertainty in total inventory			69.01			Trend uncertainty:		19.61

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	BC	0.11611067	0.06518167	2.0	50.0	50.04	0.89695	-0.00211	0.01185	-0.10529	0.03352	0.11050
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	BC	0.65	0.10686196	2.0	50.0	50.04	1.47051	-0.05831	0.01943	-2.91549	0.05495	2.91601
1 A 3 b Road Transport	1 A 3 b Cestovni promet	BC	0.52990815	0.59549217	2.0	100.0	100.02	16.37912	0.04453	0.10827	4.45277	0.30623	4.46329
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	BC	0.00308726	0.00125467	2.0	500.0	500.00	0.17252	-0.00014	0.00023	-0.07149	0.00065	0.07150
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	BC	0.00016621	0.000175	2.0	500.0	500.00	0.02406	0.00001	0.00003	0.00592	0.00009	0.00592
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	BC	0.07563552	0.03339445	5.0	78.0	78.16	0.71777	-0.00302	0.00607	-0.23555	0.04293	0.23943
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	BC	3.66637722	2.53718003	2.0	76.0	76.03	53.04479	0.02044	0.46129	1.55336	1.30473	2.02861
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	BC	0.0267969	0.00296632	10.0	50.0	50.99	0.04159	-0.00268	0.00054	-0.13408	0.00763	0.13430
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	BC	0.00039979	0.00010944	2.0	50.0	50.04	0.00151	-0.00003	0.00002	-0.00141	0.00006	0.00141
2 B 10 a, 2 H 1, 2 H 2 Chemical industry: Other, Pulp and Paper industry, Food and beverages industry	2 B 10 a Kemijska industrija: ostalo, 2 H 1 Industrija papira, 2 H 2 Industrija hrane i pića	BC	0.00621899	0.00056255	2.0	50.0	50.04	0.00774	-0.00065	0.00010	-0.03226	0.00029	0.03226
2 A 1, 2 A 2 Cement and Lime production	2 A 1, 2 A 2 Proizvodnja cementa i vapna	BC	0.00807372	0.00880689	2.0	50.0	50.04	0.12119	0.00063	0.00160	0.03153	0.00453	0.03186
2 A 3 Glass production	2 A 3 Proizvodnja stakla	BC	0.00019338	0.00089461	2.0	60.0	60.03	0.01477	0.00014	0.00016	0.00836	0.00046	0.00838
2 C Metal production	2 C Industrija metala	BC	0.01841216	1.2787E-05	7.5	50.0	50.56	0.00018	-0.00221	0.00000	-0.11054	0.00002	0.11054
2D3b	2D3b	BC	0.02370627	0.102543	15.5	200.0	200.60	5.65671	0.01579	0.01864	3.15867	0.40868	3.18500
2D3c	2D3c	BC	2.5496E-07	2.2366E-07	30	50.0	58.31	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2D3a, 2D3i, 2G	2D3a, 2D3i, 2G	BC	0.14690565	0.1031875	10	50.0	50.99	1.44691	0.00110	0.01876	0.05509	0.26532	0.27098
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	BC	0.03997349	1.0447E-05	65.0	25.0	69.64	0.00020	-0.00480	0.00000	-0.12007	0.00017	0.12007
5 C Waste incineration	5 C Termička obrada otpada	BC	0.190898	0.077773	5.0	50.0	50.25	1.07470	-0.00880	0.01414	-0.44018	0.09999	0.45140
TOTAL			5.50	3.64	% Uncertainty in total inventory			55.86			Trend uncertainty:		6.56

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	PM2.5	1.0440582	1.85649551	2.0	50.0	50.04	3.54361	0.02932	0.04648	1.46583	0.13148	1.47171
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	PM2.5	2.51989538	0.30186274	2.0	50.0	50.04	0.57619	-0.03384	0.00756	-1.69178	0.02138	1.69192
1 A 3 b Road Transport	1 A 3 b Cestovni promet	PM2.5	1.25914211	1.27309104	2.0	100.0	100.02	4.85715	0.01118	0.03188	1.11783	0.09016	1.12146
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	PM2.5	0.07683294	0.02251571	2.0	100.0	100.02	0.08590	-0.00070	0.00056	-0.06990	0.00159	0.06992
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	PM2.5	0.06219254	0.05645103	2.0	200.0	200.01	0.43068	0.00039	0.00141	0.07826	0.00400	0.07836
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	PM2.5	0.2224452	0.10609804	5.0	78.0	78.16	0.31632	-0.00100	0.00266	-0.07795	0.01878	0.08018
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	PM2.5	30.1570459	20.6499849	2.0	76.0	76.03	59.88514	0.02124	0.51704	1.61443	1.46242	2.17831
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	PM2.5	0.07863937	0.01262013	10.0	50.0	50.99	0.02455	-0.00098	0.00032	-0.04882	0.00447	0.04903
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	PM2.5	0.30753285	0.08418504	2.0	50.0	50.04	0.16069	-0.00295	0.00211	-0.14732	0.00596	0.14744
2 B 10 a, 2 H 1, 2 H 2 Chemical industry: Other, Pulp and Paper industry, Food and beverages industry	2 B 10 a Kemijska industrija: ostalo, 2 H 1 Industrija papira, 2 H 2 Industrija hrane i pića	PM2.5	0.28536899	0.03125286	2.0	50.0	50.04	0.05965	-0.00391	0.00078	-0.19537	0.00221	0.19538
2 A 1, 2 A 2 Cement and Lime production	2 A 1, 2 A 2 Proizvodnja cementa i vapna	PM2.5	0.17489686	0.18022129	2.0	50.0	50.04	0.34400	0.00164	0.00451	0.08189	0.01276	0.08288
2 A 3 Glass production	2 A 3 Proizvodnja stakla	PM2.5	0.07373689	0.11786388	2.0	60.0	60.03	0.26990	0.00174	0.00295	0.10435	0.00835	0.10469
2 A 5 a Quarrying and mining of mineral products	2 A 5 a Vađenje kamen	PM2.5	0.13509404	0.15343237	5.0	50.0	50.25	0.29409	0.00162	0.00384	0.08107	0.02716	0.08550
2 A 5 b Construction and demolition	2 A 5 b Građenje i rušenje objekata	PM2.5	0.90840849	0.45827475	325.0	155.0	360.07	6.29430	-0.00345	0.01147	-0.53548	5.27388	5.30100
2 C Metal production	2 C Industrija metala	PM2.5	0.2683954	0.00355184	7.5	50.0	50.56	0.00685	-0.00432	0.00009	-0.21610	0.00094	0.21610
2D3b	2D3b	PM2.5	0.29718992	0.0417368	15.5	200.0	200.60	0.31936	-0.00384	0.00105	-0.76782	0.02291	0.76816
2D3c	2D3c	PM2.5	0.0019612	0.00172045	30	50.0	58.31	0.00383	0.00001	0.00004	0.00054	0.00183	0.00191
2D3a, 2D3i, 2G	2D3a, 2D3i, 2G	PM2.5	0.43597726	0.37690985	10	50.0	50.99	0.73309	0.00227	0.00944	0.11358	0.13346	0.17525
3B1, 3B2, 3B4d, 3B4e, 3B4f,	3B1, 3B2, 3B4d, 3B4e, 3B4f,	PM2.5	0.11793285	0.03959969	10.0	100.0	100.50	0.15181	-0.00095	0.00099	-0.09467	0.01402	0.09570
3B3, 3B4g	3B3, 3B4g	PM2.5	0.17833608	0.05196952	50.0	100.0	111.80	0.22164	-0.00163	0.00130	-0.16297	0.09201	0.18715
3 D a, b, c, d, e	3 D a, b, c, d, e	PM2.5	0.18358398	0.08687514	5	50.0	50.25	0.16652	-0.00084	0.00218	-0.04210	0.01538	0.04482
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	PM2.5	0.43171367	0.00011283	65.0	25.0	69.64	0.00030	-0.00709	0.00000	-0.17729	0.00026	0.17729
5 A Biological treatment of waste - Solid waste disposal on land	5 A Biološka obrada otpada -Odlagališta otpada	PM2.5	3.389E-05	6.0382E-05	5	100.0	100.12	0.00023	0.00000	0.00000	0.00010	0.00001	0.00010
5 C 1 b v Cremation	5 C 1 b v Kremiranje	PM2.5	5.0801E-05	0.00025355	5	80.0	80.16	0.00078	0.00001	0.00001	0.00044	0.00004	0.00044
5 C Waste incineration	5 C Termička obrada otpada	PM2.5	0.44	0.14715357	5.0	50.0	50.25	0.28206	-0.00362	0.00368	-0.18121	0.02605	0.18307
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	PM2.5	0.2735262	0.16159806	10.0	700.0	700.07	4.31533	-0.00045	0.00405	-0.31450	0.05722	0.31967
TOTAL			39.94	26.22	% Uncertainty in total inventory			60.68			Trend uncertainty:		6.33

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	PM10	1.63595337	2.18778533	2.0	50.0	50.04	3.00239	0.01993	0.03695	0.99644	0.10450	1.00190
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	PM10	2.63187473	0.30913063	2.0	50.0	50.04	0.42423	-0.02214	0.00522	-1.10699	0.01477	1.10709
1 A 3 b Road Transport	1 A 3 b Cestovni promet	PM10	1.53083496	1.83373172	2.0	100.0	100.02	5.02999	0.01504	0.03097	1.50443	0.08759	1.50698
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	PM10	0.08152346	0.02358947	2.0	100.0	100.02	0.06471	-0.00045	0.00040	-0.04494	0.00113	0.04496
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	PM10	0.06842553	0.06474377	2.0	200.0	200.01	0.35514	0.00038	0.00109	0.07636	0.00309	0.07642
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	PM10	0.25106859	0.11098395	5.0	78.0	78.16	0.23790	-0.00074	0.00187	-0.05746	0.01325	0.05897
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	PM10	30.9153443	21.1739179	2.0	76.0	76.03	44.14788	0.03589	0.35759	2.72791	1.01141	2.90937
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	PM10	0.13232627	0.01262013	10.0	50.0	50.99	0.01765	-0.00116	0.00021	-0.05815	0.00301	0.05823
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	PM10	0.70476278	0.19292405	2.0	50.0	50.04	0.26476	-0.00407	0.00326	-0.20353	0.00922	0.20374
2 B 10 a, 2 H 1, 2 H 2 Chemical industry: Other, Pulp and Paper industry, Food and beverages industry	2 B 10 a Kemijska industrija: ostalo, 2 H 1 Industrija papira, 2 H 2 Industrija hrane i pića	PM10	0.38872364	0.04167048	2.0	50.0	50.04	0.05719	-0.00334	0.00070	-0.16693	0.00199	0.16694
2 A 1, 2 A 2 Cement and Lime production	2 A 1, 2 A 2 Proizvodnja cementa i vapna	PM10	0.37377356	0.37791511	2.0	50.0	50.04	0.51863	0.00250	0.00638	0.12475	0.01805	0.12605
2 A 3 Glass production	2 A 3 Proizvodnja stakla	PM10	0.08302727	0.13300447	2.0	60.0	60.03	0.21898	0.00138	0.00225	0.08296	0.00635	0.08321
2 A 5 a Quarrying and mining of mineral products	2 A 5 a Vađenje kamen	PM10	1.35094035	1.5343237	5.0	50.0	50.25	2.11443	0.01186	0.02591	0.59299	0.18322	0.62065
2 A 5 b Construction and demolition	2 A 5 b Građenje i rušenje objekata	PM10	9.08408494	4.58274748	325.0	155.0	360.07	45.25399	-0.01705	0.07739	-2.64282	35.57160	35.66964
2 C Metal production	2 C Industrija metala	PM10	0.36259418	0.00405925	7.5	50.0	50.56	0.00563	-0.00370	0.00007	-0.18510	0.00073	0.18510
2D3b	2D3b	PM10	1.27367108	0.178872	15.5	200.0	200.60	0.98405	-0.01022	0.00302	-2.04452	0.06622	2.04559
2D3c	2D3c	PM10	0.009806	0.00860224	30	50.0	58.31	0.01376	0.00004	0.00015	0.00216	0.00616	0.00653
2D3a, 2D3i, 2G	2D3a, 2D3i, 2G	PM10	0.50634248	0.49895791	10	50.0	50.99	0.69774	0.00316	0.00843	0.15802	0.11917	0.19792
3B1, 3B2, 3B4d, 3B4e, 3B4f,	3B1, 3B2, 3B4d, 3B4e, 3B4f,	PM10	0.18447329	0.06327279	10.0	100.0	100.50	0.17439	-0.00085	0.00107	-0.08499	0.01511	0.08632
3B3, 3B4g	3B3, 3B4g	PM10	1.66304968	0.55266863	50.0	100.0	111.80	1.69459	-0.00796	0.00933	-0.79592	0.65998	1.03395
3 D a, b, c, d, e	3 D a, b, c, d, e	PM10	4.77318348	2.25875364	5	50.0	50.25	3.11275	-0.01148	0.03815	-0.57418	0.26973	0.63438
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	PM10	0.45569776	0.0001191	65.0	25.0	69.64	0.00023	-0.00474	0.00000	-0.11842	0.00018	0.11842
5 A Biological treatment of waste - Solid waste disposal on land	5 A Biološka obrada otpada -Odlagališta otpada	PM10	0.00022491	0.00040072	5.0	100.0	100.12	0.00110	0.00000	0.00001	0.00044	0.00005	0.00045
5 C 1 b v Cremation	5 C 1 b v Kremiranje	PM10	5.0801E-05	0.00025355	5.0	80.0	80.16	0.00056	0.00000	0.00000	0.00030	0.00003	0.00030
5 C Waste incineration	5 C Termička obrada otpada	PM10	0.48	0.15659588	5.0	50.0	50.25	0.21580	-0.00233	0.00264	-0.11643	0.01870	0.11792
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	PM10	0.2735262	0.16159806	10.0	700.0	700.07	3.10258	-0.00012	0.00273	-0.08082	0.03859	0.08957
TOTAL			59.21	36.46	% Uncertainty in total inventory			**63.72**			Trend uncertainty:		**35.94**

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kt	kt	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	TSP	2.7455401	2.48222456	2.0	50.0	50.04	2.34356	0.00989	0.02660	0.49436	0.07523	0.50005
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	TSP	2.73576978	0.32008683	2.0	50.0	50.04	0.30221	-0.01321	0.00343	-0.66072	0.00970	0.66079
1 A 3 b Road Transport	1 A 3 b Cestovni promet	TSP	1.7796215	2.36072447	2.0	100.0	100.02	4.45502	0.01446	0.02530	1.44633	0.07155	1.44810
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	TSP	0.08599443	0.02476352	2.0	100.0	100.02	0.04673	-0.00026	0.00027	-0.02580	0.00075	0.02581
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	TSP	0.06842553	0.06474377	2.0	100.0	100.02	0.12218	0.00028	0.00069	0.02773	0.00196	0.02780
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	TSP	0.25733132	0.11499985	5.0	78.0	78.16	0.16959	-0.00033	0.00123	-0.02603	0.00871	0.02745
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	TSP	32.5166366	22.2305365	2.0	76.0	76.03	31.88833	0.04019	0.23821	3.05448	0.67375	3.12791
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	TSP	0.25224617	0.01262013	10.0	50.0	50.99	0.01214	-0.00140	0.00014	-0.06999	0.00191	0.07001
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	TSP	0.89697081	0.2455397	2.0	50.0	50.04	0.23182	-0.00283	0.00263	-0.14135	0.00744	0.14155
2 B 10 a, 2 H 1, 2 H 2, 2 I Chemical industry: Other, Pulp and Paper industry, Food and beverages industry, Wood processing	2 B 10 a Kemijska industrija: ostalo, 2 H 1 Industrija papira, 2 H 2 Industrija hrane i pića, 2 I Prerada drva	TSP	0.84968855	0.22129457	2.0	50.0	50.04	0.20893	-0.00280	0.00237	-0.13996	0.00671	0.14012
2 A 1, 2 A 2 Cement and Lime production	2 A 1, 2 A 2 Proizvodnja cementa i vapna	TSP	0.15988608	0.10096519	2.0	50.0	50.04	0.09533	0.00011	0.00108	0.00545	0.00306	0.00625
2 A 3 Glass production	2 A 3 Proizvodnja stakla	TSP	0.09246417	0.14896027	2.0	60.0	60.03	0.16873	0.00103	0.00160	0.06201	0.00451	0.06217
2 A 5 a Quarrying and mining of mineral products	2 A 5 a Vađenje kamen	TSP	2.75591831	3.13002035	5.0	50.0	50.25	2.96753	0.01676	0.03354	0.83816	0.23716	0.87107
2 A 5 b Construction and demolition	2 A 5 b Građenje i rušenje objekata	TSP	30.3822566	15.3307757	325.0	155.0	360.07	104.15218	-0.02055	0.16427	-3.18472	75.50289	75.57002
2 C Metal production	2 C Industrija metala	TSP	0.48292718	0.00514955	7.5	50.0	50.56	0.00491	-0.00288	0.00006	-0.14417	0.00059	0.14417
2D3b	2D3b	TSP	5.51924133	0.775112	15.5	200.0	200.60	2.93368	-0.02527	0.00831	-5.05319	0.18206	5.05647
2D3c	2D3c	TSP	0.039224	0.03440897	30	50.0	58.31	0.03786	0.00013	0.00037	0.00650	0.01564	0.01694
2D3a, 2D3i, 2G	2D3a, 2D3i, 2G	TSP	0.53760027	0.5319312	10	50.0	50.99	0.51175	0.00243	0.00570	0.12141	0.08061	0.14573
3B1, 3B2, 3B4d, 3B4e, 3B4f	3B1, 3B2, 3B4d, 3B4e, 3B4f,	TSP	0.92532961	0.36406075	10.0	100.0	100.50	0.69032	-0.00173	0.00390	-0.17298	0.05517	0.18156
3B3, 3B4g	3B3, 3B4g	TSP	4.239498	1.92039123	50.0	100.0	111.80	4.05100	-0.00522	0.02058	-0.52190	1.45504	1.54581
3 D a, b, c, d, e	3 D a, b, c, d, e	TSP	4.77318348	2.25875364	5	50.0	50.25	2.14150	-0.00484	0.02420	-0.24204	0.17114	0.29644
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	TSP	0.46369246	0.00012119	65.0	25.0	69.64	0.00016	-0.00282	0.00000	-0.07051	0.00012	0.07051
5 A Biological treatment of waste - Solid waste disposal on land	5 A Biološka obrada otpada -Odlagališta otpada	TSP	0.00047549	0.00084718	5.0	100.0	100.12	0.00160	0.00001	0.00001	0.00062	0.00006	0.00062
5 C 1 b v Cremation	5 C 1 b v Kremiranje	TSP	5.6452E-05	0.00028176	5.0	80.0	80.16	0.00043	0.00000	0.00000	0.00021	0.00002	0.00022
5 C Waste incineration	5 C Termička obrada otpada	TSP	0.49	0.15983996	5.0	50.0	50.25	0.15154	-0.00128	0.00171	-0.06397	0.01211	0.06510
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	TSP	0.2735262	0.16159806	10.0	700.0	700.07	2.13450	0.00007	0.00173	0.04694	0.02449	0.05294
TOTAL			93.33	53.00	% Uncertainty in total inventory			109.24			Trend uncertainty:		75.84

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	PAH	0.02584834	0.01694054	2.0	100.0	100.02	0.12715	0.00009	0.00073	0.00936	0.00205	0.00958
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	PAH	2.31634003	0.29386118	2.0	100.0	100.02	2.20559	-0.04401	0.01259	-4.40055	0.03560	4.40070
1 A 3 b Road Transport	1 A 3 b Cestovni promet	PAH	0.18123362	0.41104148	2.0	400.0	400.00	12.33806	0.01317	0.01761	5.26979	0.04980	5.27003
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	PAH	0.05731881	0.02524663	2.0	400.0	400.00	0.75782	-0.00032	0.00108	-0.12802	0.00306	0.12806
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	PAH	0.13131512	0.0201512	5.0	400.0	400.03	0.60491	-0.00235	0.00086	-0.93899	0.00610	0.93901
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	PAH	18.2107403	12.1150431	2.0	400.0	400.00	363.65231	0.07310	0.51894	29.24180	1.46780	29.27862
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	PAH	0.29468499	8.9848E-07	10.0	400.0	400.12	0.00003	-0.00720	0.00000	-2.88175	0.00000	2.88175
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	PAH	0.00429265	0.00117508	2.0	400.0	400.00	0.03527	-0.00005	0.00005	-0.02185	0.00014	0.02185
2 C Metal production	2 C Industrija metala	PAH	0.61685761	0.08118491	7.5	400.0	400.07	2.43729	-0.01160	0.00348	-4.64085	0.03688	4.64100
2 D 3 i, 2G	3 D 3 i, 2G	PAH	0.00385834	0.00242081	10.0	400.0	400.12	0.07269	0.00001	0.00010	0.00374	0.00147	0.00402
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	PAH	0.18339836	4.7931E-05	65.0	100.0	119.27	0.00043	-0.00448	0.00000	-0.44819	0.00019	0.44819
5 C Waste incineration	5 C Termička obrada otpada	PAH	1.319682	0.3590157	5.0	100.0	100.12	2.69744	-0.01688	0.01538	-1.68796	0.10874	1.69145
5 C 1 b v Cremation	5 C 1 b v Kremiranje	PAH	4.9542E-08	2.4727E-07	5.0	100.0	100.12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL			23.35	13.33	% Uncertainty in total inventory			363.89			Trend uncertainty:		30.63

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kg	kg	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	HCB	0.00500698	0.07509576	2.0	100.0	100.02	23.39448	0.01056	0.01059	1.05576	0.02995	1.05619
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	HCB	0.03365543	0.01662401	2.0	100.0	100.02	5.17885	0.00213	0.00234	0.21293	0.00663	0.21303
1 A 3 b Road Transport	1 A 3 b Cestovni promet	HCB	0.00043856	0.00084864	2.0	400.0	400.00	1.05730	0.00012	0.00012	0.04675	0.00034	0.04675
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	HCB	0.00013462	0	2.0	400.0	400.00	0.00000	0.00000	0.00000	-0.00034	0.00000	0.00034
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	HCB	0.00338459	0.00385761	2.0	400.0	400.00	4.80612	0.00052	0.00054	0.20895	0.00154	0.20895
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	HCB	0.00201686	0.00310059	5.0	400.0	400.03	3.86321	0.00042	0.00044	0.16974	0.00309	0.16977
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	HCB	0.21397433	0.21050078	2.0	400.0	400.00	262.25893	0.02831	0.02968	11.32370	0.08396	11.32401
3 D f Use of pesticides	3 D f Uporaba pesticida	HCB	6.8180805	0.00993853	3.0	30.0	30.15	0.93329	-0.04173	0.00140	-1.25181	0.00595	1.25182
5 C Waste incineration	5 C Termička obrada otpada	HCB	0.0145	0	5.0	100.0	100.12	0.00000	-0.00009	0.00000	-0.00926	0.00000	0.00926
5 C 1 b v Cremation	5 C 1 b v Kremiranje	HCB	0.0002196	0.00109605	5.0	100.0	100.12	0.34181	0.00015	0.00015	0.01532	0.00109	0.01535
TOTAL			7.09	0.32	% Uncertainty in total inventory			263.38			Trend uncertainty:		11.45

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			g I-TEQ	g I-TEQ	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	PCDD/PCDF	0.2129213	0.83271502	2.0	100.0	100.02	3.33064	0.00918	0.00994	0.91819	0.02812	0.91862
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	PCDD/PCDF	2.6904125	0.32366099	2.0	100.0	100.02	1.29456	-0.00572	0.00386	-0.57224	0.01093	0.57235
1 A 3 b Road Transport	1 A 3 b Cestovni promet	PCDD/PCDF	0.5040118	0.8667275	2.0	400.0	400.00	13.86414	0.00855	0.01035	3.42009	0.02927	3.42022
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	PCDD/PCDF	0.04764714	0.00266165	2.0	400.0	400.00	0.04258	-0.00014	0.00003	-0.05521	0.00009	0.05521
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	PCDD/PCDF	0.00601137	0.00627119	2.0	400.0	400.00	0.10031	0.00005	0.00007	0.02138	0.00021	0.02138
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	PCDD/PCDF	0.21185927	0.06337436	5.0	400.0	400.03	1.01380	0.00000	0.00076	0.00061	0.00535	0.00538
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	PCDD/PCDF	33.7375724	20.6807096	2.0	400.0	400.00	330.80788	0.12614	0.24689	50.45717	0.69830	50.46200
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	PCDD/PCDF	1.668	0	10.0	400.0	400.12	0.00000	-0.00594	0.00000	-2.37730	0.00000	2.37730
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	PCDD/PCDF	0.02434635	0.00666465	2.0	400.0	400.00	0.10661	-0.00001	0.00008	-0.00288	0.00023	0.00289
2 C Metal production	2 C Industrija metala	PCDD/PCDF	0.5307944	0.50740572	7.5	400.0	400.07	8.11777	0.00417	0.00606	1.66619	0.06425	1.66743
2 G Other product use	2 G Ostala uporaba proizvoda	PCDD/PCDF	0.0012091	0.00084928	10.0	400.0	400.12	0.01359	0.00001	0.00001	0.00233	0.00014	0.00234
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	PCDD/PCDF	39.9734878	0.01044711	65.0	50.0	82.01	0.03426	-0.14166	0.00012	-7.08285	0.01146	7.08286
5 C Waste incineration	5 C Termička obrada otpada	PCDD/PCDF	1.41316754	0.0770205	5.0	100.0	100.12	0.30839	-0.00412	0.00092	-0.41161	0.00650	0.41166
5 C 1 b v Cremation	5 C 1 b v Kremiranje	PCDD/PCDF	3.9528E-05	0.00019729	5.0	100.0	100.12	0.00079	0.00000	0.00000	0.00022	0.00002	0.00022
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	PCDD/PCDF	2.745048	1.627916	30.0	100.0	104.40	6.79658	0.00965	0.01943	0.96480	0.82451	1.26912
TOTAL			83.77	25.01	% Uncertainty in total inventory			**331.29**			Trend uncertainty:		**51.18**

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			kg	kg	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	PCB	1.083	2.406	2.0	100.0	100.02	74.35391	0.34078	0.48260	34.07811	1.36499	34.10543
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	PCB	2.11	0.39117023	2.0	100.0	100.02	12.09092	-0.19496	0.07848	-19.49648	0.22197	19.49774
1 A 3 b Road Transport	1 A 3 b Cestovni promet	PCB	0.0001059	0.00017233	2.0	400.0	400.00	0.02130	0.00002	0.00003	0.00831	0.00010	0.00831
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	PCB	3.6E-02	0	2.0	400.0	400.00	0.00000	-0.00474	0.00000	-1.89749	0.00000	1.89749
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	PCB	2.7E-03	1.8E-03	2.0	400.0	400.00	0.22695	0.00002	0.00037	0.00835	0.00104	0.00842
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	PCB	0.15	3.5E-05	5.0	400.0	400.03	0.00427	-0.01980	0.00001	-7.91834	0.00005	7.91834
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	PCB	0.75	0.01	2.0	400.0	400.00	1.39837	-0.09583	0.00227	-38.33178	0.00642	38.33178
2 C Metal production	2 C Industrija metala	PCB	0.85	0.42	7.5	400	400.07	52.27779	-0.02537	0.08483	-10.14781	0.89976	10.18762
5 C Waste incineration	5 C Termička obrada otpada	PCB	0.0028	0	5.0	100	100.12	0.00000	-0.00036	0.00000	-0.03647	0.00000	0.03647
5 C 1 b v Cremation	5 C 1 b v Kremiranje	PCB	6.0E-04	3.0E-03	5.0	100	100.12	0.09270	0.00052	0.00060	0.05229	0.00425	0.05246
TOTAL			4.98	3.24	% Uncertainty in total inventory			91.70			Trend uncertainty:		56.42

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Pb	0.62418557	0.43035572	2.0	100.0	100.02	5.14898	0.00080	0.00081	0.07953	0.00230	0.07956
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Pb	5.17573191	0.34595747	2.0	100.0	100.02	4.13920	0.00050	0.00065	0.04995	0.00185	0.04998
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Pb	440.772652	3.4414664	2.0	200.0	200.01	82.33833	-0.00662	0.00651	-1.32334	0.01841	1.32347
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Pb	0.35758188	0.10967505	2.0	400.0	400.00	5.24783	0.00020	0.00021	0.07869	0.00059	0.07870
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Pb	0.00540638	0.00627132	2.0	400.0	400.00	0.30008	0.00001	0.00001	0.00468	0.00003	0.00468
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Pb	0.17477713	0.02402517	5.0	400.0	400.03	1.14965	0.00004	0.00005	0.01609	0.00032	0.01609
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Pb	3.51358674	1.17521575	2.0	400.0	400.00	56.23281	0.00212	0.00222	0.84700	0.00629	0.84703
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Pb	0.21397622	0.000494	10.0	400.0	400.12	0.02367	-0.00001	0.00000	-0.00219	0.00001	0.00219
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Pb	0.4100438	0.11224672	2.0	400.0	400.00	5.37089	0.00020	0.00021	0.08001	0.00060	0.08002
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Pb	0.468333	0.53459932	2.0	400.0	400.00	25.58000	0.00100	0.00101	0.39884	0.00286	0.39885
2 C Metal production	2 C Industrija metala	Pb	76.3933844	0.43975162	7.5	400.0	400.07	21.04508	-0.00145	0.00083	-0.58026	0.00882	0.58033
2 G Other product use	2 G Ostala uporaba proizvoda	Pb	0.555856	1.718528	10.0	400.0	400.12	82.25439	0.00323	0.00325	1.29346	0.04597	1.29428
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Pb	0.00879417	2.2984E-06	65.0	100.0	119.27	0.00003	0.00000	0.00000	-0.00003	0.00000	0.00003
5 C Waste incineration	5 C Termička obrada otpada	Pb	0.05318573	0.02047052	5.0	100.0	100.12	0.24518	0.00004	0.00004	0.00371	0.00027	0.00372
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Pb	4.3964E-05	0.00021943	5.0	700.0	700.02	0.01837	0.00000	0.00000	0.00029	0.00000	0.00029
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	Pb	0.00079725	0.00046923	30.0	700.0	700.64	0.03933	0.00000	0.00000	0.00060	0.00004	0.00061
TOTAL			528.73	8.36	% Uncertainty in total inventory			133.81			Trend uncertainty:		2.16

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Cd	0.0398587	0.03284681	2.0	100.0	100.02	4.15283	0.00552	0.02730	0.55174	0.07721	0.55712
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Cd	0.08331757	0.03579979	2.0	100.0	100.02	4.52617	-0.01576	0.02975	-1.57615	0.08415	1.57839
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Cd	0.00735259	0.01499366	2.0	200.0	200.01	3.79073	0.00844	0.01246	1.68856	0.03524	1.68892
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Cd	0.00077392	0.00015651	2.0	400.0	400.00	0.07913	-0.00029	0.00013	-0.11712	0.00037	0.11712
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Cd	0.00043159	0.00048273	2.0	400.0	400.00	0.24408	0.00017	0.00040	0.06614	0.00113	0.06615
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Cd	0.00264174	0.00762418	5.0	400.0	400.03	3.85523	0.00489	0.00634	1.95706	0.04480	1.95757
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Cd	0.55912475	0.54903957	2.0	400.0	400.00	277.60860	0.15009	0.45629	60.03495	1.29058	60.04882
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Cd	0.00777703	0.00073601	10.0	400.0	400.12	0.37226	-0.00364	0.00061	-1.45497	0.00865	1.45500
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Cd	0.08072737	0.02209857	2.0	400.0	400.00	11.17361	-0.02573	0.01837	-10.29059	0.05195	10.29072
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Cd	0.0358137	0.04088112	2.0	400.0	400.00	20.67055	0.01440	0.03397	5.76087	0.09610	5.76167
2 C Metal production	2 C Industrija metala	Cd	0.2367564	0.03382705	7.5	400.0	400.07	17.10662	-0.10105	0.02811	-40.42055	0.29818	40.42165
2 G Other product use	2 G Ostala uporaba proizvoda	Cd	0.06634072	0.04910527	10.0	400.0	400.12	24.83634	0.00456	0.04081	1.82357	0.57714	1.91272
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Cd	0.07035334	1.8387E-05	65.0	100.0	119.27	0.00277	-0.03840	0.00002	-3.84030	0.00140	3.84030
5 C Waste incineration	5 C Termička obrada otpada	Cd	0.0103857	0.00251462	5.0	100.0	100.12	0.31826	-0.00358	0.00209	-0.35846	0.01478	0.35876
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Cd	7.3639E-06	3.6754E-05	5.0	100.0	100.12	0.00465	0.00003	0.00003	0.00265	0.00022	0.00266
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	Cd	0.00161105	0.00094767	30.0	700.0	700.64	0.83930	-0.00009	0.00079	-0.06489	0.03341	0.07298
TOTAL			1.20	0.79	% Uncertainty in total inventory			280.35			Trend uncertainty:		73.55

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Hg	0.06344416	0.12413322	2.0	100.0	100.02	36.86239	0.09657	0.11495	9.65657	0.32511	9.66204
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Hg	0.12	0.12310554	2.0	100.0	100.02	36.55721	0.07960	0.11399	7.96048	0.32242	7.96701
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Hg	0.00862013	0.01399219	2.0	200.0	200.01	8.30895	0.01047	0.01296	2.09324	0.03665	2.09356
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Hg	0.0020208	0.00021897	2.0	400.0	400.00	0.26005	-0.00038	0.00020	-0.15233	0.00057	0.15234
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Hg	0.0011994	0.00144421	2.0	400.0	400.00	1.71517	0.00099	0.00134	0.39637	0.00378	0.39639
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Hg	0.00806037	0.00129743	5.0	400.0	400.03	1.54094	-0.00113	0.00120	-0.45054	0.00850	0.45062
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Hg	0.05066553	0.02653407	2.0	400.0	400.00	31.51215	0.00993	0.02457	3.97330	0.06949	3.97390
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Hg	0.70839317	0.00017221	10.0	400.0	400.12	0.20458	-0.20309	0.00016	-81.23661	0.00226	81.23661
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Hg	0.08969708	0.02455397	2.0	400.0	400.00	29.16055	-0.00317	0.02274	-1.26611	0.06431	1.26774
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Hg	0.00082647	0.00094341	2.0	400.0	400.00	1.12040	0.00063	0.00087	0.25396	0.00247	0.25397
2 C Metal production	2 C Industrija metala	Hg	0.00857783	0.00845676	7.5	400.0	400.07	10.04498	0.00535	0.00783	2.14124	0.08306	2.14285
2 G Other product use	2 G Ostala uporaba proizvoda	Hg	4.0413E-05	0.00012494	10.0	400.0	400.12	0.14843	0.00010	0.00012	0.04161	0.00164	0.04164
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Hg	0.01119258	2.9252E-06	65.0	100.0	119.27	0.00104	-0.00323	0.00000	-0.32294	0.00025	0.32294
5 C Waste incineration	5 C Termička obrada otpada	Hg	0.00	0	5.0	100.0	100.12	0.00000	-0.00134	0.00000	-0.13382	0.00000	0.13382
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Hg	0.00218136	0.01088743	5.0	100.0	100.12	3.23650	0.00945	0.01008	0.94514	0.07129	0.94782
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	Hg	0.00161105	0.00094767	30.0	700.0	700.64	1.97134	0.00041	0.00088	0.28857	0.03723	0.29097
TOTAL			1.08	0.34	% Uncertainty in total inventory			68.75			Trend uncertainty:		82.36

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	As	0.77941468	0.17078961	2.0	100.0	100.02	46.90431	0.01593	0.01974	1.59322	0.05583	1.59419
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	As	0.09915086	0.0651383	2.0	100.0	100.02	17.88907	0.00704	0.00753	0.70448	0.02129	0.70480
1 A 3 b Road Transport	1 A 3 b Cestovni promet	As	0.01952296	0.03954267	2.0	200.0	200.01	21.71612	0.00447	0.00457	0.89495	0.01293	0.89505
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	As	0.00094291	5.4742E-05	2.0	400.0	400.00	0.06012	0.00000	0.00001	0.00070	0.00002	0.00070
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	As	0.00298178	0.00193917	2.0	400.0	400.00	2.12983	0.00021	0.00022	0.08384	0.00063	0.08384
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	As	0.00731397	0.00150714	5.0	400.0	400.03	1.65543	0.00014	0.00017	0.05544	0.00123	0.05545
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	As	0.02316772	0.00923401	2.0	400.0	400.00	10.14192	0.00095	0.00107	0.38177	0.00302	0.38178
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	As	0.00786199	0.00012108	10.0	400.0	400.12	0.13303	-0.00002	0.00001	-0.00970	0.00020	0.00970
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	As	0.01793942	0.00491079	2.0	400.0	400.00	5.39364	0.00048	0.00057	0.19210	0.00161	0.19211
2 A 3 Glass production	2 A 3 Proizvodnja stakla	As	0.0523431	0.05974934	2.0	400.0	400.00	65.62404	0.00665	0.00691	2.66002	0.01953	2.66009
2 C Metal production	2 C Industrija metala	As	7.59739707	0.00253703	7.5	400.0	400.07	2.78693	-0.03634	0.00029	-14.53696	0.00311	14.53696
2 G Other product use	2 G Ostala uporaba proizvoda	As	0.00094297	0.00291536	10.0	400.0	400.12	3.20297	0.00033	0.00034	0.13293	0.00476	0.13302
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	As	0.00051166	1.3372E-07	65.0	100.0	119.27	0.00004	0.00000	0.00000	-0.00025	0.00000	0.00025
5 C Waste incineration	5 C Termička obrada otpada	As	0.040906	0.00415465	5.0	100.0	100.12	1.14220	0.00028	0.00048	0.02812	0.00340	0.02832
5 C 1 b v Cremation	5 C 1 b v Kremiranje	As	1.9925E-05	9.9448E-05	5.0	100.0	100.12	0.02734	0.00001	0.00001	0.00114	0.00008	0.00114
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	As	0.00255698	0.00150284	30.0	700.0	700.64	2.89117	0.00016	0.00017	0.11287	0.00737	0.11311
TOTAL			8.65	0.36	% Uncertainty in total inventory			86.40			Trend uncertainty:		14.92

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Cr	1.91682979	0.1698535	2.0	100.0	100.02	5.92789	-0.13789	0.02971	-13.78884	0.08403	13.78910
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Cr	0.32118938	0.13801801	2.0	100.0	100.02	4.81683	-0.00402	0.02414	-0.40178	0.06828	0.40754
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Cr	0.64278153	1.30430565	2.0	200.0	200.01	91.02697	0.17158	0.22813	34.31680	0.64526	34.32286
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Cr	0.00522056	0.0010276	2.0	400.0	400.00	0.14343	-0.00028	0.00018	-0.11119	0.00051	0.11119
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Cr	0.00346049	0.00241596	2.0	400.0	400.00	0.33721	0.00012	0.00042	0.04767	0.00120	0.04768
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Cr	0.08068901	0.02385766	5.0	400.0	400.03	3.33013	-0.00290	0.00417	-1.16047	0.02951	1.16084
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Cr	1.05364537	0.98340274	2.0	400.0	400.00	137.25742	0.07948	0.17200	31.79169	0.48650	31.79541
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Cr	0.10541263	0.0019641	10.0	400.0	400.12	0.27422	-0.00890	0.00034	-3.55878	0.00486	3.55878
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Cr	0.42285767	0.11575443	2.0	400.0	400.00	16.15630	-0.01682	0.02025	-6.72623	0.05727	6.72647
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Cr	0.0633627	0.07232814	2.0	400.0	400.00	10.09513	0.00709	0.01265	2.83784	0.03578	2.83807
2 C Metal production	2 C Industrija metala	Cr	1.0807925	0.01691352	7.5	400.0	400.07	2.36107	-0.09163	0.00296	-36.65110	0.03138	36.65111
2 G Other product use	2 G Ostala uporaba proizvoda	Cr	0.0110604	0.0341952	10.0	400.0	400.12	4.77419	0.00501	0.00598	2.00447	0.08458	2.00626
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Cr	0.00639576	1.6715E-06	65.0	100.0	119.27	0.00007	-0.00056	0.00000	-0.05605	0.00003	0.05605
5 C Waste incineration	5 C Termička obrada otpada	Cr	0.00113693	0.00032622	5.0	100.0	100.12	0.01140	-0.00004	0.00006	-0.00426	0.00040	0.00428
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Cr	1.9852E-05	9.9083E-05	5.0	100.0	100.12	0.00346	0.00002	0.00002	0.00156	0.00012	0.00156
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	Cr	0.00244325	0.00143639	30.0	700.0	700.64	0.35116	0.00004	0.00025	0.02592	0.01066	0.02802
TOTAL			5.72	2.87	% Uncertainty in total inventory			166.09			Trend uncertainty:		61.60

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Cu	0.874229739	0.365542335	2.0	100.0	100.02	1.18774	-0.07218	0.02158	-7.21780	0.06104	7.21805
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Cu	0.521694242	0.384296469	2.0	100.0	100.02	1.24868	-0.03327	0.02269	-3.32743	0.06417	3.32805
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Cu	13.96499443	28.28882823	2.0	200.0	200.01	183.80737	0.17039	1.67010	34.07868	4.72375	34.40451
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Cu	0.070499171	0.02633129	2.0	400.0	400.00	0.34216	-0.00601	0.00155	-2.40362	0.00440	2.40363
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Cu	0.037125635	0.042504196	2.0	400.0	400.00	0.55232	-0.00147	0.00251	-0.58953	0.00710	0.58957
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Cu	0.036236108	0.006629648	5.0	400.0	400.03	0.08616	-0.00350	0.00039	-1.39852	0.00277	1.39852
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Cu	0.724620628	0.585124861	2.0	400.0	400.00	7.60344	-0.04318	0.03454	-17.27266	0.09771	17.27293
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Cu	0.032060436	0.000970467	10.0	400.0	400.12	0.01261	-0.00338	0.00006	-1.35296	0.00081	1.35296
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Cu	0.179394163	0.04910794	2.0	400.0	400.00	0.63814	-0.01635	0.00290	-6.53849	0.00820	6.53849
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Cu	0.00192843	0.002201291	2.0	400.0	400.00	0.02860	-0.00008	0.00013	-0.03078	0.00037	0.03078
2 C Metal production	2 C Industrija metala	Cu	0.08251068	0.003382705	7.5	400.0	400.07	0.04396	-0.00865	0.00020	-3.46097	0.00212	3.46097
2 G Other product use	2 G Ostala uporaba proizvoda	Cu	0.3800874	1.019109113	10.0	400.0	400.12	13.24685	0.01938	0.06017	7.75269	0.85087	7.79924
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Cu	0.005836129	1.52528E-06	65.0	100.0	119.27	0.00001	-0.00063	0.00000	-0.06261	0.00001	0.06261
5 C Waste incineration	5 C Termička obrada otpada	Cu	0.021505	0.005029	5.0	100.0	100.12	0.01636	-0.00201	0.00030	-0.20103	0.00210	0.20104
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Cu	1.81975E-05	9.0826E-05	5.0	100.0	100.12	0.00030	0.00000	0.00001	0.00034	0.00004	0.00034
5 E Other waste (Building and car fires)	5 E Ostali otpad (Požari na građevinama i vozilima)	Cu	0.00567462	0.00334032	30.0	700.0	700.64	0.07603	-0.00041	0.00020	-0.28814	0.00837	0.28826
TOTAL			16.94	30.78	% Uncertainty in total inventory			184.45			Trend uncertainty:		40.88

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Ni	11.6433713	1.6589303	2.0	100.0	100.02	57.00923	-0.01914	0.09729	-1.91356	0.27518	1.93325
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Ni	0.2536837	0.13402434	2.0	100.0	100.02	4.60575	0.00532	0.00786	0.53198	0.02223	0.53244
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Ni	0.09776538	0.19760181	2.0	200.0	200.01	13.57916	0.01061	0.01159	2.12189	0.03278	2.12214
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Ni	0.00644622	0.00105296	2.0	400.0	400.00	0.14471	0.00000	0.00006	-0.00111	0.00017	0.00112
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Ni	0.10591894	0.04830059	2.0	400.0	400.00	6.63817	0.00177	0.00283	0.70890	0.00801	0.70895
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Ni	0.86880829	0.13312771	5.0	400.0	400.03	18.29754	-0.00089	0.00781	-0.35573	0.05521	0.35999
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Ni	0.36966944	0.15986577	2.0	400.0	400.00	21.97106	0.00567	0.00938	2.26952	0.02652	2.26967
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Ni	0.07931627	0.00233757	10.0	400.0	400.12	0.32136	-0.00066	0.00014	-0.26275	0.00194	0.26276
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Ni	0.78164599	0.21397031	2.0	400.0	400.00	29.40689	0.00472	0.01255	1.88871	0.03549	1.88905
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Ni	0.1349901	0.15409039	2.0	400.0	400.00	21.17733	0.00768	0.00904	3.07400	0.02556	3.07411
2 C Metal production	2 C Industrija metala	Ni	2.6514066	0.11839467	7.5	400.0	400.07	16.27416	-0.01957	0.00694	-7.82734	0.07365	7.82769
2 G Other product use	2 G Ostala uporaba proizvoda	Ni	0.0539157	0.08869056	10.0	400.0	400.12	12.19279	0.00466	0.00520	1.86462	0.07356	1.86607
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Ni	0.00415724	1.0865E-06	65.0	100.0	119.27	0.00004	-0.00004	0.00000	-0.00416	0.00001	0.00416
5 C Waste incineration	5 C Termička obrada otpada	Ni	0.0000406	0	5.0	100.0	100.12	0.00000	0.00000	0.00000	-0.00004	0.00000	0.00004
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Ni	2.5371E-05	0.00012663	5.0	100.0	100.12	0.00436	0.00001	0.00001	0.00072	0.00005	0.00072
TOTAL			17.05	2.91	% Uncertainty in total inventory			77.74			Trend uncertainty:		9.60

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Se	0.07919249	0.02812585	2.0	100.0	100.02	7.04870	0.08676	0.06080	8.67586	0.17198	8.67756
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Se	0.07453101	0.06147056	2.0	100.0	100.02	15.40531	0.00612	0.13289	0.61170	0.37587	0.71795
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Se	0.0102347	0.0216702	2.0	200.0	200.01	10.86003	0.02775	0.04685	5.55026	0.13250	5.55185
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Se	0.00088099	0.00027735	2.0	400.0	400.00	0.27797	0.00104	0.00060	0.41745	0.00170	0.41746
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Se	0.00431358	0.00482941	2.0	400.0	400.00	4.84034	0.00239	0.01044	0.95777	0.02953	0.95823
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Se	0.00247402	0.00089733	5.0	400.0	400.03	0.89942	0.00267	0.00194	1.06982	0.01372	1.06991
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Se	0.03241913	0.02345374	2.0	400.0	400.00	23.50683	0.00976	0.05070	3.90341	0.14341	3.90605
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Se	0.01143806	0.0004586	10.0	400.0	400.12	0.45977	0.02034	0.00099	8.13516	0.01402	8.13518
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Se	0.01793942	0.00491079	2.0	400.0	400.00	4.92191	0.02284	0.01062	9.13423	0.03003	9.13428
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Se	0.220392	0.25157615	2.0	400.0	400.00	252.14557	0.13216	0.54387	52.86348	1.53828	52.88586
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Se	0.00159894	4.1788E-07	65.0	100.0	119.27	0.00012	0.00298	0.00000	0.29813	0.00008	0.29813
5 C Waste incineration	5 C Termička obrada otpada	Se	0.00712745	0.00128675	5.0	100.0	100.12	0.32281	0.01051	0.00278	1.05108	0.01967	1.05127
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Se	2.8958E-05	0.00014453	5.0	100.0	100.12	0.03626	0.00026	0.00031	0.02584	0.00221	0.02594
TOTAL			0.46	0.40	% Uncertainty in total inventory			254.13			Trend uncertainty:		55.42

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR Source		Pollutant	Emissions 1990	Emissions 2022	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total emissions in year 2013	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	NFR Izvor	Onečišćujuća tvar	Emisija 1990	Emisija 2022	Nesigurnost podatka o aktivnosti	Nesigurnost faktora emisije	Ukupna nesigurnost	Ukupna nesigurnost kao % ukupne emisije u promatranoj godini t	Tip A osjetljivost	Tip B osjetljivost	Nesigurnost trenda emisije izražena preko nesigurnosti faktora emisije	Nesigurnost trenda emisije izražena preko nesigurnosti podatka o aktivnosti	Nesigurnost trenda emisije izražena preko ukupne emisije
			t	t	%	%	%	%	%	%	%	%	%
1 A 1 Energy Industries	1 A 1 Termoelektrane, javne toplane i kotlovnice	Zn	2.73092892	2.88957506	2.0	100.0	100.02	7.68494	0.00936	0.07050	0.93555	0.19941	0.95657
1 A 2 Manufacturing Industries and Construction	1 A 2 Izgaranje u industriji	Zn	5.54234863	1.89619339	2.0	100.0	100.02	5.04300	0.07771	0.04626	7.77130	0.13086	7.77240
1 A 3 b Road Transport	1 A 3 b Cestovni promet	Zn	4.10371807	8.68277299	2.0	200.0	200.01	46.17741	0.11985	0.21185	23.97095	0.59920	23.97844
1 A 3 a Aviation (LTO), 1 A 3 c Railways	1 A 3 a Zračni promet (LTO), 1 A 3 c Željeznički promet	Zn	0.11703629	0.05068494	2.0	400.0	400.00	0.53909	0.00138	0.00124	0.55341	0.00350	0.55342
1 A 3 dii National naigation	1 A 3 dii Pomorski promet i unutarnja plovidba	Zn	0.04926633	0.05800493	2.0	400.0	400.00	0.61695	0.00031	0.00142	0.12491	0.00400	0.12497
1 A 4 a Commercial, institutional combustion	1 A 4 a Izgaranje u sektoru opće potrošnje	Zn	0.30460203	0.31907911	5.0	400.0	400.03	3.39400	0.00097	0.00779	0.38624	0.05505	0.39015
1 A 4 b Residential combustion , 1 A 4 c Combustion in Agriculture/Forestry/ Fishing	1 A 4 b Izgaranje u sektoru kućanstva, 1 A 4 c Izgaranje u Poljoprivredi/šumarstvu/ribarstvu	Zn	22.9264414	21.7580818	2.0	400.0	400.00	231.42242	0.01749	0.53087	6.99722	1.50153	7.15652
1 B Extraction and distribution of fossil fuels	1 B Ekstrakcija i distribucija fosilnih goriva	Zn	0.15842718	0.0074472	10.0	400.0	400.12	0.07923	0.00337	0.00018	1.34602	0.00257	1.34603
1 B 2 a iv Refining / storage	1 B 2 a iv Rafiniranje / skladištenje	Zn	0.15376643	0.04209252	2.0	400.0	400.00	0.44770	0.00242	0.00103	0.96618	0.00290	0.96618
2 A 3 Glass production	2 A 3 Proizvodnja stakla	Zn	0.1019313	0.11635397	2.0	400.0	400.00	1.23756	0.00056	0.00284	0.22273	0.00803	0.22288
2 C Metal production	2 C Industrija metala	Zn	2.68198038	0.60888686	7.5	400.0	400.07	6.47727	0.04516	0.01486	18.06356	0.15757	18.06425
2 G Other product use	2 G Ostala uporaba proizvoda	Zn	0.2169857	0.59285056	10.0	400.0	400.12	6.30754	0.00961	0.01446	3.84257	0.20456	3.84802
3 F Field burning of agricultural residues	3 F Spaljivanje žetvenih ostataka na poljoprivrednim površinama	Zn	0.04477031	1.1701E-05	65.0	100.0	119.27	0.00004	0.00100	0.00000	0.10020	0.00003	0.10020
5 C Waste incineration	5 C Termička obrada otpada	Zn	1.853155	0.584826	5.0	100.0	100.12	1.55700	0.02721	0.01427	2.72073	0.10090	2.72260
5 C 1 b v Cremation	5 C 1 b v Kremiranje	Zn	0.00023442	0.00117	5.0	100.0	100.12	0.00311	0.00002	0.00003	0.00233	0.00020	0.00234
TOTAL			40.99	37.61	% Uncertainty in total inventory			**236.37**			Trend uncertainty:		**32.24**

Impact of recalculations 1990-2021 by pollutant and NFR/SNAP97 sector

SO2										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-2.0E-05	0	0	0	0.0719	0	-3.1E-05	0.0718
1991	0	0	-1.7E-05	0	0	0	0.0524	0	-3.1E-05	0.0524
1992	0	0	-4.3E-05	0	0	0	0.0487	0	-3.1E-05	0.0486
1993	0	0	-9.5E-06	0	0	0	0.0583	0	-3.1E-05	0.0583
1994	0	0	-1.1E-05	0	0	0	0.0741	0	-3.1E-05	0.0741
1995	0	0	-5.3E-06	0	0	0	0.0626	0	-3.1E-05	0.0626
1996	0	0	-8.4E-06	0	0	0	0.0503	0	-3.1E-05	0.0503
1997	0	0	-8.0E-06	0	0	0	0.0559	0	-3.1E-05	0.0559
1998	0	0	-5.4E-06	0	0	0	0.0460	0	-3.1E-05	0.0460
1999	0	0	-4.3E-06	0	0	0	0.0569	0	-3.1E-05	0.0569
2000	0	0	-6.0E-06	0	0	0	0.0709	0	-3.1E-05	0.0708
2001	0	0	-1.3E-06	0	0	0	0.0618	0	-3.4E-05	0.0618
2002	0	0	-8.0E-07	0	0	0	0.0626	0	-3.5E-05	0.0626
2003	0	0	-3.0E-07	0	0	0	0.0420	0	-3.6E-05	0.0420
2004	0	0	-6.9E-09	0	0	0	0.0529	0	-3.8E-05	0.0528
2005	0	0	1.2E-07	0	0	0	0.0444	0	-3.9E-05	0.0444
2006	0	0	2.6E-07	0	0	0	0.0507	0	-4.1E-05	0.0506
2007	0	0	2.0E-07	-2E-06	0	0	0.0396	0	-4.5E-05	0.0396
2008	0	0	1.4E-07	0	0	0	0.0417	0	-3.6E-05	0.0417
2009	0	0	1.3E-07	0	0	0	0.0296	0	-4.1E-05	0.0295
2010	0	0	5.2E-08	0	0	0	0.0427	0	-1.2E-05	0.0427
2011	0	0	1.2E-08	0	0	0	0.0490	0	-1.3E-05	0.0489
2012	0	0	1.6E-03	0	0	0	0.0344	0	-2.0E-05	0.0360
2013	0	0	1.5E-03	0	0	0	0.0323	0	-1.1E-05	0.0338
2014	0	0	1.6E-03	0	0	0	0.0261	0	-1.1E-05	0.0277
2015	0	0	1.5E-03	0	0	0	0.0256	0	-1.1E-05	0.0271
2016	0	0	5.4E-09	0	0	0	0.0269	0	-1.2E-05	0.0269
2017	0	0	5.6E-09	0	0	0	0.0311	0	0	0.0311
2018	0	0	1.9E-03	0	0	0	0.0310	0	0	0.0329
2019	0	2.2E-06	1.5E-07	0	0	0	0.0375	0	0	0.0375
2020	0	2.2E-06	9.7E-10	0	0	0	0.0361	0	0	0.0361
2021	0	-0.0139	-4.7E-04	-0.0003	0.0001	0	0.0381	0	-0.0006	0.0229

NOX										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-1.93	0	0	0	0.033	0	4.2E-05	-1.90
1991	0	0	-1.86	0	0	0	0.024	0	4.2E-05	-1.84
1992	0	0	-1.78	0	0	0	0.022	0	4.2E-05	-1.75
1993	0	0	-1.90	0	0	0	0.026	0	4.2E-05	-1.88
1994	0	0	-1.76	0	0	0	0.032	0	4.2E-05	-1.72
1995	0	0	-1.68	0	0	0	0.027	0	4.2E-05	-1.65
1996	0	0	-1.64	0	0	0	0.022	0	4.2E-05	-1.62
1997	0	0	-2.09	0	0	0	0.024	0	4.2E-05	-2.06
1998	0	0	-2.23	0	0	0	0.020	0	4.2E-05	-2.21
1999	0	0	-2.19	0	0	0	0.025	0	4.2E-05	-2.16
2000	0	0	-2.41	0	0	0	0.031	0	4.2E-05	-2.38
2001	0	0	-1.78	0	0	0	0.027	0	4.7E-05	-1.75
2002	0	0	-2.33	0	0	0	0.027	0	4.8E-05	-2.30
2003	0	0	-2.42	0	0	0	0.018	0	4.9E-05	-2.40
2004	0	0	-2.49	0	0	0	0.023	0	5.2E-05	-2.47
2005	0	0	-2.78	0	0	0	0.019	0	5.3E-05	-2.76
2006	0	0	-2.40	0	0	0	0.022	0	5.6E-05	-2.38
2007	0	0	-2.27	-0.0109	0	0	0.017	0	6.1E-05	-2.26
2008	0	0	-2.18	0	0	0	0.018	0	5.0E-05	-2.16
2009	0	0	-1.99	0	0	0	0.013	0	5.6E-05	-1.97
2010	0	0	-1.80	0	0	0	0.019	0	1.6E-05	-1.78
2011	0	0	-1.67	0	0	0	0.021	0	1.7E-05	-1.65
2012	0	0	0.51	0	0	0	0.015	0	2.8E-05	0.52
2013	0	0	0.48	0	0	0	0.014	0	1.4E-05	0.49
2014	0	0	0.57	0	0	0	0.011	0	1.5E-05	0.58
2015	0	0	0.43	0	0	0	0.011	0	1.6E-05	0.44
2016	0	0	-0.95	0	0	0	0.012	0	1.7E-05	-0.94
2017	0	0	-1.26	0	0	0	0.014	0	0	-1.24
2018	0	0	0.28	0	0	0	0.014	0	0	0.29
2019	0	1.8E-05	0.52	0	0	0	0.016	-0.002	0	0.53
2020	0	1.8E-05	-1.25	0	0	0	0.016	0.003	0	-1.23
2021	0	0.007	-0.13	0	0	0	0.017	0.003	-0.02	-0.12

NMVOC										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-0.634	0	0	0	-0.617	2.430	0	1.5627
1991	0	0	-0.517	0	0	0	-0.406	1.812	0	1.2861
1992	0	0	-0.439	0	0	0	-0.354	0.895	0	0.5097
1993	0	0	-0.288	0	0	0	-0.442	0.703	0	0.3862
1994	0	0	-0.403	0	0	0	-0.449	0.821	0	0.3910
1995	0	0	-0.350	0	0	0	-0.480	0.788	0	0.3938
1996	0	0	-0.388	0	0	0	-0.460	0.781	0	0.3826
1997	0	0	-0.411	0	0	0	-0.460	0.761	0	0.3527
1998	0	0	-0.488	0	0	0	-0.451	0.633	0	0.1687
1999	0	0	-0.408	0	0	0	-0.493	0.525	0	0.1152
2000	0	0	-0.529	0	0	0	-0.465	0.524	0	0.0303
2001	0	0	-0.303	0	0	0	-0.435	0.469	0	0.2405
2002	0	0	-0.369	0	0	0	-0.435	0.438	0	0.1552
2003	0	0	-0.409	0	0	0	-0.438	0.440	0	0.1239
2004	0	0	-0.429	0	0	0	-0.457	0.429	0	0.0863
2005	0	0	-0.452	0	0	0	-0.445	0.393	0	0.0533
2006	0	0	-0.436	0	0	0	-0.424	0.363	0	0.0788
2007	0	0	-0.405	-0.0004	0	0	-0.457	0.307	0	0.0540
2008	0	0	-0.371	0	0	0	-0.388	0.216	0	0.1312
2009	0	0	-0.357	0	0	0	-0.434	0.114	0	0.0585
2010	0	0	-0.333	0	0	0	-0.383	0.033	0	0.0955
2011	0	0	-0.274	0	0	0	-0.315	-0.037	0	0.2148
2012	0	0	0.028	0	0	0	-0.263	-0.106	0	0.5519
2013	0	0	0.022	0	0	0	-0.276	-0.204	0	0.4674
2014	0	0	0.089	0	0	0	-0.220	-0.280	0	0.5432
2015	0	0	0.068	0	0	0	-0.270	-0.359	0.0055	0.4165
2016	0	0	-0.121	0	0	0	-0.293	-0.440	0.0016	0.1216
2017	0	0	-0.155	0	0	0	-0.481	-0.521	0.0037	-0.1789
2018	0	0	0.006	0	0	0	-0.489	-0.592	0.0019	-0.1016
2019	0	6E-05	0.007	0	0	0	-0.407	-0.674	0.0012	-0.1913
2020	0	6E-05	-0.875	0	0	0	-0.343	-0.709	0.0011	-1.1294
2021	0	0.022	-0.444	0	0	0	-0.323	-0.849	0.0004	-0.8677

CO										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-7.051	0	0	0	0.062	0	-2.4E-05	-6.990
1991	0	0	-5.967	0	0	0	0.045	0	-2.4E-05	-5.922
1992	0	0	-5.147	0	0	0	0.041	0	-2.4E-05	-5.106
1993	0	0	-3.817	0	0	0	0.048	0	-2.4E-05	-3.769
1994	0	0	-4.756	0	0	0	0.060	0	-2.4E-05	-4.696
1995	0	0	-4.159	0	0	0	0.051	0	-2.4E-05	-4.109
1996	0	0	-4.499	0	0	0	0.041	0	-2.4E-05	-4.458
1997	0	0	-4.861	0	0	0	0.045	0	-2.4E-05	-4.816
1998	0	0	-5.650	0	0	0	0.037	0	-2.4E-05	-5.612
1999	0	0	-4.798	0	0	0	0.046	0	-2.4E-05	-4.752
2000	0	0	-5.908	0	0	0	0.058	0	-2.4E-05	-5.851
2001	0	0	-3.489	0	0	0	0.050	0	-2.6E-05	-3.439
2002	0	0	-3.862	0	0	0	0.051	0	-2.7E-05	-3.811
2003	0	0	-4.449	0	0	0	0.034	0	-2.8E-05	-4.415
2004	0	0	-4.338	0	0	0	0.043	0	-2.9E-05	-4.295
2005	0	0	-4.169	0	0	0	0.036	0	-3.0E-05	-4.133
2006	0	0	-3.542	0	0	0	0.041	0	-3.2E-05	-3.501
2007	0	0	-2.745	-0.0013	0	0	0.032	0	-3.5E-05	-2.714
2008	0	0	-2.055	0	0	0	0.034	0	-2.8E-05	-2.021
2009	0	0	-1.959	0	0	0	0.024	0	-3.1E-05	-1.935
2010	0	0	-1.937	0	0	0	0.035	0	-9.2E-06	-1.903
2011	0	0	-1.508	0	0	0	0.040	0	-9.8E-06	-1.468
2012	0	0	0.523	0	0	0	0.028	0	-1.6E-05	0.551
2013	0	0	0.416	0	0	0	0.026	0	-8.2E-06	0.442
2014	0	0	1.140	0	0	0	0.021	0	-8.7E-06	1.161
2015	0	0	0.941	0	0	0	0.021	0	-8.8E-06	0.962
2016	0	0	-0.123	0	0	0	0.022	0	-9.5E-06	-0.101
2017	0	0	-0.411	0	0	0	0.025	0	0	-0.385
2018	0	0	0.152	0	0	0	0.025	0	0	0.943
2019	0	0.0001	0.510	0	0	0	0.030	0	0	0.540
2020	0	0.0001	-2.837	0	0	0	0.029	0	0	-2.808
2021	0	0.041	-0.390	0	0	0	0.031	0	-0.235	-0.553

NH3										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	0.0002	0	-2.685	0	0	0	0	-2.68
1991	0	0	0.0002	0	-3.185	0	0	0	0	-3.18
1992	0	0	0.0002	0	-2.782	0	0	0	0	-2.78
1993	0	0	0.0001	0	-2.933	0	0	0	0	-2.93
1994	0	0	0.0002	0	-2.654	0	0	0	0	-2.65
1995	0	0	0.0002	0	-2.802	0	0	0	0	-2.80
1996	0	0	0.0002	0	-3.134	0	0	0	0	-3.13
1997	0	0	0.0004	0	-2.877	0	0	0	0	-2.88
1998	0	0	0.0006	0	-2.888	0	0	0	0	-2.89
1999	0	0	0.0006	0	-2.835	0	0	0	0	-2.83
2000	0	0	0.0007	0	-2.518	0	0	0	0	-2.52
2001	0	0	0.0002	0	-2.777	0	0	0	0	-2.78
2002	0	0	0.0002	0	-2.652	0	0	0	0	-2.65
2003	0	0	0.0001	0	-3.054	0	0	0	0	-3.05
2004	0	0	0.0000	0	-2.981	0	0	0	0	-2.98
2005	0	0	-0.0001	0	-3.155	0	0	0	0	-3.15
2006	0	0	-0.0002	0	-2.853	0	0	0	0	-2.85
2007	0	0	-0.0004	0	-2.708	0	0	0	0	-2.71
2008	0	0	-0.0004	0	-2.672	0	0	0	0	-2.67
2009	0	0	-0.0005	0	-2.743	0	0	0	0	-2.74
2010	0	0	-0.0006	0	-2.899	0	0	0	0	-2.90
2011	0	0	-0.0006	0	-2.780	0	0	0	-7.2E-10	-2.78
2012	0	0	0.0122	0	-2.728	0	0	0	6.0E-09	-2.72
2013	0	0	0.0118	0	-2.663	0	0	0	-0.0005	-2.65
2014	0	0	0.0122	0	-2.304	0	0	0	-0.0021	-2.29
2015	0	0	0.0126	0	-2.593	0	0	0	-0.0025	-2.58
2016	0	0	-0.0010	0	-2.472	0	0	0	-0.0154	-2.49
2017	0	0	-0.0012	0	-2.345	0	0	0	-0.0219	-2.37
2018	0	0	0.0134	0	-2.203	0	0	0	-0.0025	-2.19
2019	0	0	0.0110	0	-2.110	0	0	0.006	-0.0026	-2.10
2020	0	0	-0.0440	0	-2.113	0	0	-0.253	-0.0012	-2.41
2021	0	0.003	0.0025	0	-2.268	0	0	-0.234	-0.0153	-2.51

TSP										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-0.106	0	0	0	0.033	0	-0.002	-0.076
1991	0	0	-0.120	0	0	0	0.071	0	-0.002	-0.051
1992	0	0	-0.120	0	0	0	0.068	0	-0.002	-0.055
1993	0	0	-0.148	0	0	0	0.011	0	-0.002	-0.139
1994	0	0	-0.117	0	0	0	18.929	0	-0.002	18.810
1995	0	0	-0.103	0	0	0	10.477	0	-0.002	10.372
1996	0	0	-0.092	0	0	0	8.336	0	-0.002	8.242
1997	0	0	-0.125	0	0	0	6.848	0	-0.002	6.720
1998	0	0	-0.126	0	0	0	8.870	0	-0.002	8.741
1999	0	0	-0.122	0	0	0	-2.865	0	-0.002	-2.990
2000	0	0	-0.220	0	0	0	-5.813	0	-0.002	-6.035
2001	0	0	-0.156	0	0	0	0.128	0	-0.003	-0.031
2002	0	0	-0.226	0	0	0	0.165	0	-0.003	-0.064
2003	0	0	-0.241	0	0	0	0.110	0	-0.003	-0.134
2004	0	0	-0.229	0	0	0	0.231	0	-0.003	-0.001
2005	0	0	-0.244	0	0	0	0.696	0	-0.003	0.449
2006	0	0	-0.180	0	0	0	0.156	0	-0.003	-0.027
2007	0	0	-0.131	-0.0003	0	0	0.143	0	-0.003	0.008
2008	0	0	-0.120	0	0	0	-0.447	0	-0.003	-0.569
2009	0	0	-0.092	0	0	0	0.121	0	-0.003	0.026
2010	0	0	-0.077	0	0	0	3.348	0	-0.001	3.271
2011	0	0	-0.051	0	0	0	-3.781	0	-0.001	-3.833
2012	0	0	0.189	0	0	0	3.324	0	-0.002	3.511
2013	0	0	0.160	0	0	0	5.910	0	-0.001	6.069
2014	0	0	0.206	0	0	0	-9.006	0	-0.001	-8.801
2015	0	0	0.205	0	0	0	8.969	0	-0.001	9.174
2016	0	0	0.075	0	0	0	-1.594	0	-0.001	-1.520
2017	0	0	0.071	0	0	0	2.546	0	0	2.617
2018	0	0	0.202	0	0	0	-4.748	0	0	-4.542
2019	0	3E-05	0.237	0	0	0	5.832	0	0	6.069
2020	0	3E-05	0.033	0	0	0	-6.531	0	0	-6.498
2021	0	0.011	0.189	0	0	0	2.974	0	-0.019	3.155

PM2.5										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-0.110	0	0	0	0.001	0	-2.1E-07	-0.110
1991	0	0	-0.121	0	0	0	0.002	0	-7.1E-07	-0.119
1992	0	0	-0.122	0	0	0	0.002	0	-1.1E-06	-0.120
1993	0	0	-0.149	0	0	0	0.000	0	-1.3E-06	-0.149
1994	0	0	-0.121	0	0	0	0.565	0	-5.2E-07	0.444
1995	0	0	-0.112	0	0	0	0.313	0	-1.3E-06	0.200
1996	0	0	-0.103	0	0	0	0.249	0	-1.2E-06	0.146
1997	0	0	-0.137	0	0	0	0.204	0	-1.8E-06	0.067
1998	0	0	-0.140	0	0	0	0.265	0	-2.4E-06	0.125
1999	0	0	-0.138	0	0	0	-0.086	0	-3.7E-06	-0.224
2000	0	0	-0.236	0	0	0	-0.174	0	-5.2E-07	-0.410
2001	0	0	-0.171	0	0	0	0.003	0	-6.9E-07	-0.168
2002	0	0	-0.238	0	0	0	0.005	0	-2.0E-07	-0.234
2003	0	0	-0.258	0	0	0	0.003	0	-2.7E-07	-0.255
2004	0	0	-0.248	0	0	0	0.007	0	-5.9E-07	-0.241
2005	0	0	-0.262	0	0	0	0.021	0	-9.9E-08	-0.241
2006	0	0	-0.205	0	0	0	0.004	0	3.1E-06	-0.201
2007	0	0	-0.164	-0.00023	0	0	0.004	0	7.6E-06	-0.160
2008	0	0	-0.152	0	0	0	-0.014	0	1.1E-05	-0.165
2009	0	0	-0.126	0	0	0	0.003	0	-9.7E-07	-0.122
2010	0	0	-0.108	0	0	0	0.100	0	2.9E-07	-0.008
2011	0	0	-0.083	0	0	0	-0.113	0	4.0E-07	-0.196
2012	0	0	0.096	0	0	0	0.099	0	7.0E-07	0.195
2013	0	0	0.077	0	0	0	0.176	0	1.9E-07	0.253
2014	0	0	0.117	0	0	0	-0.269	0	2.1E-07	-0.152
2015	0	0	0.114	0	0	0	0.268	0	2.1E-07	0.381
2016	0	0	0.026	0	0	0	-0.048	0	2.3E-07	-0.022
2017	0	0	0.025	0	0	0	0.076	0	0	0.101
2018	0	0	0.105	0	0	0	-0.142	0	0	-0.032
2019	0	2.8E-05	0.125	0	0	0	0.174	0	0	0.299
2020	0	2.8E-05	0.013	0	0	0	-0.195	0	0	-0.182
2021	0	0.010	0.100	0	0	0	0.089	0	-0.0173	0.181

PM10										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-0.086	0	0	0	0.006	0	1.0E-05	-0.081
1991	0	0	-0.103	0	0	0	0.018	0	6.7E-06	-0.085
1992	0	0	-0.105	0	0	0	0.017	0	3.8E-06	-0.088
1993	0	0	-0.132	0	0	0	0.000	0	2.8E-06	-0.132
1994	0	0	-0.101	0	0	0	5.650	0	7.9E-06	5.549
1995	0	0	-0.087	0	0	0	3.126	0	2.5E-06	3.039
1996	0	0	-0.075	0	0	0	2.487	0	3.7E-06	2.412
1997	0	0	-0.107	0	0	0	2.042	0	-2.8E-07	1.935
1998	0	0	-0.107	0	0	0	2.647	0	-4.2E-06	2.540
1999	0	0	-0.102	0	0	0	-0.859	0	-1.3E-05	-0.961
2000	0	0	-0.199	0	0	0	-1.740	0	8.0E-06	-1.939
2001	0	0	-0.137	0	0	0	0.035	0	8.0E-06	-0.103
2002	0	0	-0.205	0	0	0	0.046	0	1.2E-05	-0.159
2003	0	0	-0.220	0	0	0	0.030	0	1.1E-05	-0.190
2004	0	0	-0.208	0	0	0	0.066	0	1.0E-05	-0.142
2005	0	0	-0.220	0	0	0	0.205	0	1.4E-05	-0.015
2006	0	0	-0.158	0	0	0	0.044	0	3.6E-05	-0.114
2007	0	0	-0.109	-0.0003	0	0	0.041	0	6.7E-05	-0.069
2008	0	0	-0.098	0	0	0	-0.136	0	8.8E-05	-0.233
2009	0	0	-0.071	0	0	0	0.034	0	8.6E-06	-0.037
2010	0	0	-0.057	0	0	0	0.998	0	6.3E-06	0.941
2011	0	0	-0.032	0	0	0	-1.132	0	7.3E-06	-1.164
2012	0	0	0.177	0	0	0	0.991	0	1.2E-05	1.168
2013	0	0	0.151	0	0	0	1.763	0	5.2E-06	1.915
2014	0	0	0.195	0	0	0	-2.692	0	5.5E-06	-2.496
2015	0	0	0.195	0	0	0	2.678	0	5.6E-06	2.873
2016	0	0	0.089	0	0	0	-0.478	0	6.0E-06	-0.389
2017	0	0	0.088	0	0	0	0.759	0	0	0.847
2018	0	0	0.191	0	0	0	-1.420	0	0	-1.224
2019	0	2.9E-05	0.219	0	0	0	1.740	0	0	1.959
2020	0	2.9E-05	0.061	0	0	0	-1.953	0	0	-1.892
2021	0	0.010	0.184	0	0	0	0.886	0	-0.0185	1.062

BC										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1990	0	0	-0.050	0	0	0	0	0	-5.4E-05	-0.050
1991	0	0	-0.058	0	0	0	0	0	-5.4E-05	-0.058
1992	0	0	-0.058	0	0	0	0	0	-5.4E-05	-0.058
1993	0	0	-0.071	0	0	0	0	0	-5.4E-05	-0.071
1994	0	0	-0.056	0	0	0	0	0	-5.4E-05	-0.056
1995	0	0	-0.052	0	0	0	0	0	-5.4E-05	-0.052
1996	0	0	-0.046	0	0	0	0	0	-5.4E-05	-0.046
1997	0	0	-0.064	0	0	0	0	0	-5.4E-05	-0.064
1998	0	0	-0.065	0	0	0	0	0	-5.4E-05	-0.065
1999	0	0	-0.064	0	0	0	0	0	-5.4E-05	-0.064
2000	0	0	-0.120	0	0	0	0	0	-5.5E-05	-0.120
2001	0	0	-0.086	0	0	0	0	0	-6.0E-05	-0.086
2002	0	0	-0.122	0	0	0	0	0	-6.1E-05	-0.122
2003	0	0	-0.135	0	0	0	0	0	-6.3E-05	-0.135
2004	0	0	-0.130	0	0	0	0	0	-6.7E-05	-0.130
2005	0	0	-0.139	0	0	0	0	0	-6.8E-05	-0.139
2006	0	0	-0.107	0	0	0	0	0	-7.3E-05	-0.107
2007	0	0	-0.082	-7.1E-07	0	0	0	0	-7.9E-05	-0.082
2008	0	0	-0.076	0	0	0	0	0	-6.4E-05	-0.076
2009	0	0	-0.060	0	0	0	0	0	-7.2E-05	-0.061
2010	0	0	-0.050	0	0	0	0	0	-2.1E-05	-0.050
2011	0	0	-0.035	0	0	0	0	0	-2.2E-05	-0.035
2012	0	0	0.065	0	0	0	0	0	-3.6E-05	0.065
2013	0	0	0.056	0	0	0	0	0	-1.9E-05	0.056
2014	0	0	0.080	0	0	0	0	0	-2.0E-05	0.080
2015	0	0	0.079	0	0	0	0	0	-2.0E-05	0.079
2016	0	0	0.033	0	0	0	0	0	-2.2E-05	0.033
2017	0	0	0.036	0	0	0	0	0	0	0.036
2018	0	0	0.079	0	0	0	0	0	0	0.079
2019	0	7.8E-06	0.092	0	0	0	0	0	0	0.092
2020	0	7.8E-06	0.041	0	0	0	0	0	0	0.041
2021	0	0.003	0.081	0	0	0	0	0	-0.009	0.075

Pb										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	1.153	0	0	0	0	0	-0.009	1.145
1991	0	0	0.869	0	0	0	0	0	-0.009	0.861
1992	0	0	0.842	0	0	0	0	0	-0.009	0.834
1993	0	0	0.903	0	0	0	0	0	-0.009	0.894
1994	0	0	0.978	0	0	0	0	0	-0.009	0.970
1995	0	0	1.049	0	0	0	0	0	-0.009	1.040
1996	0	0	1.142	0	0	0	0	0	-0.009	1.133
1997	0	0	1.286	0	0	0	0	0	-0.009	1.278
1998	0	0	1.352	0	0	0	0	0	-0.009	1.343
1999	0	0	1.453	0	0	0	0	0	-0.009	1.444
2000	0	0	1.480	0	0	0	0	0	-0.009	1.471
2001	0	0	1.323	0	0	0	0	0	-0.010	1.314
2002	0	0	1.428	0	0	0	0	0	-0.010	1.419
2003	0	0	1.573	0	0	0	0	0	-0.010	1.562
2004	0	0	1.628	0	0	0	0	0	-0.011	1.617
2005	0	0	1.702	0	0	0	0	0	-0.011	1.691
2006	0	0	1.843	0	0	0	0	0	-0.012	1.831
2007	0	0	2.006	-2.3E-05	0	0	0	0	-0.013	1.994
2008	0	0	1.950	0	0	0	0	0	-0.010	1.940
2009	0	0	1.969	0	0	0	0	0	-0.011	1.957
2010	0	0	1.879	0	0	0	0	0	-0.003	1.875
2011	0	0	1.844	0	0	0	0	0	-0.004	1.840
2012	0	0	2.006	0	0	0	0	0	-0.006	2.001
2013	0	0	2.026	0	0	0	0	0	-0.003	2.023
2014	0	0	2.015	0	0	0	0	0	-0.003	2.012
2015	0	0	2.125	0	0	0	0	0	-0.003	2.122
2016	0	0	2.029	0	0	0	0	0	-0.003	2.025
2017	0	0	2.193	0	0	0	0	0	0	2.193
2018	0	0	2.309	0	0	0	0	0	0	2.309
2019	0	5.4E-06	2.349	0	0	0	0	0	0	2.349
2020	0	5.4E-06	2.015	0	0	0	0	0	0	2.015
2021	0	0.002	2.223	-4.5E-08	2.0E-08	0	0	0	-0.002	2.223

Cd										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	0.0048	0	-0.0020	0	0	0	-0.0011	0.0016
1991	0	0	0.0036	0	-0.0011	0	0	0	-0.0011	0.0014
1992	0	0	0.0035	0	-0.0003	0	0	0	-0.0011	0.0020
1993	0	0	0.0037	0	-0.0003	0	0	0	-0.0011	0.0023
1994	0	0	0.0040	0	-0.0002	0	0	0	-0.0011	0.0028
1995	0	0	0.0043	0	-0.0002	0	0	0	-0.0011	0.0031
1996	0	0	0.0047	0	-0.0002	0	0	0	-0.0011	0.0034
1997	0	0	0.0053	0	-0.0001	0	0	0	-0.0011	0.0040
1998	0	0	0.0056	0	-0.0002	0	0	0	-0.0011	0.0042
1999	0	0	0.0060	0	-0.0003	0	0	0	-0.0011	0.0046
2000	0	0	0.0061	0	-0.0002	0	0	0	-0.0011	0.0047
2001	0	0	0.0055	0	-0.0001	0	0	0	-0.0012	0.0041
2002	0	0	0.0059	0	-0.0002	0	0	0	-0.0013	0.0045
2003	0	0	0.0065	0	-0.0002	0	0	0	-0.0013	0.0050
2004	0	0	0.0067	0	-0.0001	0	0	0	-0.0014	0.0052
2005	0	0	0.0070	0	-0.0002	0	0	0	-0.0014	0.0054
2006	0	0	0.0076	0	-0.0002	0	0	0	-0.0015	0.0060
2007	0	0	0.0083	-1.8E-06	-0.0001	0	0	0	-0.0016	0.0066
2008	0	0	0.0081	0	-0.0001	0	0	0	-0.0013	0.0067
2009	0	0	0.0081	0	-0.0001	0	0	0	-0.0015	0.0066
2010	0	0	0.0078	0	-0.0001	0	0	0	-0.0004	0.0072
2011	0	0	0.0076	0	-0.0001	0	0	0	-0.0005	0.0071
2012	0	0	0.0079	0	-0.0001	0	0	0	-0.0007	0.0070
2013	0	0	0.0080	0	-0.0001	0	0	0	-0.0004	0.0075
2014	0	0	0.0079	0	-0.0001	0	0	0	-0.0004	0.0075
2015	0	0	0.0084	0	0.0000	0	0	0	-0.0004	0.0079
2016	0	0	0.0084	0	0.0000	0	0	0	-0.0004	0.0079
2017	0	0	0.0091	0	-0.0001	0	0	0	0	0.0090
2018	0	0	0.0091	0	0.0000	0	0	0	0	0.0091
2019	0	2.6E-06	0.0098	0	0.0000	0	0	0	0	0.0097
2020	0	2.6E-06	0.0083	0	0.0000	0	0	0	0	0.0083
2021	0	0.0009	0.0092	-3.4E-09	0.0000	0	0	0	-0.0003	0.0098

Hg										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	-1.7E-07	0	-0.007	0	0	0	-0.001	-0.009
1991	0	0	-1.4E-07	0	-0.008	0	0	0	-0.001	-0.009
1992	0	0	-1.1E-07	0	-0.007	0	0	0	-0.001	-0.009
1993	0	0	-7.8E-08	0	-0.008	0	0	0	-0.001	-0.009
1994	0	0	-1.1E-07	0	-0.008	0	0	0	-0.001	-0.009
1995	0	0	-7.6E-08	0	-0.009	0	0	0	-0.001	-0.011
1996	0	0	-7.3E-08	0	-0.011	0	0	0	-0.001	-0.012
1997	0	0	-7.0E-08	0	-0.011	0	0	0	-0.001	-0.013
1998	0	0	-7.3E-08	0	-0.011	0	0	0	-0.001	-0.013
1999	0	0	-5.2E-08	0	-0.013	0	0	0	-0.001	-0.014
2000	0	0	-5.2E-08	0	-0.011	0	0	0	-0.001	-0.013
2001	0	0	-1.4E-08	0	-0.013	0	0	0	-0.002	-0.014
2002	0	0	-1.1E-08	0	-0.012	0	0	0	-0.002	-0.014
2003	0	0	-4.6E-09	0	-0.014	0	0	0	-0.002	-0.016
2004	0	0	-8.0E-11	0	-0.014	0	0	0	-0.002	-0.016
2005	0	0	2.9E-09	0	-0.015	0	0	0	-0.002	-0.017
2006	0	0	5.8E-09	0	-0.015	0	0	0	-0.002	-0.017
2007	0	0	7.6E-09	-5.3E-06	-0.014	0	0	0	-0.002	-0.016
2008	0	0	7.5E-09	0	-0.016	0	0	0	-0.002	-0.017
2009	0	0	7.9E-09	0	-0.016	0	0	0	-0.002	-0.018
2010	0	0	7.3E-09	0	-0.016	0	0	0	-0.001	-0.017
2011	0	0	7.3E-09	0	-0.015	0	0	0	-0.001	-0.016
2012	0	0	0.001	0	-0.014	0	0	0	-0.001	-0.014
2013	0	0	0.001	0	-0.013	0	0	0	0.000	-0.013
2014	0	0	0.001	0	-0.012	0	0	0	-0.001	-0.012
2015	0	0	0.001	0	-0.012	0	0	0	-0.001	-0.012
2016	0	0	3.6E-09	0	-0.013	0	0	0	-0.001	-0.013
2017	0	0	3.4E-09	0	-0.013	0	0	0	0	-0.013
2018	0	0	0.0006	0	-0.012	0	0	0	0	-0.012
2019	0	1.1E-07	0.0007	0	-0.012	0	0	0	0	-0.012
2020	0	1.1E-07	-0.0006	0	-0.013	0	0	0	0	-0.013
2021	0	4.1E-05	0.0004	-6.7E-08	-0.014	0	0	0	0	-0.013

DIOX										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ	g I-TEQ
1990	0	0	0.002	0	-0.019	0	0	0	-5.265	-5.28
1991	0	0	0.002	0	-0.020	0	0	0	-5.265	-5.28
1992	0	0	0.001	0	-0.019	0	0	0	-5.265	-5.28
1993	0	0	0.001	0	-0.020	0	0	0	-5.265	-5.28
1994	0	0	0.001	0	-0.020	0	0	0	-5.265	-5.28
1995	0	0	0.001	0	-0.024	0	0	0	-5.265	-5.29
1996	0	0	0.001	0	-0.028	0	0	0	-5.265	-5.29
1997	0	0	0.001	0	-0.029	0	0	0	-5.531	-5.56
1998	0	0	0.001	0	-0.030	0	0	0	-5.917	-5.95
1999	0	0	0.001	0	-0.033	0	0	0	-6.057	-6.09
2000	0	0	0.001	0	-0.029	0	0	0	-6.477	-6.51
2001	0	0	2.3E-04	0	-0.033	0	0	0	-7.105	-7.14
2002	0	0	1.9E-04	0	-0.032	0	0	0	-6.613	-6.64
2003	0	0	7.8E-05	0	-0.037	0	0	0	-6.154	-6.19
2004	0	0	1.8E-06	0	-0.037	0	0	0	-6.449	-6.49
2005	0	0	-6.8E-05	0	-0.040	0	0	0	-6.501	-6.54
2006	0	0	-1.4E-04	0	-0.038	0	0	0	-6.940	-6.98
2007	0	0	-1.9E-04	-2.3E-05	-0.036	0	0	0	-7.581	-7.62
2008	0	0	-2.0E-04	0	-0.040	0	0	0	-6.105	-6.15
2009	0	0	-2.4E-04	0	-0.041	0	0	0	-6.851	-6.89
2010	0	0	-2.5E-04	0	-0.043	0	0	0	-2.013	-2.06
2011	0	0	-2.5E-04	0	-0.040	0	0	0	-2.126	-2.17
2012	0	0	0.085	0	-0.036	0	0	0	-3.445	-3.40
2013	0	0	0.065	0	-0.035	0	0	0	-1.776	-1.75
2014	0	0	0.060	0	-0.031	0	0	0	-1.890	-1.86
2015	0	0	0.056	0	-0.031	0	0	0	-1.916	-1.89
2016	0	0	-0.003	0	-0.033	0	0	0	-2.060	-2.10
2017	0	0	-0.002	0	-0.033	0	0	0	0	-0.035
2018	0	0	0.055	0	-0.032	0	0	0	0	0.023
2019	0	2E-05	0.067	0	-0.032	0	0	0	0	0.035
2020	0	2E-05	-0.008	0	-0.033	0	0	0	0	-0.042
2021	0	0.007	0.047	0	-0.036	0	0	0	-0.013	0.006

PCBs										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg
1990	0	0	3.9E-07	0	0	0	0	0	0	3.9E-07
1991	0	0	3.3E-07	0	0	0	0	0	0	3.3E-07
1992	0	0	2.6E-07	0	0	0	0	0	0	2.6E-07
1993	0	0	1.8E-07	0	0	0	0	0	0	1.8E-07
1994	0	0	2.5E-07	0	0	0	0	0	0	2.5E-07
1995	0	0	1.9E-07	0	0	0	0	0	0	1.9E-07
1996	0	0	2.0E-07	0	0	0	0	0	0	2.0E-07
1997	0	0	2.0E-07	0	0	0	0	0	0	2.0E-07
1998	0	0	2.1E-07	0	0	0	0	0	0	2.1E-07
1999	0	0	1.6E-07	0	0	0	0	0	0	1.6E-07
2000	0	0	1.6E-07	0	0	0	0	0	0	1.6E-07
2001	0	0	5.0E-08	0	0	0	0	0	0	5.0E-08
2002	0	0	4.0E-08	0	0	0	0	0	0	4.0E-08
2003	0	0	1.6E-08	0	0	0	0	0	0	1.6E-08
2004	0	0	6.0E-10	0	0	0	0	0	0	6.0E-10
2005	0	0	-1.5E-08	0	0	0	0	0	0	-1.4E-08
2006	0	0	-3.0E-08	0	0	0	0	0	0	-3.0E-08
2007	0	0	-4.0E-08	-6.7E-06	0	0	0	0	0	-6.7E-06
2008	0	0	-4.3E-08	0	0	0	0	0	0	-4.4E-08
2009	0	0	-5.1E-08	0	0	0	0	0	0	-5.1E-08
2010	0	0	-5.3E-08	0	0	0	0	0	0	-5.2E-08
2011	0	0	-5.2E-08	0	0	0	0	0	0	-5.2E-08
2012	0	0	1.7E-05	0	0	0	0	0	0	1.7E-05
2013	0	0	1.3E-05	0	0	0	0	0	0	1.3E-05
2014	0	0	1.2E-05	0	0	0	0	0	0	1.2E-05
2015	0	0	1.1E-05	0	0	0	0	0	0	1.1E-05
2016	0	0	-4.7E-07	0	0	0	0	0	0	-4.7E-07
2017	0	0	-2.5E-07	0	0	0	0	0	0	-2.5E-07
2018	0	0	1.1E-05	0	0	0	0	0	0	1.1E-05
2019	0	0	1.3E-05	0	0	0	0	0	0	1.3E-05
2020	0	0	-1.8E-06	0	0	0	0	0	0	-1.8E-06
2021	0	4.3E-06	9.3E-06	0	0	0	0	0	0	1.4E-05

HCB										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg
1990	0	0	1.8E-06	0	0	0	0	0	0	1.8E-06
1991	0	0	1.5E-06	0	0	0	0	0	0	1.5E-06
1992	0	0	1.2E-06	0	0	0	0	0	0	1.2E-06
1993	0	0	8.6E-07	0	0	0	0	0	0	8.6E-07
1994	0	0	1.2E-06	0	0	0	0	0	0	1.2E-06
1995	0	0	9.0E-07	0	0	0	0	0	0	9.0E-07
1996	0	0	9.1E-07	0	0	0	0	0	0	9.1E-07
1997	0	0	9.0E-07	0	0	0	0	0	0	9.0E-07
1998	0	0	9.9E-07	0	0	0	0	0	0	9.9E-07
1999	0	0	7.7E-07	0	0	0	0	0	0	7.7E-07
2000	0	0	7.6E-07	0	0	0	0	0	0	7.6E-07
2001	0	0	2.3E-07	0	0	0	0	0	0	2.3E-07
2002	0	0	1.9E-07	0	0	0	0	0	0	1.9E-07
2003	0	0	7.8E-08	0	0	0	0	0	0	7.8E-08
2004	0	0	2.0E-09	0	0	0	0	0	0	2.0E-09
2005	0	0	-6.8E-08	0	0	0	0	0	0	-6.8E-08
2006	0	0	-1.4E-07	0	0	0	0	0	0	-1.4E-07
2007	0	0	-1.9E-07	-1.4E-05	0	0	0	0	0	-1.4E-05
2008	0	0	-2.0E-07	0	0	0	0	0	0	-2.0E-07
2009	0	0	-2.4E-07	0	0	0	0	0	0	-2.4E-07
2010	0	0	-2.5E-07	0	0	0	0	0	0	-2.5E-07
2011	0	0	-2.5E-07	0	0	0	0	0	0	-2.5E-07
2012	0	0	8.4E-05	0	0	0	0	0	0	8.4E-05
2013	0	0	6.3E-05	0	0	0	0	0	0	6.3E-05
2014	0	0	5.9E-05	0	0	0	0	0	0	5.9E-05
2015	0	0	5.5E-05	0	0	0	0	0	0	5.5E-05
2016	0	0	-2.5E-06	0	0	0	0	0	0	-2.5E-06
2017	0	0	-1.5E-06	0	0	0	0	0	0	-1.5E-06
2018	0	0	5.4E-05	0	0	0	0	0	0	5.4E-05
2019	0	0	6.6E-05	0	0	0	0	0	0	6.6E-05
2020	0	0	-8.2E-06	0	0	0	0	0	0	-8.2E-06
2021	0	0.0004	4.6E-05	0	0	0	0	0	0	4.1E-04

PAHs										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	0.006	0	-0.039	0	0	0	1.31	1.28
1991	0	0	0.004	0	-0.040	0	0	0	1.24	1.20
1992	0	0	0.004	0	-0.040	0	0	0	0.95	0.91
1993	0	0	0.004	0	-0.042	0	0	0	0.91	0.87
1994	0	0	0.005	0	-0.041	0	0	0	0.85	0.82
1995	0	0	0.007	0	-0.049	0	0	0	0.81	0.77
1996	0	0	0.008	0	-0.058	0	0	0	0.81	0.76
1997	0	0	0.008	0	-0.060	0	0	0	0.78	0.73
1998	0	0	0.009	0	-0.061	0	0	0	0.77	0.72
1999	0	0	0.010	0	-0.068	0	0	0	0.71	0.65
2000	0	0	0.010	0	-0.060	0	0	0	0.59	0.54
2001	0	0	0.010	0	-0.067	0	0	0	0.58	0.52
2002	0	0	0.008	0	-0.066	0	0	0	0.56	0.51
2003	0	0	0.010	0	-0.075	0	0	0	0.55	0.48
2004	0	0	0.010	0	-0.075	0	0	0	0.55	0.48
2005	0	0	0.010	0	-0.081	0	0	0	0.54	0.47
2006	0	0	0.012	0	-0.078	0	0	0	0.56	0.49
2007	0	0	0.015	0	-0.075	0	0	0	0.58	0.52
2008	0	0	0.015	0	-0.083	0	0	0	0.59	0.52
2009	0	0	0.015	0	-0.085	0	0	0	0.59	0.52
2010	0	0	0.014	0	-0.088	0	0	0	0.59	0.52
2011	0	0	0.014	0	-0.081	0	0	0	0.57	0.50
2012	0	0	0.040	0	-0.074	0	0	0	0.54	0.51
2013	0	0	0.035	0	-0.071	0	0	0	0.52	0.48
2014	0	0	0.036	0	-0.063	0	0	0	0.52	0.49
2015	0	0	0.037	0	-0.064	0	0	0	0.50	0.47
2016	0	0	0.020	0	-0.067	0	0	0	0.46	0.41
2017	0	0	0.019	0	-0.069	0	0	0	0.42	0.37
2018	0	0	0.039	0	-0.066	0	0	0	0.43	0.40
2019	0	7E-06	0.045	0	-0.065	0	0	0	0.40	0.38
2020	0	7E-06	0.012	0	-0.069	0	0	0	0.40	0.34
2021	0	0.0025	0.037	0	-0.074	0	0	0	0.36	0.33

As										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	0.013	0	-0.001	0	0	0	0	0.012
1991	0	0	0.010	0	-0.001	0	0	0	0	0.009
1992	0	0	0.010	0	-0.001	0	0	0	0	0.008
1993	0	0	0.010	0	-0.001	0	0	0	0	0.009
1994	0	0	0.011	0	-0.001	0	0	0	0	0.010
1995	0	0	0.012	0	-0.001	0	0	0	0	0.011
1996	0	0	0.013	0	-0.002	0	0	0	0	0.011
1997	0	0	0.015	0	-0.002	0	0	0	0	0.013
1998	0	0	0.015	0	-0.002	0	0	0	0	0.014
1999	0	0	0.016	0	-0.002	0	0	0	0	0.015
2000	0	0	0.017	0	-0.002	0	0	0	0	0.015
2001	0	0	0.015	0	-0.002	0	0	0	0	0.013
2002	0	0	0.016	0	-0.002	0	0	0	0	0.014
2003	0	0	0.018	0	-0.002	0	0	0	0	0.016
2004	0	0	0.018	0	-0.002	0	0	0	0	0.016
2005	0	0	0.019	0	-0.002	0	0	0	0	0.017
2006	0	0	0.021	0	-0.002	0	0	0	0	0.019
2007	0	0	0.023	-7.1E-06	-0.002	0	0	0	0	0.021
2008	0	0	0.022	0	-0.002	0	0	0	0	0.020
2009	0	0	0.022	0	-0.002	0	0	0	0	0.020
2010	0	0	0.021	0	-0.002	0	0	0	0	0.019
2011	0	0	0.021	0	-0.002	0	0	0	0	0.019
2012	0	0	0.021	0	-0.002	0	0	0	0	0.019
2013	0	0	0.022	0	-0.002	0	0	0	0	0.020
2014	0	0	0.022	0	-0.002	0	0	0	0	0.020
2015	0	0	0.023	0	-0.002	0	0	0	0	0.021
2016	0	0	0.023	0	-0.002	0	0	0	0	0.021
2017	0	0	0.025	0	-0.002	0	0	0	0	0.023
2018	0	0	0.025	0	-0.002	0	0	0	0	0.023
2019	0	3.8E-08	0.027	0	-0.002	0	0	0	0	0.025
2020	0	3.8E-08	0.023	0	-0.002	0	0	0	0	0.021
2021	0	1.4E-05	0.025	-1.7E-08	-0.002	0	0	0	-0.0006	0.023

Cr										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	0.438	0	0	0	0	0	-0.0003	0.438
1991	0	0	0.330	0	0	0	0	0	-0.0003	0.330
1992	0	0	0.319	0	0	0	0	0	-0.0003	0.319
1993	0	0	0.341	0	0	0	0	0	-0.0003	0.341
1994	0	0	0.370	0	0	0	0	0	-0.0003	0.370
1995	0	0	0.396	0	0	0	0	0	-0.0003	0.396
1996	0	0	0.431	0	0	0	0	0	-0.0003	0.430
1997	0	0	0.485	0	0	0	0	0	-0.0003	0.484
1998	0	0	0.509	0	0	0	0	0	-0.0003	0.509
1999	0	0	0.547	0	0	0	0	0	-0.0003	0.547
2000	0	0	0.557	0	0	0	0	0	-0.0003	0.557
2001	0	0	0.497	0	0	0	0	0	-0.0003	0.497
2002	0	0	0.537	0	0	0	0	0	-0.0003	0.537
2003	0	0	0.591	0	0	0	0	0	-0.0003	0.591
2004	0	0	0.612	0	0	0	0	0	-0.0003	0.611
2005	0	0	0.640	0	0	0	0	0	-0.0003	0.639
2006	0	0	0.693	0	0	0	0	0	-0.0004	0.692
2007	0	0	0.754	-8.8E-06	0	0	0	0	-0.0004	0.754
2008	0	0	0.733	0	0	0	0	0	-0.0003	0.733
2009	0	0	0.740	0	0	0	0	0	-0.0004	0.740
2010	0	0	0.706	0	0	0	0	0	-0.0001	0.706
2011	0	0	0.693	0	0	0	0	0	-0.0001	0.693
2012	0	0	0.712	0	0	0	0	0	-0.0002	0.712
2013	0	0	0.723	0	0	0	0	0	-9.4E-05	0.723
2014	0	0	0.718	0	0	0	0	0	-1.0E-04	0.718
2015	0	0	0.759	0	0	0	0	0	-0.0001	0.759
2016	0	0	0.762	0	0	0	0	0	-0.0001	0.762
2017	0	0	0.824	0	0	0	0	0	0	0.824
2018	0	0	0.825	0	0	0	0	0	0	0.825
2019	0	4.6E-06	0.884	0	0	0	0	0	0	0.884
2020	0	4.6E-06	0.757	0	0	0	0	0	0	0.757
2021	0	0.002	0.836	-1.1E-07	5.0E-08	0	0	0	-3.9E-05	0.838

Cu										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	9.64	0	0	0	0	0	-0.01	9.63
1991	0	0	7.27	0	0	0	0	0	-0.014	7.26
1992	0	0	7.03	0	0	0	0	0	-0.014	7.02
1993	0	0	7.51	0	0	0	0	0	-0.014	7.50
1994	0	0	8.16	0	0	0	0	0	-0.014	8.14
1995	0	0	8.72	0	0	0	0	0	-0.014	8.71
1996	0	0	9.48	0	0	0	0	0	-0.014	9.47
1997	0	0	10.67	0	0	0	0	0	-0.014	10.66
1998	0	0	11.21	0	0	0	0	0	-0.014	11.20
1999	0	0	12.04	0	0	0	0	0	-0.014	12.03
2000	0	0	12.26	0	0	0	0	0	-0.014	12.25
2001	0	0	10.95	0	0	0	0	0	-0.015	10.93
2002	0	0	11.82	0	0	0	0	0	-0.015	11.80
2003	0	0	13.01	0	0	0	0	0	-0.016	12.99
2004	0	0	13.47	0	0	0	0	0	-0.017	13.45
2005	0	0	14.08	0	0	0	0	0	-0.017	14.07
2006	0	0	15.25	0	0	0	0	0	-0.018	15.23
2007	0	0	16.60	-0.0002	0	0	0	0	-0.020	16.58
2008	0	0	16.13	0	0	0	0	0	-0.016	16.12
2009	0	0	16.29	0	0	0	0	0	-0.018	16.27
2010	0	0	15.54	0	0	0	0	0	-0.005	15.54
2011	0	0	15.25	0	0	0	0	0	-0.006	15.25
2012	0	0	15.64	0	0	0	0	0	-0.009	15.64
2013	0	0	15.90	0	0	0	0	0	-0.005	15.90
2014	0	0	15.79	0	0	0	0	0	-0.005	15.78
2015	0	0	16.69	0	0	0	0	0	-0.005	16.69
2016	0	0	16.78	0	0	0	0	0	-0.005	16.77
2017	0	0	18.14	0	0	0	0	0	0	18.14
2018	0	0	18.15	0	0	0	0	0	0	18.15
2019	0	1.2E-06	19.43	0	0	0	0	0	0	19.43
2020	0	1.2E-06	16.68	0	0	0	0	0	0	16.68
2021	0	0.0004	18.39	-1.2E-07	5.5E-08	0	0	0	-0.001	18.39

Ni										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	0.065	0	0	0	0	0	-0.0003	0.065
1991	0	0	0.049	0	0	0	0	0	-0.0003	0.049
1992	0	0	0.048	0	0	0	0	0	-0.0003	0.047
1993	0	0	0.051	0	0	0	0	0	-0.0003	0.050
1994	0	0	0.055	0	0	0	0	0	-0.0003	0.055
1995	0	0	0.059	0	0	0	0	0	-0.0003	0.059
1996	0	0	0.064	0	0	0	0	0	-0.0003	0.064
1997	0	0	0.072	0	0	0	0	0	-0.0003	0.072
1998	0	0	0.076	0	0	0	0	0	-0.0003	0.076
1999	0	0	0.081	0	0	0	0	0	-0.0003	0.081
2000	0	0	0.083	0	0	0	0	0	-0.0003	0.083
2001	0	0	0.074	0	0	0	0	0	-0.0003	0.074
2002	0	0	0.080	0	0	0	0	0	-0.0003	0.080
2003	0	0	0.088	0	0	0	0	0	-0.0003	0.088
2004	0	0	0.091	0	0	0	0	0	-0.0003	0.091
2005	0	0	0.095	0	0	0	0	0	-0.0003	0.095
2006	0	0	0.103	0	0	0	0	0	-0.0004	0.103
2007	0	0	0.113	-0.0002	0	0	0	0	-0.0004	0.112
2008	0	0	0.109	0	0	0	0	0	-0.0003	0.109
2009	0	0	0.110	0	0	0	0	0	-0.0004	0.110
2010	0	0	0.105	0	0	0	0	0	-0.0001	0.105
2011	0	0	0.103	0	0	0	0	0	-0.0001	0.103
2012	0	0	0.106	0	0	0	0	0	-0.0002	0.106
2013	0	0	0.108	0	0	0	0	0	-0.0001	0.108
2014	0	0	0.107	0	0	0	0	0	-0.0001	0.107
2015	0	0	0.114	0	0	0	0	0	-0.0001	0.113
2016	0	0	0.114	0	0	0	0	0	-0.0001	0.114
2017	0	0	0.123	0	0	0	0	0	0	0.123
2018	0	0	0.123	0	0	0	0	0	0	0.123
2019	0	4E-07	0.132	0	0	0	0	0	0	0.132
2020	0	4E-07	0.113	0	0	0	0	0	0	0.113
2021	0	0.0001	0.125	-4.5E-09	2.0E-09	0	0	0	0	0.125

Se										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	0.006	0	0	0	0	0	0	0.006
1991	0	0	0.005	0	0	0	0	0	0	0.005
1992	0	0	0.004	0	0	0	0	0	0	0.004
1993	0	0	0.005	0	0	0	0	0	0	0.005
1994	0	0	0.005	0	0	0	0	0	0	0.005
1995	0	0	0.006	0	0	0	0	0	0	0.006
1996	0	0	0.006	0	0	0	0	0	0	0.006
1997	0	0	0.007	0	0	0	0	0	0	0.007
1998	0	0	0.007	0	0	0	0	0	0	0.007
1999	0	0	0.008	0	0	0	0	0	0	0.008
2000	0	0	0.008	0	0	0	0	0	0	0.008
2001	0	0	0.007	0	0	0	0	0	0	0.007
2002	0	0	0.008	0	0	0	0	0	0	0.008
2003	0	0	0.009	0	0	0	0	0	0	0.009
2004	0	0	0.009	0	0	0	0	0	0	0.009
2005	0	0	0.009	0	0	0	0	0	0	0.009
2006	0	0	0.010	0	0	0	0	0	0	0.010
2007	0	0	0.011	-1.8E-05	0	0	0	0	0	0.011
2008	0	0	0.011	0	0	0	0	0	0	0.011
2009	0	0	0.011	0	0	0	0	0	0	0.011
2010	0	0	0.010	0	0	0	0	0	0	0.010
2011	0	0	0.010	0	0	0	0	0	0	0.010
2012	0	0	0.010	0	0	0	0	0	0	0.010
2013	0	0	0.011	0	0	0	0	0	0	0.011
2014	0	0	0.011	0	0	0	0	0	0	0.011
2015	0	0	0.011	0	0	0	0	0	0	0.011
2016	0	0	0.011	0	0	0	0	0	0	0.011
2017	0	0	0.012	0	0	0	0	0	0	0.012
2018	0	0	0.012	0	0	0	0	0	0	0.012
2019	0	1.0E-07	0.013	0	0	0	0	0	0	0.013
2020	0	1.0E-07	0.011	0	0	0	0	0	0	0.011
2021	0	3.6E-05	0.012	-6.2E-08	2.8E-08	0	0	0	-0.0002	0.012

Zn										
SNAP	01	03	07	08	02, 08	05, 04, 09	04, 06	10	09	Total
NFR	1A1	1A2	1A3b	1A3acd	1A4	1B	2	3	5	
Unit	t	t	t	t	t	t	t	t	t	t
1990	0	0	2.54	0	0	0	0	0	0	2.54
1991	0	0	1.91	0	0	0	0	0	0	1.91
1992	0	0	1.84	0	0	0	0	0	0	1.84
1993	0	0	1.97	0	0	0	0	0	0	1.97
1994	0	0	2.14	0	0	0	0	0	0	2.14
1995	0	0	2.29	0	0	0	0	0	0	2.29
1996	0	0	2.50	0	0	0	0	0	0	2.50
1997	0	0	2.80	0	0	0	0	0	0	2.80
1998	0	0	2.95	0	0	0	0	0	0	2.95
1999	0	0	3.16	0	0	0	0	0	0	3.16
2000	0	0	3.22	0	0	0	0	0	0	3.22
2001	0	0	2.96	0	0	0	0	0	0	2.96
2002	0	0	3.18	0	0	0	0	0	0	3.18
2003	0	0	3.50	0	0	0	0	0	0	3.50
2004	0	0	3.62	0	0	0	0	0	0	3.62
2005	0	0	3.78	0	3.2E-07	0	0	0	0	3.78
2006	0	0	4.10	0	0	0	0	0	0	4.10
2007	0	0	4.47	-0.0002	0	0	0	0	0	4.47
2008	0	0	4.34	0	0	0	0	0	0	4.34
2009	0	0	4.38	0	0	0	0	0	0	4.38
2010	0	0	4.18	0	0	0	0	0	0	4.18
2011	0	0	4.11	0	0	0	0	0	0	4.11
2012	0	0	4.26	0	0	0	0	0	0	4.26
2013	0	0	4.31	0	0	0	0	0	0	4.31
2014	0	0	4.30	0	0	0	0	0	0	4.30
2015	0	0	4.55	0	0	0	0	0	0	4.55
2016	0	0	4.54	0	0	0	0	0	0	4.54
2017	0	0	4.89	0	0	0	0	0	0	4.89
2018	0	0	4.93	0	0	0	0	0	0	4.93
2019	0	0.0001	5.27	0	0	0	0	0	0	5.27
2020	0	0.0001	4.46	0	0	0	0	0	0	4.46
2021	0	0.04	4.98	-1.6E-05	7.3E-06	0	0	0	-0.07	4.95

List of abbreviations

CAEN	- Croatian Agency for Environment and Nature
CLRTAP	- Convention on Long-Range Transboundary Air Pollution
CollectER	- Collect Emission Register
COPERT	- Computer Programme to Calculate Emissions from Road Transport
CORINAIR	- Core Inventory of Air Emissions in Europe
CRF	- Common Reporting Format (UNFCCC)
EEA	- European Environmental Agency
EMEP	- Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
ETC/ACC	- European Topic Centre on Air and Climate Change
GHG	- Greenhouse gas
IPCC	- Intergovernmental Panel on Climate Change
MPMEP	- Multi-Polluant Multi-Effect Protocol
NFR	- Nomenclature for Reporting
OG-IT	- Official Gazette – International Treaties
AE-DEM	- Air Emission – Data Exchange Mode
Report*ER*	- AE-DEM module for reporting
SNAP	- Selected Nomenclature for Air Pollution
UNECE	- United Nations Economic Commission for Europe
UNFCCC	- United Nations Framework Convention on Climate Change
EPR	- Environmental Pollution Register
IIR	- Informative Inventory Report (CLRTAP)
NEC Directive	- National Emission Ceiling Directive
LULUCF	- Land Use, Land-Use Change and Forestry
CBS	- Croatian Bureau of Statistics
St.Y.	- Statistical Yearbook
MI	- Ministry of Interior
MESD	- Ministry of Environment and Energy
MA	- Ministry of Agriculture
EIHP	- Energy Institute Hrvoje Požar
SO_2	- Sulphur oxides reported as SO_2
NOx	- Nitrogen oxides reported as NO_2
NH_3	- Ammonia
NMVOC	- Non-methane volatile organic compounds
VOC	- Volatile organic compounds
CO	- Carbon monoxide

TSP	- Total suspended particulate matter
PM_{10}	- Particulate matter with diameter less than 10 µm
$PM_{2.5}$	- Particulate matter with diameter less than 2.5 µm
As	- Arsenic
Cd	- Cadmium
Cr	- Chromium
Cu	- Copper
Hg	- Mercury
Ni	- Nickel
Pb	- Lead
Se	- Selenium
Zn	- Zinc
HCH	- Hexachlorocyclohexane
PAH	- Polyaromatic hydrocarbons
PCDD/PCDF	- Dioxins and furans
DE	- Direct emission – emission from stationary sources submitted in EPR
GDP	- gross domestic product
I-TEQ	- International Toxic Equivalent; The older International Toxic Equivalent (I-TEQ) scheme by the North Atlantic Treaty Organisation (NATO) initially set up in 1989 and later extended and updated
DIY	- do-it-yourself
GO	- Gas oil
HFO	- Heavy fuel oil
KER	- Kerosene
LPG	- Liquefied petroleum gas
LF	- Liquid fuel
NG	- Natural gas
SHB	- Single house boiler

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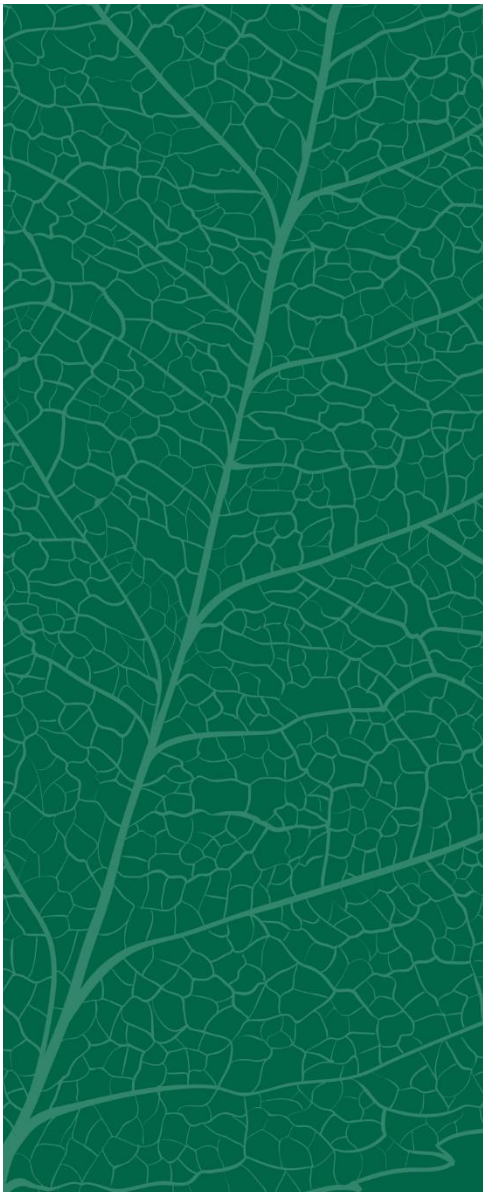

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