Informative Inventory Report for Malta 2019

Table of Contents

Figures

Tables

Equations

Glossary of terms

Term	Definition
WM	With Measures
WaM	With additional Measures
SCR	Selective catalytic reduction
AER	Annual Environment Report
TERT	Technical expert review team
HFO	Heavy Fuel Oil
GDO	Gas Diesel Oil
TSP	Total suspended particulates
EF	Emission factors
Vkm	Vehicle/kilometres (mileage or activity)
EUROSTAT	Statistical office of the European Union
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
NFR-14	Nomenclature for reporting template 2014

Executive Summary

Malta's Informative Inventory Report (IIR) contains information on the emission inventories for air pollutants in the Maltese Islands, covering the years 1990 to 2019, and the projected years 2020 to 2030. It also outlines a description of the methodology applied, data sources used, and the trends in the data during the specified time series.

There have been major changes in some of the sectors making up the NFR-14 template from the previous submission. This was due to both a change in activity data sources, and a change in the methodology used. Most sub-categories making up the energy sector are based on the statistical fuel consumption.

The greatest changes have occurred in the road transport sector. The mean Vkm from 1990-2009 was revised and the energy balance option in COPERT was no longer utilised. The cumulative mileage across the entire time series was also updated together with the projections.

Since the previous submission, some changes have been made to the following sectors. The road paving with asphalt sector was updated as Infrastructure Malta provided activity data for 2018 and 2019. Nitrogen excretion values used in the manure management N-flow tool were updated to reflect the 2019 IPCC refinement. We have also updated the methodology to estimate emissions from the waste to energy facility, which will commence operations in 2024.

The projected emission estimates for 2020 were highly affected by the COVID-19 pandemic. National measures caused a sharp decrease in fuel used in road transport sector, and in the number of the landings and take off cycles for international flights.

As with previous submissions, sectors are calculated from a tier 1 to a tier 3 level depending on the activity data available locally. Consistent efforts are being made to calculate emissions at higher tiers, whenever possible.

1. Introduction

The Environment and Resources Authority (ERA) is entrusted with the role of compiling the national emission inventories and their submission to the European Commission as an obligation under the National Emission Ceilings Directive (NECD) and the Convention on Long-Range Transboundary Air Pollution (CLRTAP). The emission inventory team at ERA is responsible for all the work related to the national emission inventory of air pollutants, including the estimation of emissions and respective drafting of reports.

Specifically, all Member States are required to submit annual national emissions of SO_x, NO_x, nmVOC, CO, NH_3, PM, BC, various heavy metals and POPs using the revised 2019 EMEP/EEA Air Pollutant Emission Inventory Guidebook.

Directive (EU) 2016/2284 of the European Parliament and of the Council of the reduction of national emissions of certain atmospheric pollutants came into force on the 14th of December 2016. This Directive was transposed into national legislation through S.L. 549.124.

In 2020, Malta published the National Air Pollution Control Programme (NAPCP). This programme outlines the plans, policies and measures taking place in Malta, in order to comply with national emission reduction commitments, as laid down in Annex II of the previously mentioned Directive, for years 2020 and 2030. The historical and projected emissions reported within the IIR are utilised within the NAPCP to monitor Malta's progress towards achieving compliance with the relevant emission ceilings.

1.1. National Emission Inventory Background and Institutional Arrangements

The Emission Inventory is compiled on an annual basis, as required by the NECD. The activity data used for the preparation of this inventory was obtained from the National Statistics Office (Malta), the Energy and Water Agency (EWA), the Regulator for Energy and Water Services (REWS), the Environment & Resources Authority (ERA), the Malta Resources Authority (MRA) as well as from other relevant public entities (such as Ministries, Departments, and Regulatory Agencies), private establishments and official published reports. This is shown in the figure below:

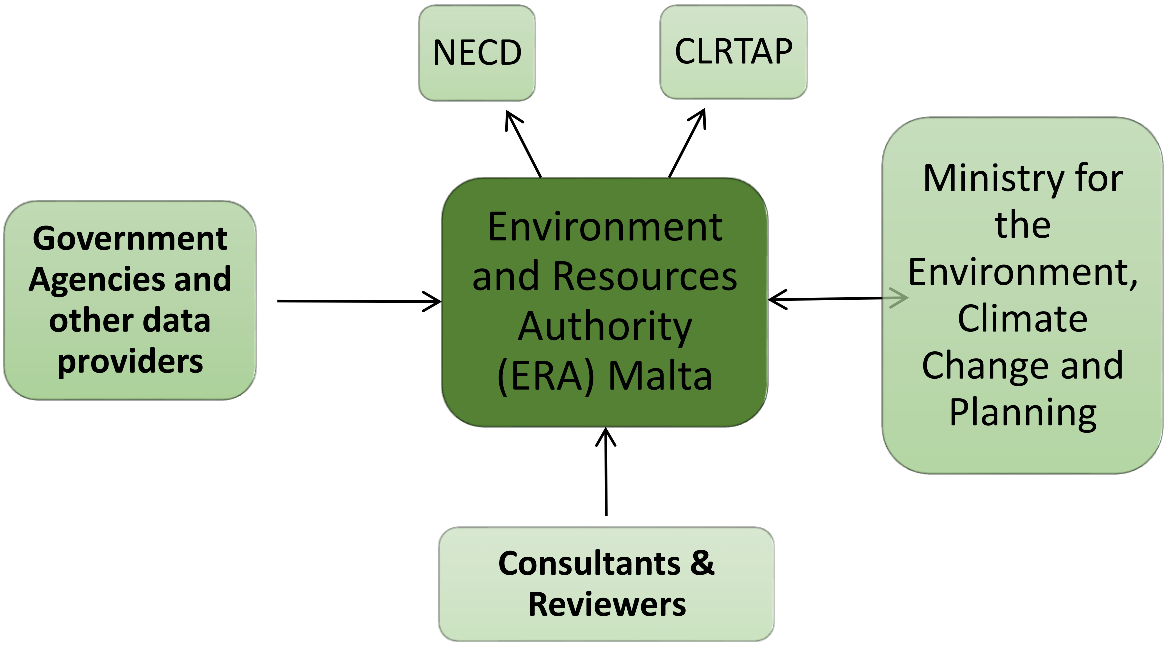

Figure 1: THE MALTESE NATIONAL EMISSION INVENTORY PROCESS

1.2. Inventory Preparation Process

1.2.1. Inventory Preparation and Management

The Inventory Team is responsible for the work on the emissions inventory, which includes data collection through the relevant authorities, calculating emissions and preparing the relevant reports. During this process, meetings with the relevant officers from other public authorities are held.

The inventory team consists of four compilers and a manager who oversees the entire inventory compilation process.

All discussions on inventory planning, preparation, and management are taken through a centralised discussion. Issues related to specific categories are presented by the inventory compiler working on that category, and are discussed as a team, internally. The air emission inventory team is in regular contact with the inventory team at the Malta Resources Authority (MRA) responsible for the compilation of the GHG inventory. The two authorities share data, experiences on methodologies and assumptions and are also working on having a shared dataset.

In cases where further assistance outside of the Authority is necessary, other expert groups and a consultancy firm are involved in the compilation process.

1.2.2. Inventory Planning

Planning of the inventory starts after submission every year. Improvements to the existing data is researched during this time. This first period includes communications with stakeholders and data providers, building relationships with potential contributors and collaborating with national entities for national studies and any new information regarding air pollution emissions. Efficient collection of the necessary activity data relies on a good relationship between the inventory team and the data providers.

1.2.3. Inventory Improvements

Improvements are prioritised according to their significance, which is in turn a result of whether the improvement will affect a key category, and whether that category could influence compliance with an emission ceiling. These areas of improvement are identified by the technical expert review team (TERT), by a consultancy firm, and through internal communications.

The inventory team is working to identify missing data sources and methods of improvements, by reviewing the activity data required for missing sources and Tier 1 estimations. Where possible, Malta strives to move to higher tiers to have more country-specific emission estimates. The latter point is being addressed through the engagement of a consultancy firm which is assisting by providing training and recommendations for improvement in various emission inventory sectors. The inventory team has also availed of a capacity building project organised by the European Commission for the year 2021.

1.3. Methods and Data Sources

The methodology used in compiling the 2019 emission inventory was mainly based on the 2019 EMEP/EEA Air Pollutant Emission Inventory Guidebook.

The basic equation for the compilation of the emission inventory is the following:

$$\textit{Emission load} = \textit{Activity Data} \times \textit{Emission Factor}$$

Equation 1: BASIC EQUATION TO ESTIMATE EMISSION LOADS

Emission projections for the relevant sectors were compiled based on the same methodology used for the historical inventory. All policies implemented prior to 2019 were included in the

WM scenario while all policies planned for implementation as from 2019 onwards were included in the WAM scenario.

1.3.1. Finalization, Publication and Submission of the Inventory

As with all other Member States, Malta submits the inventory to the CLRTAP/UNECE and NEC Directive/European Commission on February 15th. Reported data in the submission of year X relates to emissions year X-2, in other words emissions which took place during 2019 are reported in early 2021.

1.3.2. Data Storage

With regards to file storage, all activity data, compilation files, inventory submissions and IIRs are digitally stored in a server, accessible to members of the inventory team. Data is updated annually by the inventory team.

1.4. Key Category Analysis

A key category is one that is prioritised within the national inventory system, because it is significantly important for one, or a number of air pollutants in a country's national inventory of air pollutants. In this submission, the *level of assessment* of emissions was calculated based on the approach found in the EMEP/EEA Air Pollutants Emission Inventory Guidebook 2019. The key category analysis for this submission can be found in Annex I.

1.5. QA/QC and Verification Methods

The inventory team has identified the need for an ongoing development of a Quality Assurance/Quality Control (QA/QC) system within the national emission inventory. During the compilation of the inventory, efforts were made to ensure as high a level of quality and reliability as possible. Work to develop a QA/QC system has started, in order to ensure that all processes are in line with the principles of transparency, accuracy, consistency, comparability and completeness. In this submission, the best available sources of data have been used, and in specific sectors, such as power generation and cremation, in-situ monitoring data was used.

1.6. General Uncertainty Evaluation

In an inventory process, uncertainty estimates are an essential element. Uncertainties are associated with both the activity data and emission factors, and are therefore reflected in the final result. For this submission, Malta did not perform a quantitative uncertainty assessment for any of the pollutants in the emission inventory, however it is being envisaged to tackle this matter in future submissions.

1.7. General Assessment of Completeness

This submission includes the estimation of emissions from all the relevant sources and emissions listed in the NFR-14 template and explained in the EMEP/EEA air pollutant emission inventory guidebook 2019.

2. Explanation of Key Trends

2.1. Trends for Nitrogen Oxides (NO_x)

The majority of NO_x emissions were generated from the energy sector (NFR Sector 1). The emissions of NO_x, as shown in the figure below, have decreased across the time series. The shift in fuel used, from heavy fuel oil to natural gas, within the public electricity generation sector (1A1a), was the greatest contributor to this decrease.

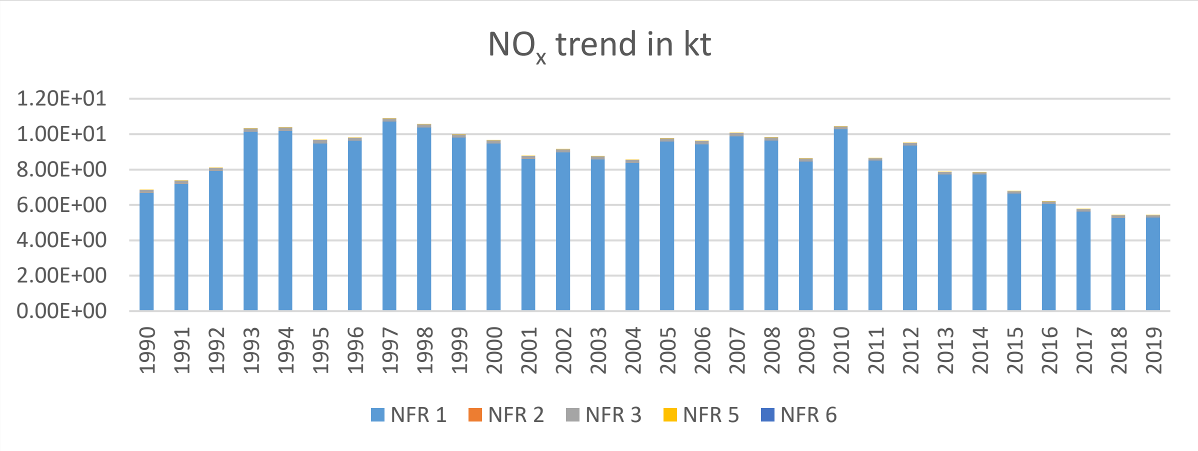

Figure 2: KEY TREND NO_X IN KT

2.2. Trends for Non-Methane Volatile Organic Compounds (nmVOC)

The Energy sector (NFR Sector 1) is the greatest contributor to nmVOC emissions; however, there are significant contributions from Industrial Processes and Product Use (NFR Sector 2), and Agriculture (NFR Sector 3). The figure below shows that nmVOC emissions have remained relatively stable since 2014, as emissions from the greatest contributors, i.e. domestic solvent use (2D3a) and road transport (1A3b), have also remained stable.

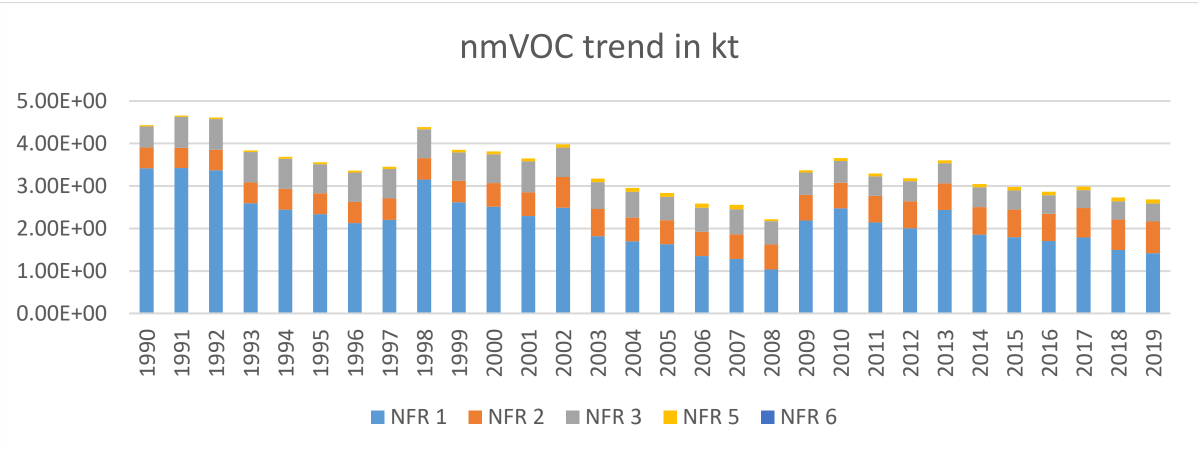

Figure 3: KEY TREND NMVOC IN KT

2.3. Trends for Sulphur Oxides (SO_x)

The figure below shows that SO_x emissions steadily decreased from 1990 to 2019. The Energy sector (NFR sector 1) is the main contributor of SO_x emissions. The decrease in emissions is mostly attributed to the drastic reductions within the public electricity generation (1A1a) and road transport (1A3b) sectors.

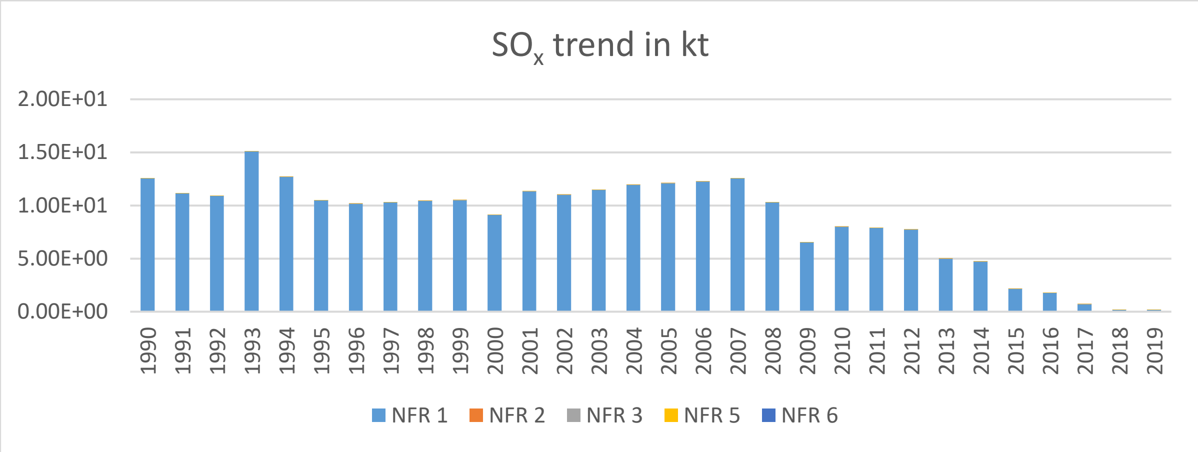

Figure 4: KEY TREND SO_X IN KT

2.4. Trends for Ammonia (NH_3)

The Agricultural sector (NFR sector 3) is the main contributor of NH_3 emissions. The figure below shows that NH_3 emissions decreased from 1990 to 2019, mostly because of a decrease in livestock numbers.

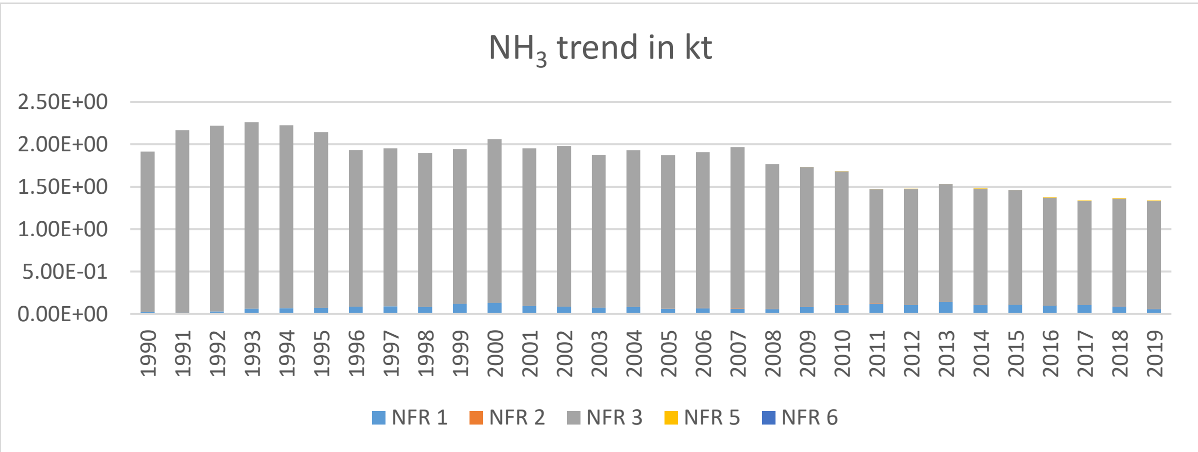

Figure 5: KEY TREND NH_3 IN KT

2.5. Trends for Particulate Matter 2.5 ($PM_{2.5}$)

The figure shows that $PM_{2.5}$ emissions decreased across the time series. The Energy sector (NFR sector 1) is the main contributor of $PM_{2.5}$ emissions. The trend is dependent on many sectors, however, it is worth noting the substantial decrease in emissions under the public electricity generation sector (1A1a).

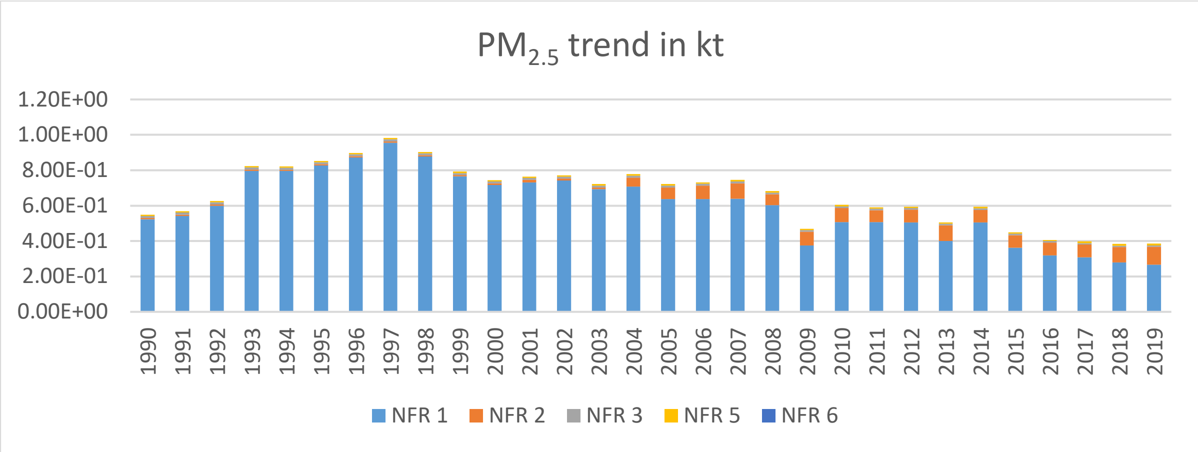

Figure 6: Key trend $PM_{2.5}$ in kt

3. Energy (NFR 1)

This sector consists of categories from which fugitive or combustion emissions arise. The sub-categories estimated in this submission are listed below:

Table 1: NFR 1 ESTIMATED SECTORS

Aggregation	Sector	NFR code
Industry	Stationary Combustion in Manufacturing Industries and Construction; Other	1A2gviii
Aviation	International Aviation LTO (civil)	1A3ai(i)
	Domestic Aviation LTO (civil)	1A3ii(i)
Road transport	Passenger Cars	1A3bi
	Light Duty Vehicles	1A3bii
	Heavy Duty Vehicles and Buses	1A3biii
	Mopeds and Motorcycles	1A3biv
	Gasoline Evaporation	1A3bv
	Automobile Tyre and Brake Wear	1A3bvi
	Automobile Road Abrasion	1A3bvii
Shipping	National Navigation	1A3dii
Other Stationary Combustion	Commercial/Institutional: Stationary	1A4ai
	Residential: Stationary	1A4bi
Off-road	Agriculture/forestry/Fishing: off-road vehicles and other machinery	1A4cii
Off-road	Agriculture/forestry/Fishing: National Fishing	1A4ciii
Fugitive	Distribution of oil products	1B2av

Furthermore, the notation key NO was used for the following sectors, as these sectors do not occur locally:

- 1A1b Petroleum refining
- 1A1c Manufacture of solid fuels and other energy industries
- 1A2a Stationary combustion in manufacturing industries and construction: Iron and steel

- 1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals
- 1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals
- 1A3c Railways
- 1A3di(ii)International inland waterways
- 1A3ei Pipeline transport
- 1A3eii Other (please specify in the IIR)
- 1A5a Other stationary (including military)
- 1A5b Other, Mobile (including military, land based and recreational boats)
- 1B1a Fugitive emission from solid fuels: Coal mining and handling
- 1B1b Fugitive emission from solid fuels: Solid fuel transformation
- 1B1c Other fugitive emissions from solid fuels
- 1B2ai Fugitive emissions oil: Exploration, production, transport
- 1B2aiv Fugitive emissions oil: Refining and storage
- 1B2b Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)
- 1B2c Venting and flaring (oil, gas, combined oil and gas)
- 1B2d Other fugitive emissions from energy production

The pollutants covered in this chapter are NO_x, nmVOCs, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PCBs.

Of these pollutants, the energy sector is a key category for: NO_x, nmVOCs, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene.

The relevant pollutant trends for key categories, as well as the methodologies used, are explained in the sections below:

1A1a: Public Electricity and Heat Production

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1A1a	Power Generation and Electricity Production	2019GB	AER & Eurostat	Tier 1, Tier 2 & Tier 3 (direct measurements)	SO_x, Hg, As	2021 submission

Emissions estimated from this sector originated from the three companies responsible for the generation of electricity from different fossil fuels and were reported under NFR code 1.A.1a. Reported emission estimates were calculated either through the procedure outlined in the 2019 Guidebook (GB) or obtained directly through continuous emission monitoring systems (CEMS) for the year 2019.

The years 1990-2004 were calculated through a Tier 1 methodology, by multiplying the total fuel by type, as found within the Eurostat Energy Balance, with the respective EF found within the 2019GB. Furthermore, emissions were also reported for projected years 2020, 2025 and 2030 for both the WM and WaM scenarios based on the latest fuel projections carried out by EWA.

Malta's electricity production has mostly relied on Heavy Fuel Oil (HFO) and Gasoil, with a small amount of coal utilized until 1995. However, a major change in local electricity production took place in 2017, with the introduction of two privately owned power plants running on natural gas; Electrogas Malta (EGM) and D3 Power Generation Limited (D3PG). Both plants joined Enemalta, i.e. the state owned energy producer, in the local production of electricity. Moreover, Enemalta also operates another power plant in Marsa, which has one operating gas turbine (MPS5). This turbine is on standby and it is only permitted to operate for testing or emergency purposes. As from 2018, HFO was fully phased out.

The table below shows the set-up of the electricity generating plants present locally during 2019:

Table 2: SET-UP OF ELECTRICITY GENERATING PLANTS

Operator	Plant	Technology	Fuel
Electrogas Malta	CCGT 1	Combined Cycle Gas Turbines	Natural Gas
	CCGT 2	Combined Cycle Gas Turbines	
	CCGT 3	Combined Cycle Gas Turbines	
Enemalta	DPS1	Steam Turbine (It was fully decommissioned by 2018)	HFO
	DPS2	Gas Turbine	Gasoil
	DPS3	Gas Turbine	
	DPS4	Gas Turbine	
	DPS5	Gas Turbine	
	DPS6 A	Diesel Engines	HFO/Gasoil
	DPS6 B	Diesel Engines	HFO/Gasoil
	MPS 5	Gas Turbine	Gasoil
D3PG (D3 Power Generation Limited)	DPS6 C	Diesel Engines	Natural Gas/ Gasoil
	DPS6 D	Diesel Engines	
	DPS6 A	Diesel Engines	Natural Gas
	DPS6 B	Diesel Engines	

In addition to gaseous and liquid fuel plants, the interconnector (electricity imported to Malta from mainland Europe) and renewable energy sources such as photovoltaic (PV) cells, supply the remaining electricity entering the grid. The introduction of the interconnector in 2015 naturally decreased the amount of gasoil and HFO used. The share of electricity coming from the interconnector increased in 2016, and then decreased from 2017 onwards.

The historical percentage share of the energy mix from 2013 to 2018 and the projected percentage share i.e. 2020, 2025 and 2030, can be observed below:

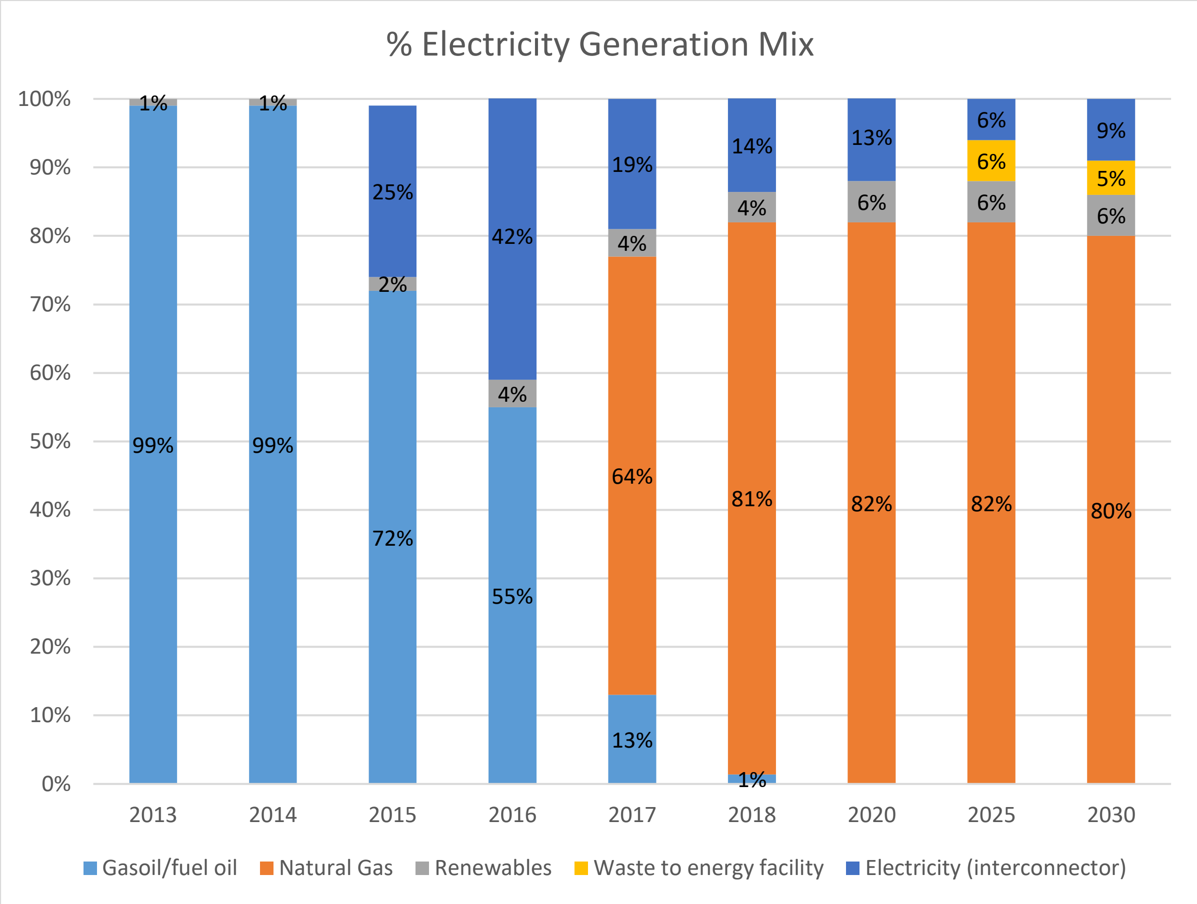

Figure 7: PERCENTAGE CONTRIBUTION OF ELECTRICITY SOURCE UNDER WAM SCENARIO (EWA)

The activity data for the four plants was obtained from the annual environment reports (AERs) submitted by Enemalta, Electrogas and D3 Power Generation Limited, as part of their obligations under the Industrial Emissions Directive.

NO_x, SO_x, and TSP emissions from D3 Power Generation Limited (D3PG), Delimara, and EGM were measured through CEMS and reported in their respective AER. Prior to 2017, the total emissions from As, Cr, Cd, Cu, Mn, Ni, Pb, Sb, and V were placed under Pb. This approach was preferred to the Tier 2 methodology within the 2019GB, as the emission estimates would have been severely overestimated. However, since the fuel used was changed in 2017, a Tier 2 methodology was used. The remaining pollutants were estimated through default factors obtained from the 2019GB.

Regarding projections, projected fuel data was made available from the EWA. These projections were last updated in 2019. The only fuel type projected for future years was natural gas, as it was assumed that the Enemalta power station (running on GDO) will only be used in case of emergency. The main plants for producing electricity, namely EGM and D3PG, use natural gas. The emissions for NO_x, TSP, SO_x, CO and heavy metals were projected by multiplying the projected fuel used by the country-specific EF for each plant. The remaining pollutants are calculated through a tier 2 methodology.

The graph below shows the trend of historical and projected fuel consumption in TJ. It is worth noting that source of fuel consumption differs as follows:

- fuel consumption from 1990-2004 is provided from Eurostat
- fuel consumption from 2005-2019 is provided by summing up data from each facility
- projected fuel consumption is provided by EWA

The difference in projected fuel consumption between the WM and WaM scenarios is attributed to the use of renewable energy sources. The graph below clearly shows very little difference between both scenarios.

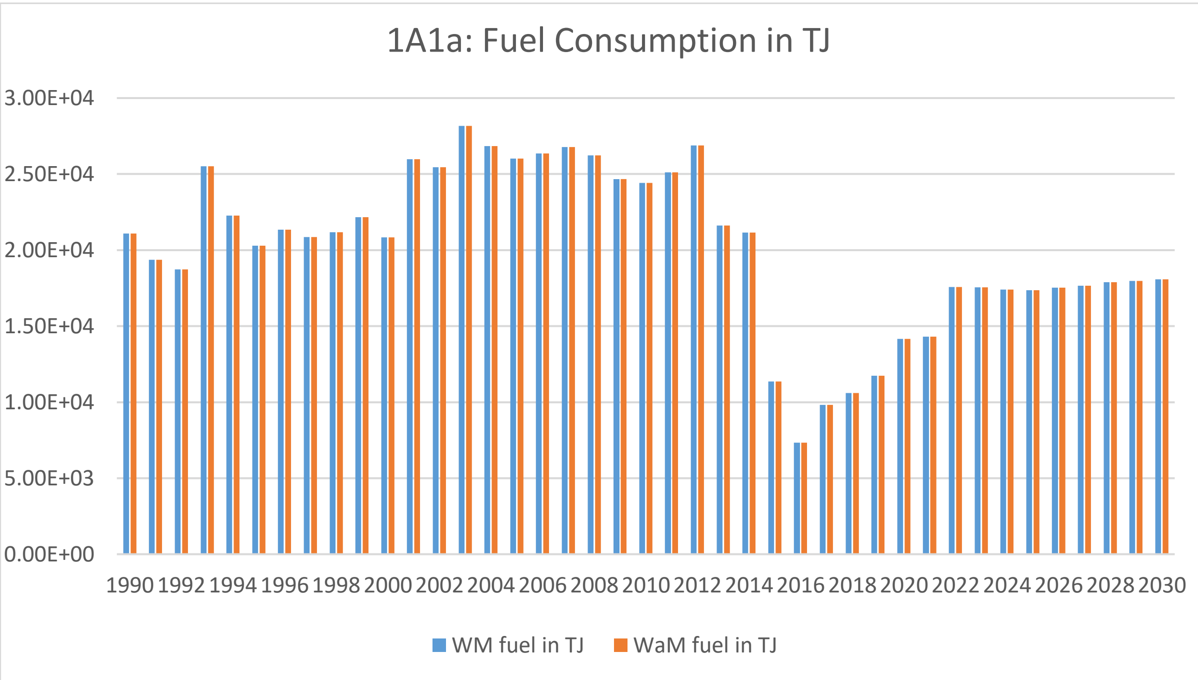

Figure 8: 1A1A HISTORICAL AND PROJECTED FUEL CONSUMPTION IN TJ (WM AND WAM SCENARIOS)

In the WaM scenario, a Waste-to-Energy (WtE) Facility will commence its operations in 2024. The emissions from this facility are included in category 1a1a. The activity data consists of the annual projected waste in tonnes entering the facility, which was provided by the Ministry for the Environment, Climate Change and Planning (MECP).

The highest daily limit values in mg/Nm^3, as listed in the Industrial Emissions (Waste Incineration) Regulations S.L. 549.81, were used to calculate emissions from the WtE facility.

There were no limit values for $PM_{2.5}$, therefore the limit value for dust was applied, as the emission factor for both of these pollutants in the 2019GB is the same.

The graph below shows the annual volume of waste entering the facility:

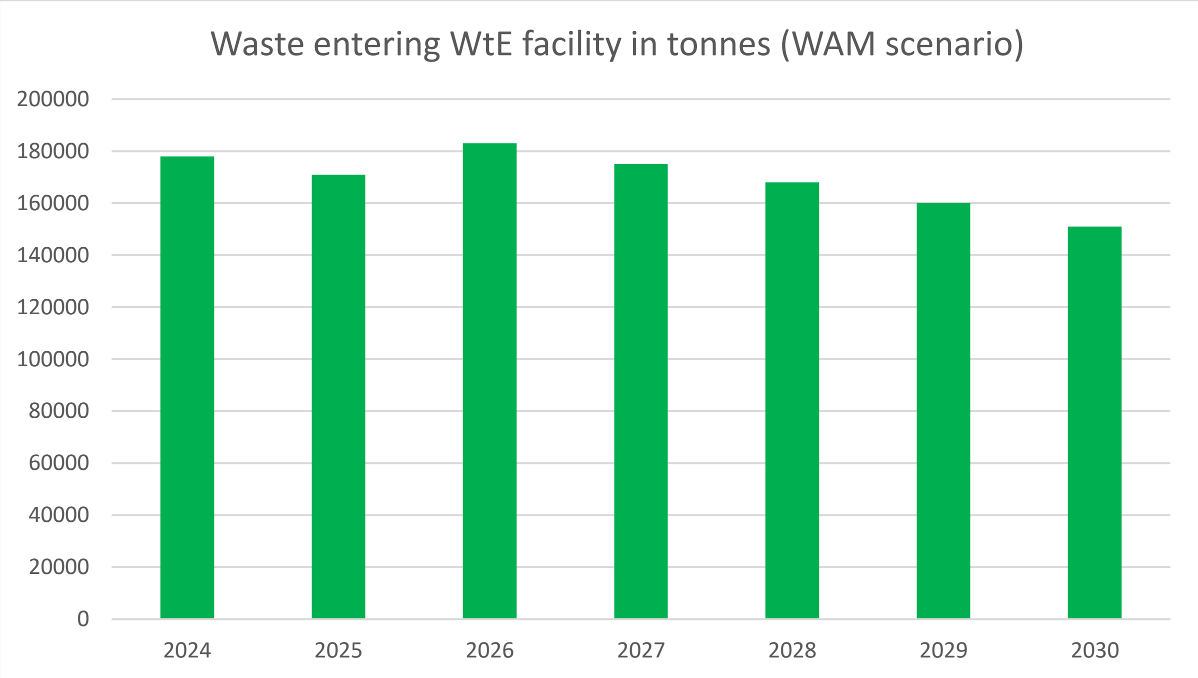

Figure 9: WASTE ENTERING WTE FACILITY IN TONNES (WAM SCENARIO)

The graphs below show the trend of emissions across the time series, 1990 to 2030:

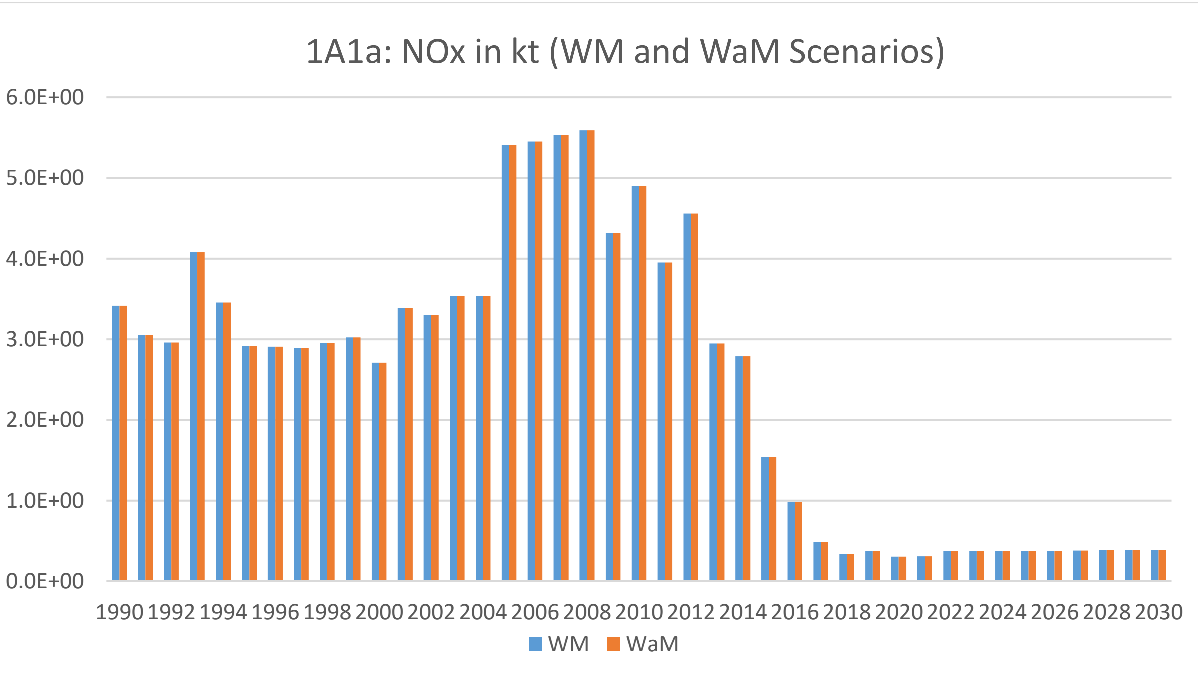

Figure 10: 1A1A NO_X IN KT TIME SERIES (WM AND WAM SCENARIOS)

There has been an overall decrease in emissions of NO_x, and this is most likely due to more efficient technologies, the use of the interconnector, and the use of Selective Catalytic Reduction (SCR) at the Delimara power station (DPS6) and D3PG.

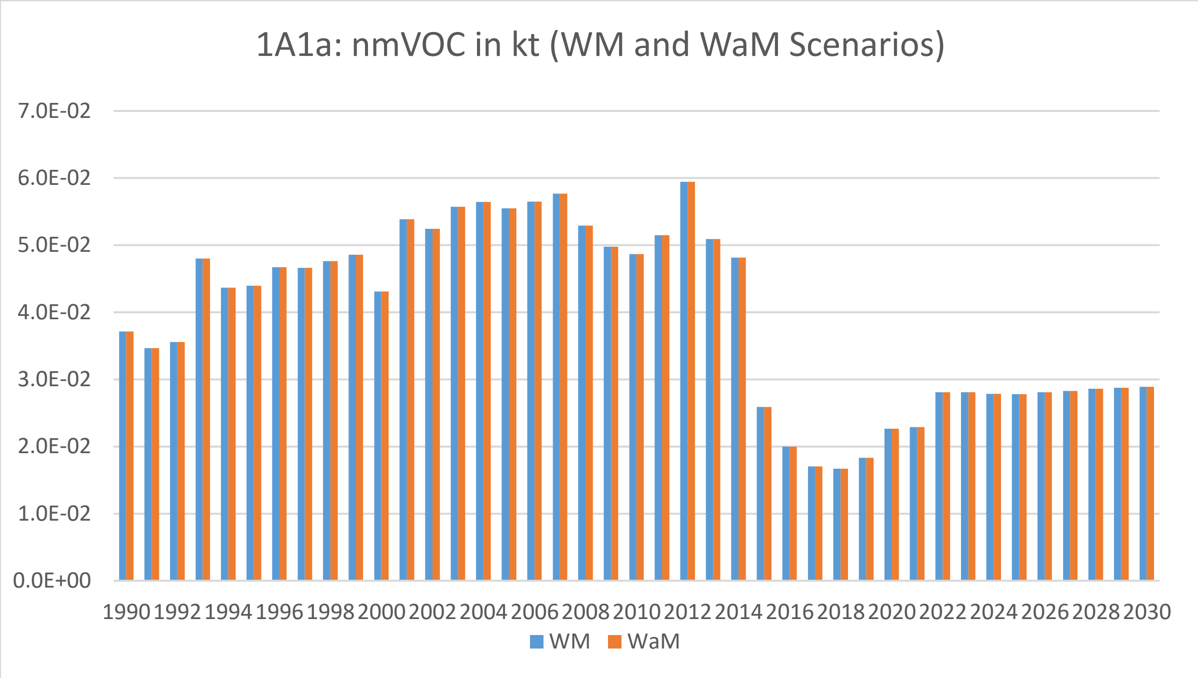

Figure 11: 1A1A NMVOC IN KT (WM AND WAM SCENARIOS)

The time series shows an overall decrease in nmVOC emissions from 2013 until 2018, with an increasing trend from 2019 till 2022, and then a constant trend until 2030. This was estimated from default factors hence emissions were directly proportional to activity or fuel consumed in GJ.

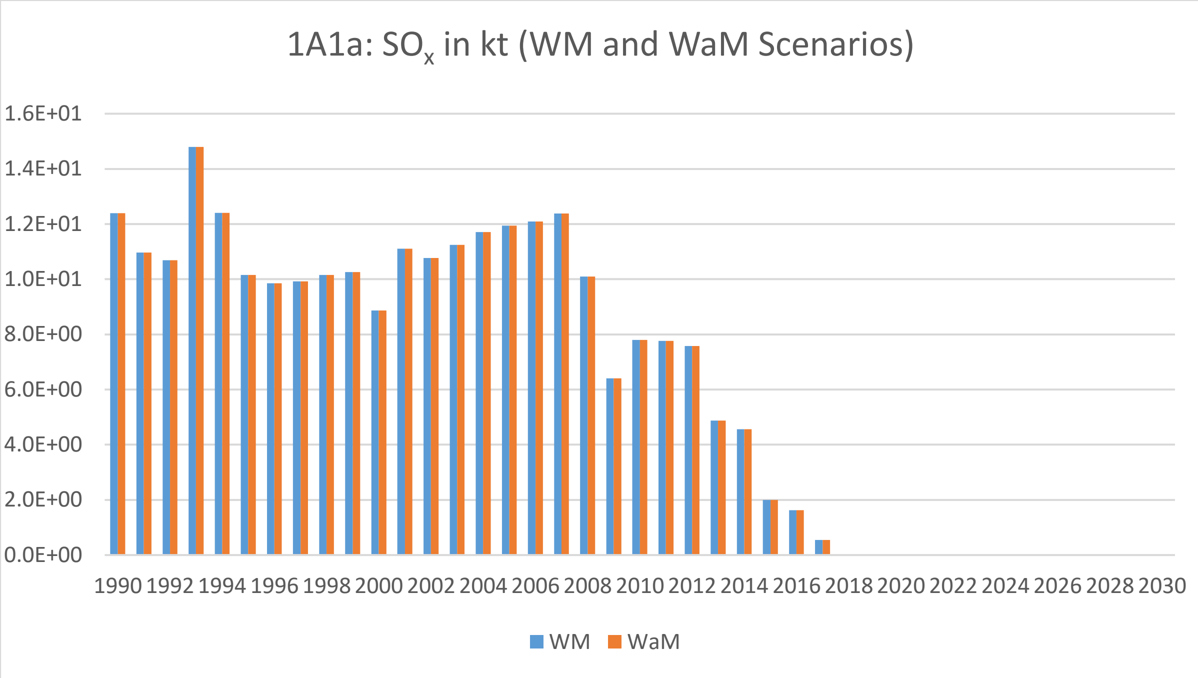

Figure 12: 1A1A SO_X IN KT (WM AND WAM SCENARIOS)

From 2005 onwards, SO_x emission loads were provided directly by the facilities. The graph shows a drastic decrease in emissions along the years. The introduction of the interconnector, and the shift to natural gas, have reduced SO_x emissions to an extent that this sector is no longer a key category for SO_x.

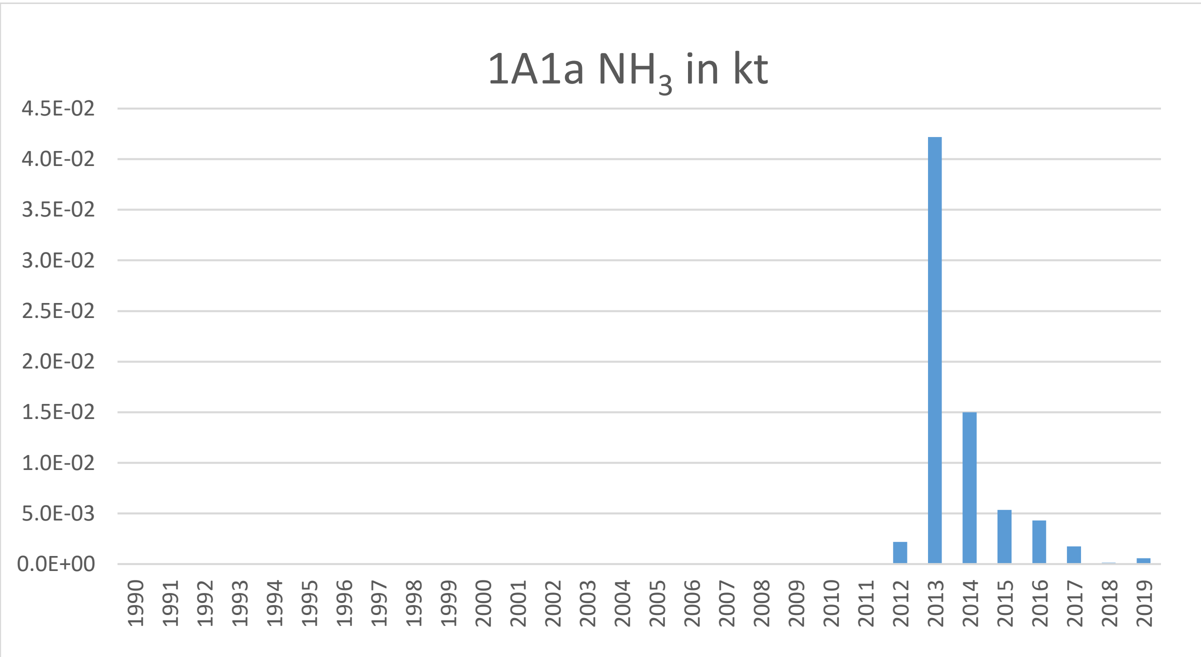

Figure 13: 1A1A NH_3 IN KT (WM AND WAM SCENARIOS)

Selective catalytic reduction was present at the Delimara power station since 2012 but not available in any other plants. The high annual average ammonia concentration recorded in 2013 was due to spent catalyst in NO_x abatement. An additional layer of new catalyst was installed and values were back to normal. This technology is currently present at the D3PG facility.

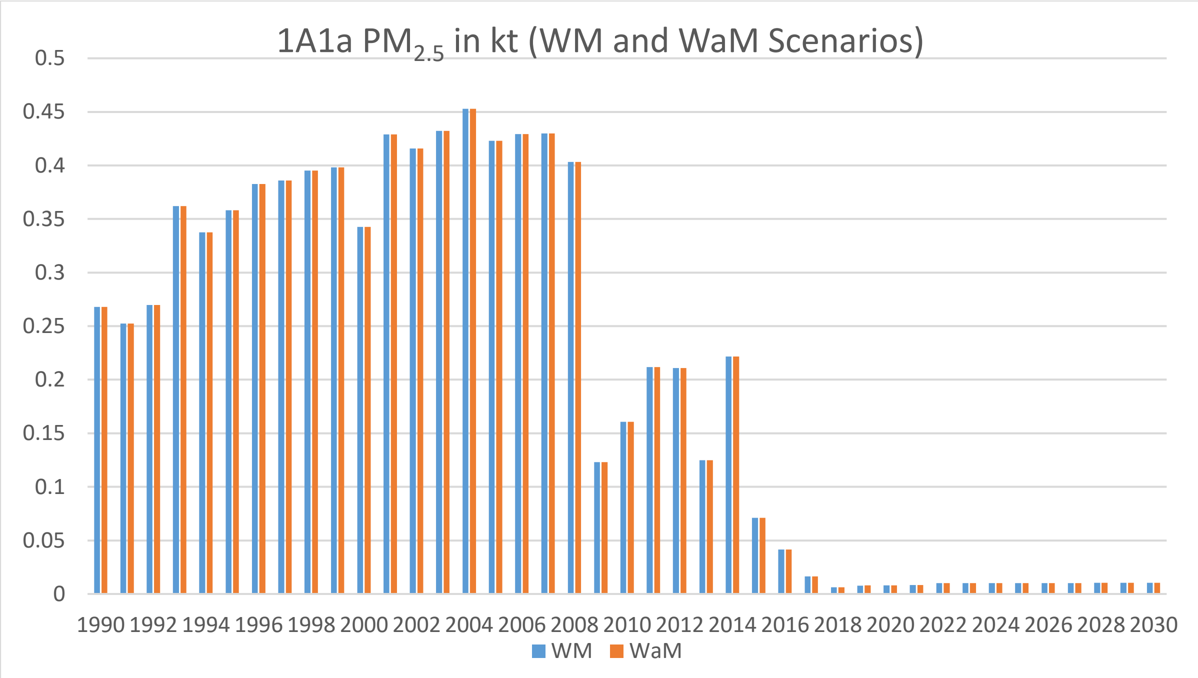

Figure 14: 1A1A $PM_{2.5}$ IN KT (WM AND WAM SCENARIOS)

The trend in $PM_{2.5}$ emissions shows a substantial decrease of emissions from 2014 onwards, which could be linked to the introduction of the interconnector, and the subsequent change in fuel.

1A2gviii: Stationary Combustion in Manufacturing Industries and Construction

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1A2gviii	Stationary Combustion in Manufacturing Industries and Construction: Other	2019GB	Eurostat	Tier 1	benzo(b)fluoranthene	2021 submission

Emissions from 'Stationary Combustion in Manufacturing Industries and Construction' were reported under group sector 1A.2.g.viii. Projected data was supplied by the Energy & Water Agency (EWA) in 2019, as fuel use in Industry for the period 2020-2030.

The graph below shows the trend of fuel consumption for the historical and projected time series:

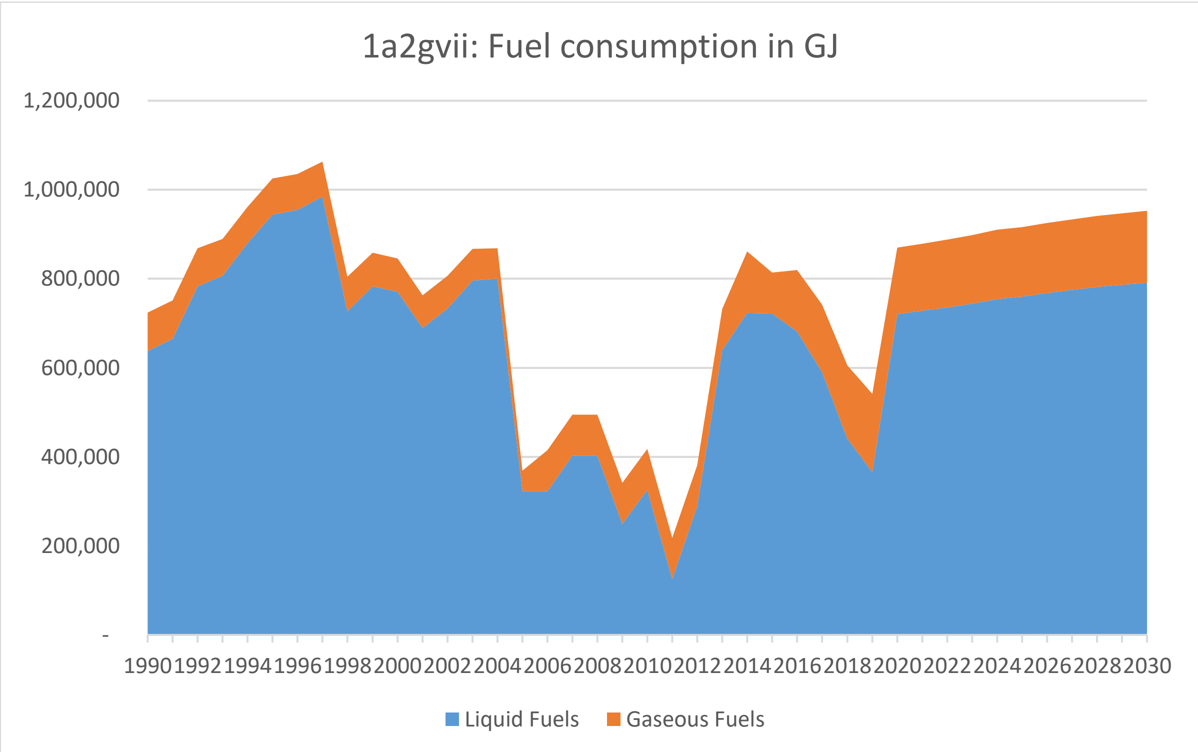

Figure 15: 1A2VGIII: FUEL CONSUMPTION IN GJ

As expected, emissions calculated show the same trend as that of fuel consumption. The percentage sulphur content obtained from the Regulator for Energy and Water Services (REWS) was used to estimate SO_x for some years and fuels. Data was available for 2014 to 2019. Therefore, the average sulphur content from 2014 to 2019 was used to calculate SO_x emissions prior to 2014.

It is worth noting that NH_3 was not estimated, since no information on availability of selective catalytic reduction equipment was available.

1A3: Transport

The transport sector covered in this submission includes the following group of sectors; 1A3ai(i) International aviation LTO (civil), 1A3aii(i) Domestic aviation LTO (civil), 1A3bi-bvii Road transport and 1A3dii National navigation (shipping).

1A3a: Aviation

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1A3a	Domestic Aviation LTO (civil), International Aviation LTO (civil)	Master emissions calculator	Malta International Airport	Master emissions calculator (EUROCONTROL)	NO_x, SO_x, CO	2021 submission

Emissions were calculated separately for each of the following categories: Domestic Aviation LTO (civil) 1A3ai(i) and International Aviation LTO (civil) 1A3ii(i).

Domestic LTOs are defined as the number of flights performed locally by flight schools, and other trips around the Maltese Islands for leisure. All other flights, which departed from the Luqa International Airport and landed in foreign airports were considered as being International flights.

This submission includes historical emissions of the time series ranging from 1990 to 2019. The only airport present on the island i.e. Malta International Airport (MIA) provided the number of LTO cycles split into domestic and international flights for 1999 to 2019 for each aircraft model, as designated through the ICAO classification. Furthermore, the number of LTO cycles for international flights from 1990 to 1998 was provided by the Civil Aviation Department at Transport Malta. No activity data was available for domestic flights prior to 1999, and consequently emissions from 1990 to 1998 were classified as 'NE'. The graph below provides a breakdown of domestic and international flights across the time series:

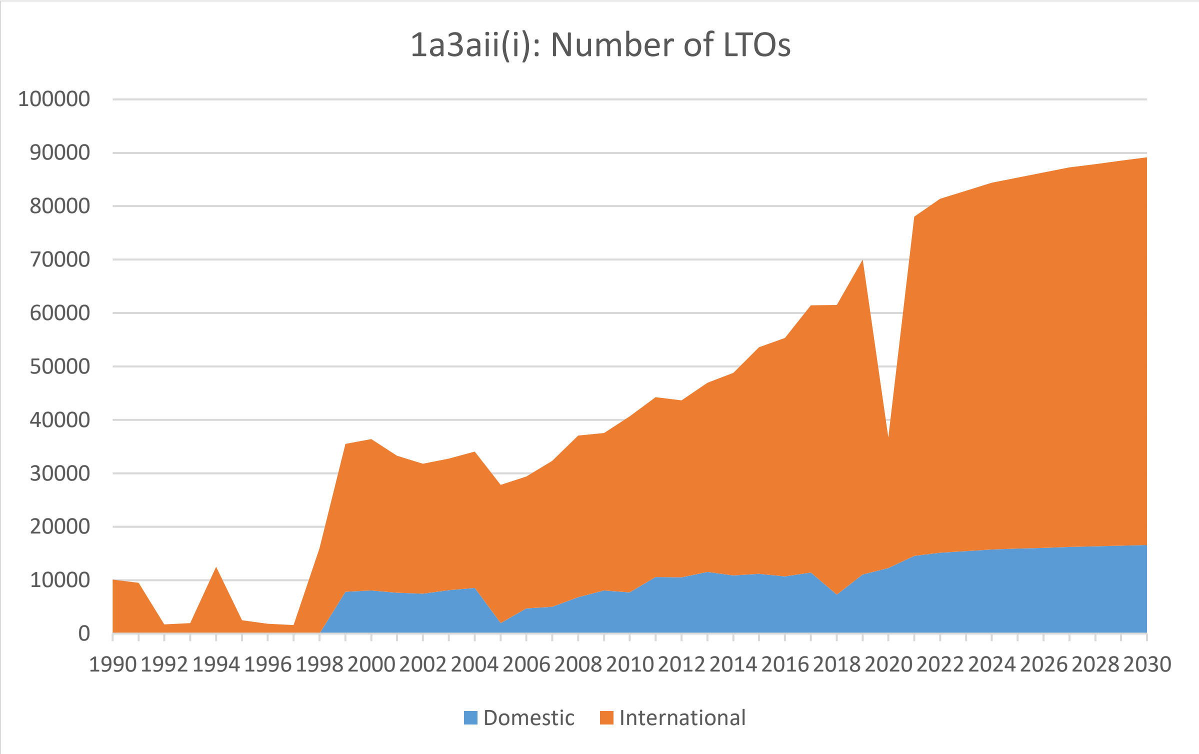

Figure 16: 1A3AI(I) NUMBER OF LTOS

A steady increase in international LTOs is seen across the time series, most notably from 2005 until 2019. Numbers of domestic flights maintained the overall same trend from 1999 until 2019.

Concerning projections, the total number of LTOs was not available post 2020. Therefore, the projected fuel use in aviation, as provided by the Energy & Water Agency (EWA) in 2019, was used. The number of LTOs per aircraft type in 2019, was multiplied by the percentage increase of projected fuel used. Hence, the LTOs increased in line with the projected fuel use. For aviation, the WM and WaM scenarios are assumed to be equal.

Due to the COVID-19 pandemic, there was a sharp decline in international LTOs in 2020. Hence instead of using projected data, the provisional number of LTOs from MIA was used instead. This caused a decrease in emissions in this sector, which is described further in the graphs below.

Emission factors were extracted from the model developed by EUROCONTROL known as 'Master emission calculator' and multiplied by the number of LTOs to calculate emissions for this sector.

The emission factors were based on the following parameters:

Table 3: ICAO DEFAULT PARAMETERS

Phases	ICAO default
Taxi	00:26:00
Take off	00:00:42
Climb out	00:02:12
Approach	00:04:00
TOTAL	**00:32:54**

The emission factors sourced from the EMEP/EEA model were provided for certain pollutants (NO_x, SO_x, nmVOC, PM, and CO). Furthermore, these emission factors were only available for a limited number of aircraft models. Hence, a considerable number of emission factors associated with domestic and international flights are missing across the time series.

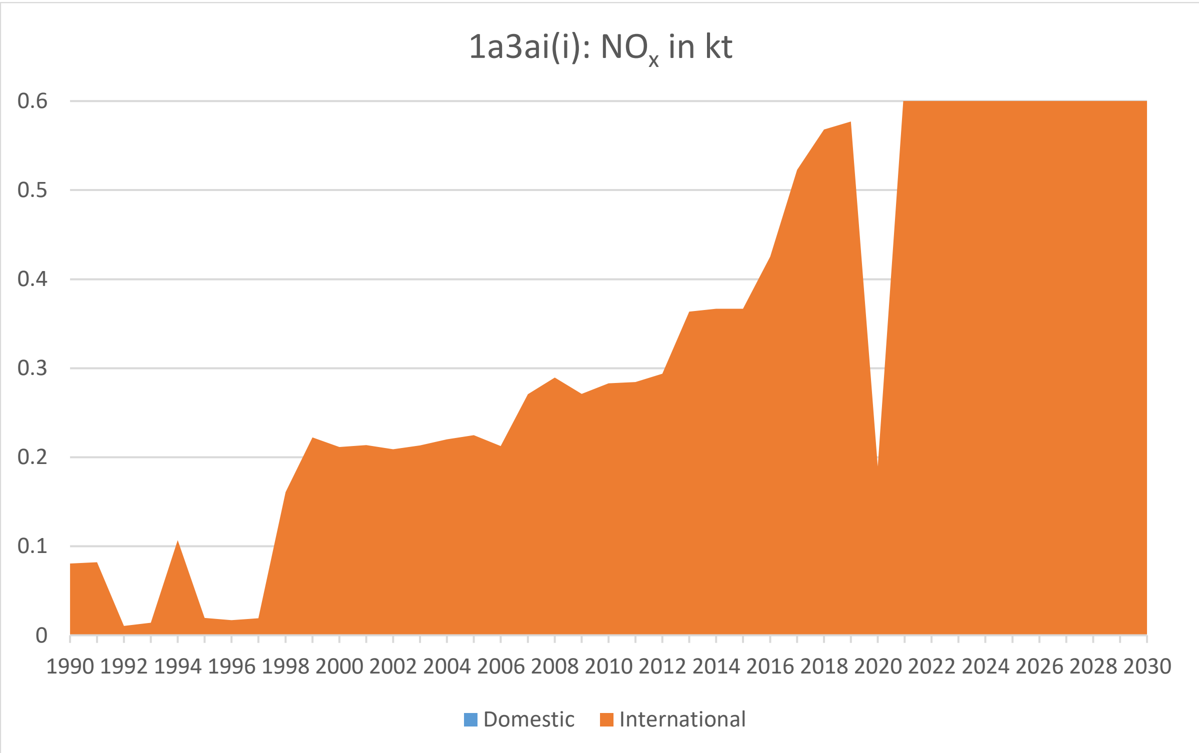

Figure 17: 1A3AI(I): DOMESTIC AND INTERNATIONAL NO_X IN KT

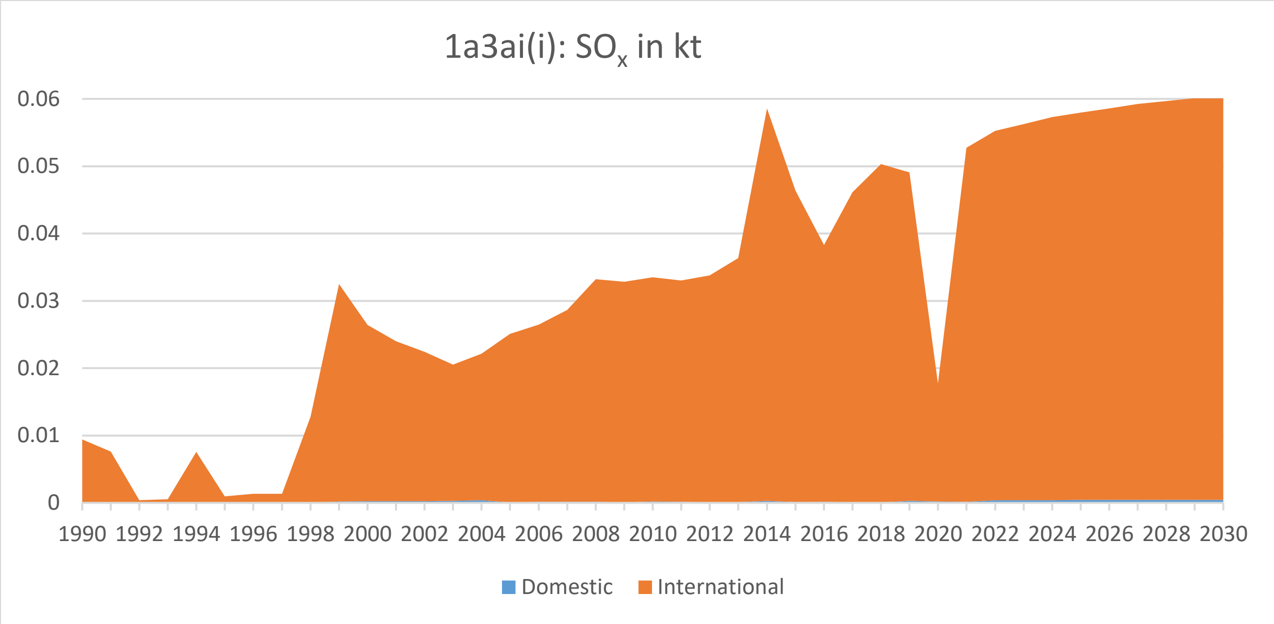

Figure 18: 1A3AI(I): DOMESTIC SO_X IN KT

International aviation is clearly the predominant source of emissions from the aviation industry. This is due to the number of international LTOs, which is considerably greater than the number of domestic LTOs. There is a clear, proportional relationship between the number of international LTOs and the emissions of NO_x and SO_x, as seen in the graphed data.

1A3b: Road Transport

NFR-Code	Name of sub-Category	Method	Activity Data Source	EF	Key Category	Year of last update
1A3b	Road Transport	COPERT 5.3	EWA, TM, REWS, MRA	Tier 3	NO_x, nmVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Hg, Cr, Cu, Se, Zn, Benzo(a)pyrene, Benzo(b)flouranthene, Benzo(k)flouranthene, Indeno (1,2,3-cd) pyrene	2021 submission

Emissions from motorised road vehicles in Malta were reported under group sector, 1A.3.b. Emissions estimated under this sector were based on the vehicle fleet circulating on public roads, excluding agricultural and military transport.

Emissions were calculated for each of the following categories:

- 1A.3.bi, Passenger Cars;
- 1A.3.bii, Light Duty Vehicles;
- 1A.3.biii, Heavy-Duty Vehicles and Buses;
- 1A.3.biv, Mopeds and Motorcycles;
- 1A.3.b.v, Gasoline Evaporation;
- 1A.3.b.vi, Tyre & brake Wear;
- 1.A.3.b.vii, Road Surface Abrasion

In this submission, road transport emissions were estimated via COPERT 5.3.0. Newer versions of the model (i.e. version 5.4.36) could not be used for this reporting period as errors were encountered and emissions could not be calculated. Consequently, Malta opted to proceed with using the older version for this reporting period until such time that the newer version of COPERT is fixed.

The updated parameters are listed in the table below:

Table 4: COPERT PARAMETERS USED

Parameters used for historical input parameters	Source of parameters used
Environmental Information	Data was obtained from the National Meteorological Office
Trip Characteristics (average trip duration and average trip length)	Transport Malta (TM) – National Transport Model
Fuel Specification	• 1990-2003: Values for 2004 for diesel, and 2005 for petrol, were carried backwards. • 2004-2007: Reporting under Directive 98/70/EC, provided by the Malta Resources Authority (MRA). • 2008-2013: These values were extrapolated. • 2014-2019: Percentage sulphur content in fuel was obtained from the Regulator of Energy and Water Services (REWS). • 2020-2030: Average percentage sulphur content from 2014-2019 was used.
Statistical consumption	• Eurostat all years • 2020 provisional data provided by REWS
Reid Vapour Pressure	COPERT 5 Default figure – EMISIA S.A
Stock	• 1990 to 2009: Data from the climate change team at MRA was used • 2010 to 2030: Model developed by the Energy and Water Agency (EWA) generated historical and projected data • Malta Public Transport provided 2020 data for buses
Vkm and Lifetime cumulative	• 1990-2009: Assumed that the mean Vkm per age of vehicle was equal to the data provided by EWA from 2010 onwards

	• 2010 to 2030: Model developed by the EWA generated historical and projected data • 2020: Vkm directly proportional to decrease in fuel use • Malta Public Transport provided 2020 data for buses
Circulation (Average speed and percentage mileage share per road type)	Transport Malta (TM)
Fuel blend	Regulator for Energy and Water Services; E0 and B7
Load and road slope	Are assumed to be 50% and 0% respectively, since no actual data was available

Each of the road types in COPERT (urban, rural, and highway) have both a speed and a respective mileage share driven. TM also provided both morning and evening peak hour, speed data for every road type. No distinction was made between different vehicle types since the information was not available at this level of detail.

The table below presents the data inputted into COPERT:

Table 5: CIRCULATION DATA

Urban Peak % Share	Urban Off Peak % Share	Rural % Share	Highway % Share	Urban Peak Speed (km/hr)	Urban Off Peak Speed (km/hr)	Rural Speed (km/hr)	Highway Speed (km/hr)
6	38	21	35	15.6	16.8	13.2	53.3

Other parameters included in COPERT, such as average trip length and distance, were obtained from the national road transport model. These parameters were kept the same for all projected years and scenarios, since no better data was available.

As described in the above table, the sulphur content was only available for a limited number of years. The 2004 value for diesel was carried backwards, since the limits for sulphur content under Directive 98/70/EC were revised in 2005, and therefore values from 2005-2007 would not be representative of data which pre-dates 2004. The sulphur content in petrol for 2004 was not available, and therefore the value from 2005 was carried backwards to 1990. A linear extrapolation was used between 2008 and 2013, and an average for the data from 2014-2019 was used for projected data. The sulphur content of petrol and diesel can be observed in the figures below.

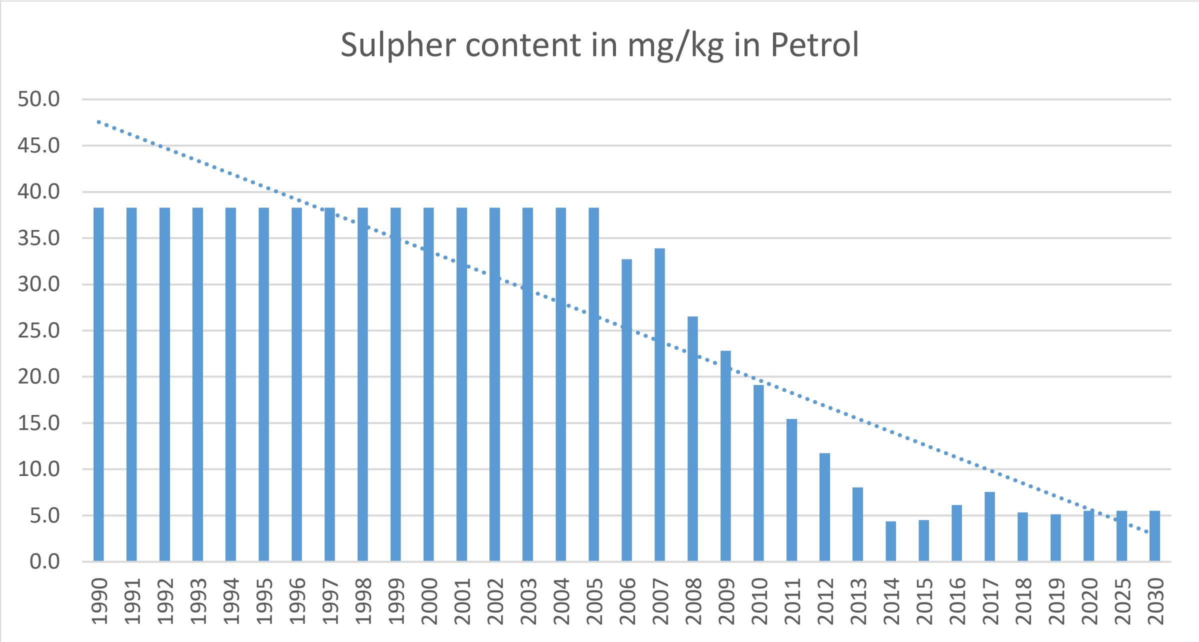

Figure 19: SULPHUR CONTENT IN MG/KG IN PETROL

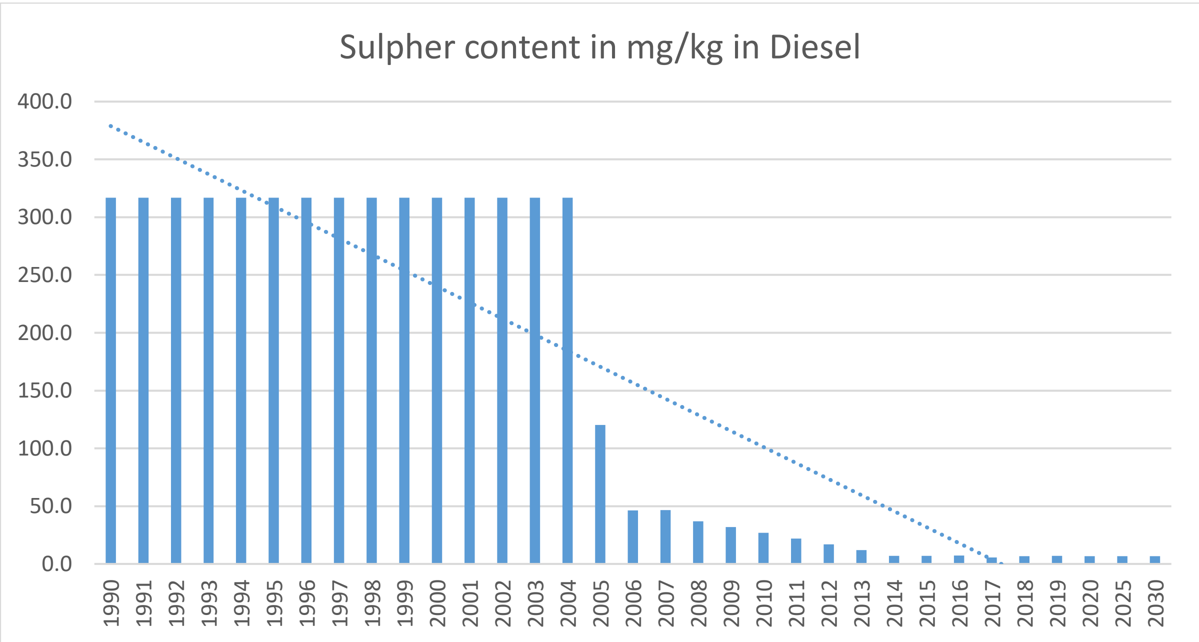

Figure 20: SULPHUR CONTENT IN MG/KG IN DIESEL

The fuel balance function was not checked for all the years, as the actual mileage data was considered sufficiently representative of the real scenario. SCR, A/C usage and mileage degradation functions were checked and default factors were used when running the model with the above input parameters.

Historical fuel consumption was provided through the Eurostat Energy Balance, whereas projected fuel consumption was provided by the EWA in 2019. This data consisted of consumption of petrol, diesel, biodiesel and LPG. However, only petrol and diesel were projected for the WM scenario, while petrol, diesel and biofuels were projected for the WaM scenario. The decision to extend the substitution of conventional fuels through the use of biofuel was taken after 2017, and therefore such a consideration could only apply for the WaM scenario. The graphs below show the fuel mix projected both for the WM and WaM scenario:

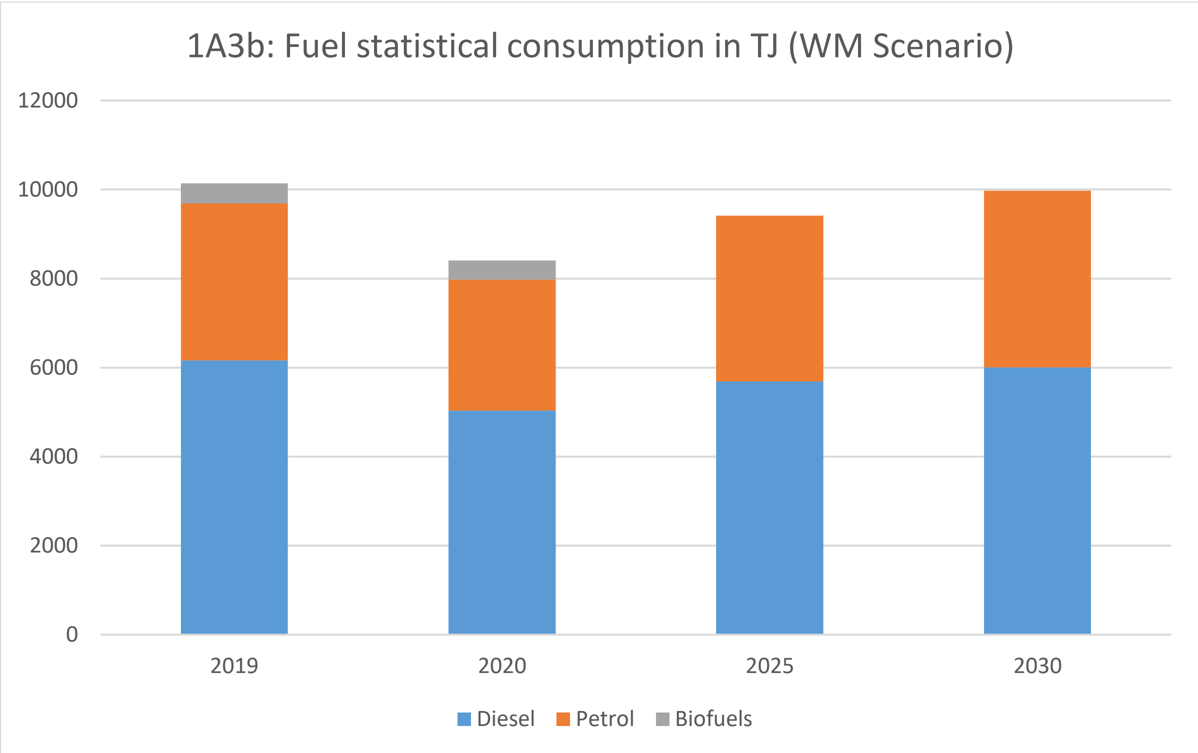

Figure 21: 1A3B: FUEL STATISTICAL CONSUMPTION IN TJ (WM SCENARIO)

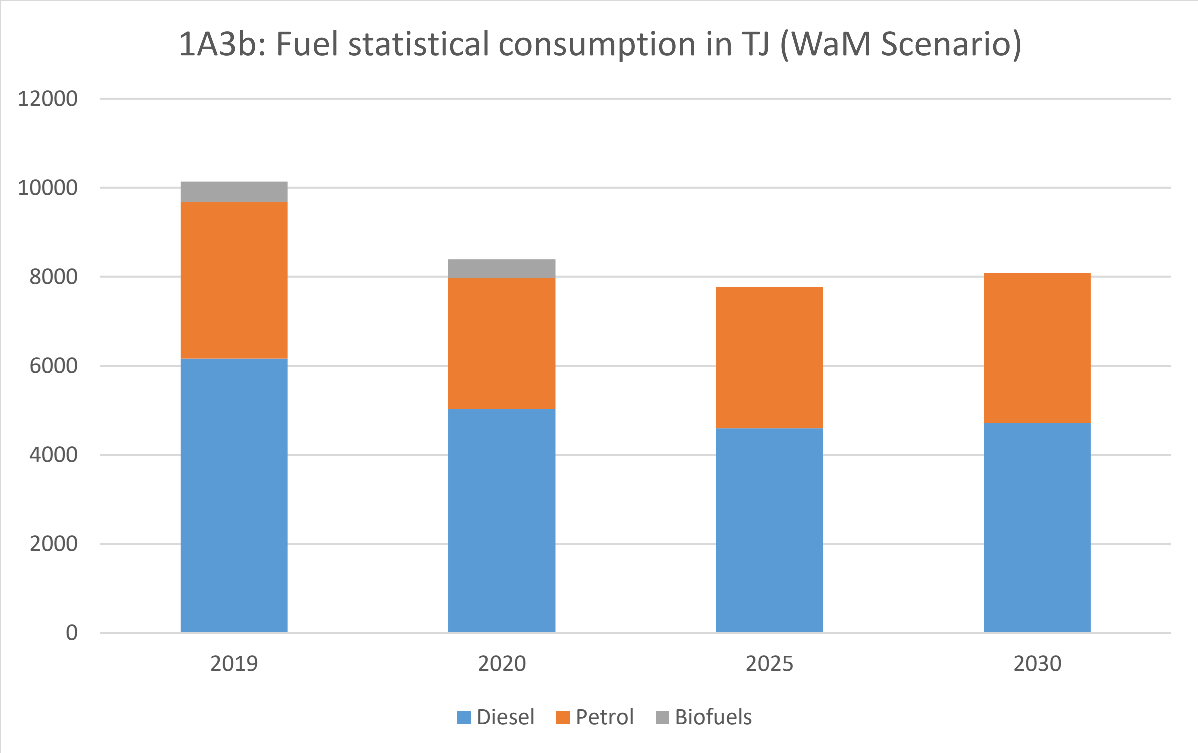

Figure 22: 1A3B: FUEL STATISTICAL CONSUMPTION IN TJ (WAM SCENARIO)

The following text is a summary of the procedure followed by the EWA to generate the stock and mileage databases from NSO data. This information was sourced from the Methodological Note of the road transport model developed by the EWA:

Annual Average vehicle per km (Vkm)

The 2017 - 2018 VRT (Vehicle Roadworthiness Testing) data provided by NSO to EWA included Vkm data. This data was used to determine the annual mean mileage a vehicle is expected to drive, based on its year of manufacture. A database was generated with the total mileage of each car aged between 4 and 100 years. Outliers were eliminated, and data on vehicles older than 25 years was ignored, as the sample size was not significant. Furthermore, vehicles under 5 years of age were not subject to a VRT. Hence, a constant Vkm figure was used for these vehicles. The resulting normalized plot indicated that as a vehicle gets older, the respective annual mileage decreases.

The cumulative mileage was calculated by summing up the annual mean mileage of each year the vehicle has been on the road. For this submission, this methodology was extended for the years 1990-2009.

Total vehicle kilometres

Moreover, total Vkm was projected for each of the five major vehicle categories. These projections made use of historical information to estimate the elasticity of total Vkm of each vehicle type against a macroeconomic indicator.

Table 6: MACROECONOMIC DRIVERS USED TO PROJECT VKM

Vehicle category	Macroeconomic driver to estimate total Vkm
New PC	Population
New LDV	Wholesale and Retail GVA
New HCV	Wholesale, Retail and construction GVA
New MC&QUAD (L-category)	Population
New Buses	MB: Population (4 -15 years) CPB: Inbound tourists (Air passengers) RB: No driver used

The total mileage of each of the five vehicle types between 2018 and 2030 was estimated using the following equation;

$$VKM_t = VKM_{t-1} + (1 \times m \times g_t)$$

Equation 2: EQUATION TO ESTIMATE TOTAL MILEAGE BY VEHICLE TYPE

Where:

- VKM_t = The estimate of total VKM driven by a vehicle category at period *t*;
- VKM_{t-1} = The estimate of total VKM driven by a vehicle category at period *t-1*;
- m = The elasticity of total VKM of a vehicle category against a macroeconomic indicator which is expected to drive the demand for that vehicle's use;
- g_t = annual growth rate of the indicator between period *t-1* and *t*

The model was used to estimate annual Vkm between 2010 and 2017 for each vehicle category. The resultant data was used to calibrate the model against energy balance statistics. The projected Vkm for 2020 - 2030 was considered to be equivalent to the demand to be matched by what remains of the stock as at end of 2017.

To account for the impact of COVID-19 in road transport in 2020, a relationship was sought between the projected fuel use, and the provisional fuel use provided by REWS in 2020.

Compared to 2019, petrol consumption decreased by 16%, while diesel consumption decreased by 18% in 2020, hence the Vkm for petrol and diesel was assumed to decrease proportionally. Concerning route buses, the provisional Vkm for 2020 was provided by Malta Public Transport.

Stock of vehicles

Vehicle stock data was provided by NSO for the five main vehicle categories (Passenger cars, Light Duty Vehicles, Heavy Duty Vehicles, Buses, and L-categories) and aggregated by fuel type and year of manufacture (YOM). The stock profile of the 2010-2017 database was extracted and used to create a survival profile for each vehicle type using the below equation:

$$Survival\ rate_v = Average\left(\frac{Stock_v - Stock_{v-1}}{Stock_v}\right) * (1 + Survival\ rate_{v-1})$$

Equation 3: EQUATION FOR THE SURVIVAL RATE PROFILE OF VEHICLES

v = vehicle's age

The survival profile was used to generate both historical and projected stock. The number of new vehicles being introduced on the market was estimated by finding the difference between the total vehicle demand and the actual service demand provided by the existing stock.

Further manipulation of data was required to organize data into COPERT format:

- Each subcategory was further broken down into the respective Euro standards based on the year of manufacture of the vehicle.
- The total mileage generated for each vehicle category was multiplied with the mileage share of each sub-category aggregated by Euro standard of the vehicle stock reported in 2017. The list of sub-categories can be found below:

Table 7: VEHICLE SUB-CATEGORIES

Vehicle category	COPERT classification
Passenger Cars	Small (0.8 - 1.4L)
	Medium (1.4-2.0L)
	Large (Large (>2.0L)
Light Commercial Vehicles	N1-I (GVW<=1305kg)

	N1-II (1305kg<GVW<=1760kg)
	N1-III (1760kg<GVW<=3500kg)
Heavy Commercial Vehicles	Rigid <=7,5 t
	Rigid 7,5 - 12 t
	Rigid 12 - 14 t
	Rigid > 14 t
L-Category	Motorcycles < 50 cm^3
	Motorcycles > 50 cm^3
	Motorcycles < 250 cm^3
	Quad and ATVs
Buses	Coaches Standard <=18 t
	Urban Buses Standard 15-18 t
	Urban Buses Midi <=15 t

The total mileage of each sub-category aggregated per Euro standard was divided by the stock to get the average annual Vkm.

The following section provides a set of graphs to help illustrate the historical and projected trends related to road transport. As a general note, the main parameters affecting changes within COPERT are mostly related to changes in:

- total vehicle kilometres
- speed (this is constant – therefore was not a variable)
- fuel consumption
- stock – including the penetration of new vehicle technologies with lower emission levels

The graphs below show NO_x emissions for the historical and projected time periods.

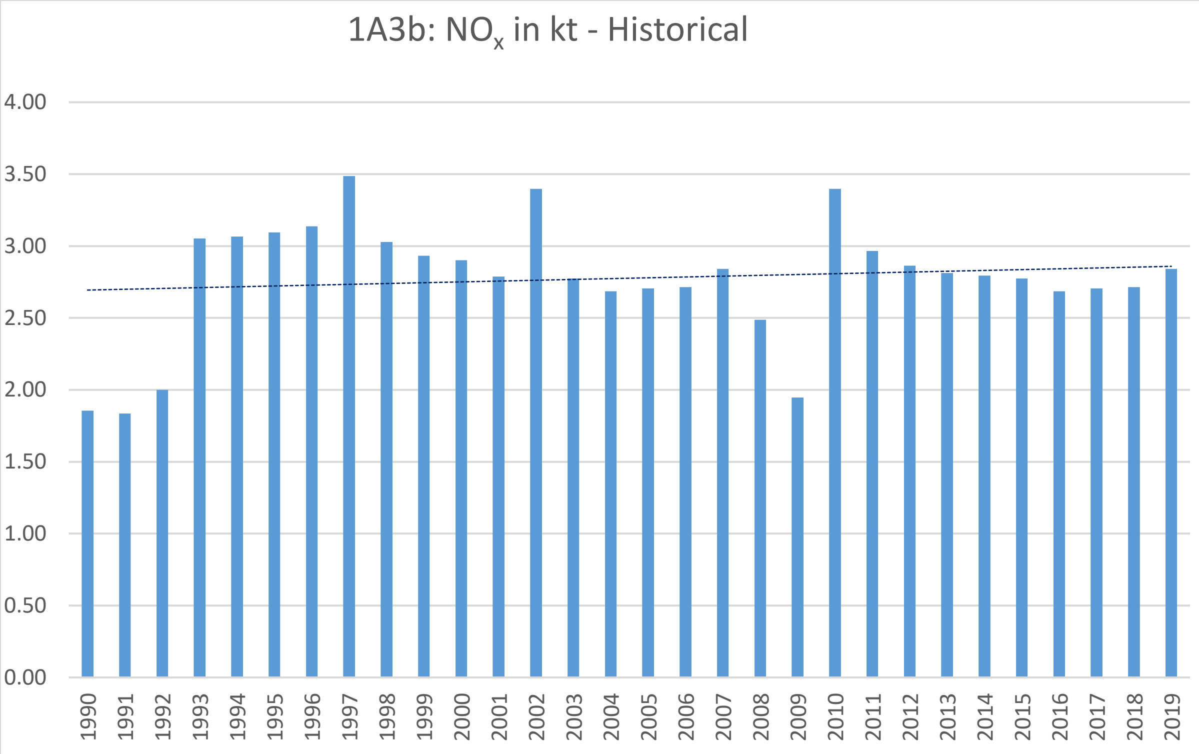

Figure 23: 1A3B: NO$_X$ IN KT - HISTORICAL

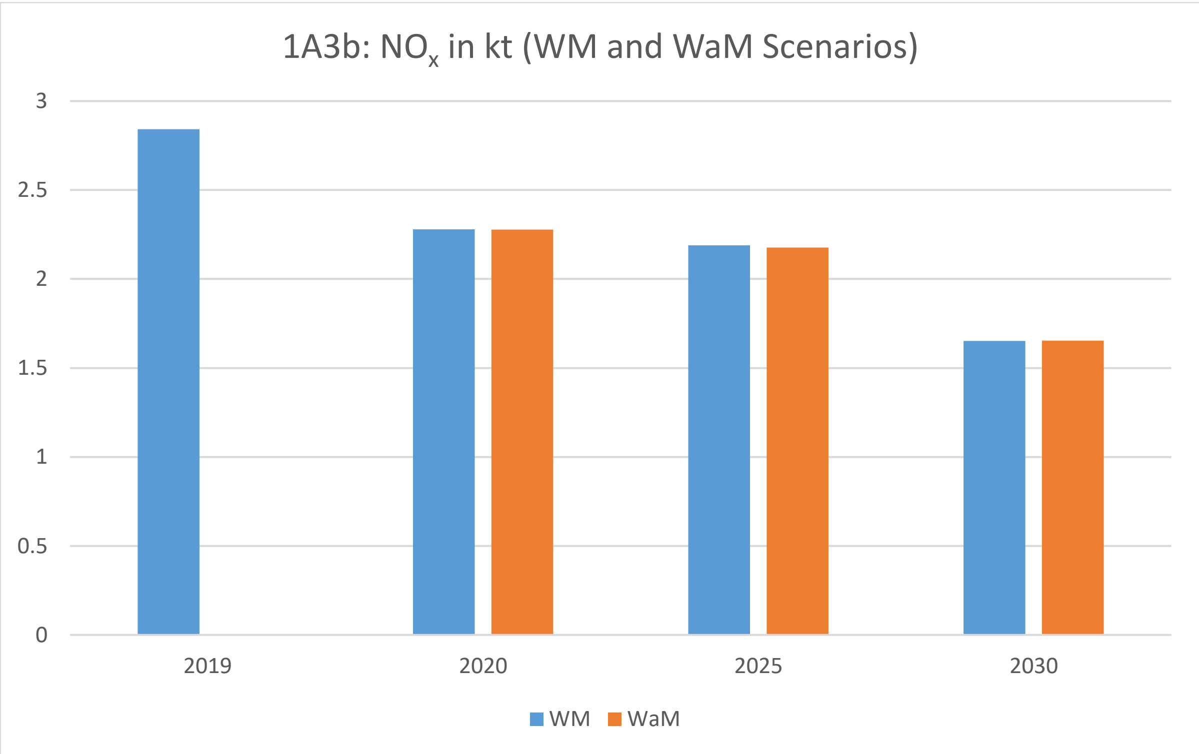

Figure 24: 1A3B: NO$_X$ IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

The graphs below for nmVOC show a decreasing trend across both the historical and projected time series, under both WM and WaM scenarios.

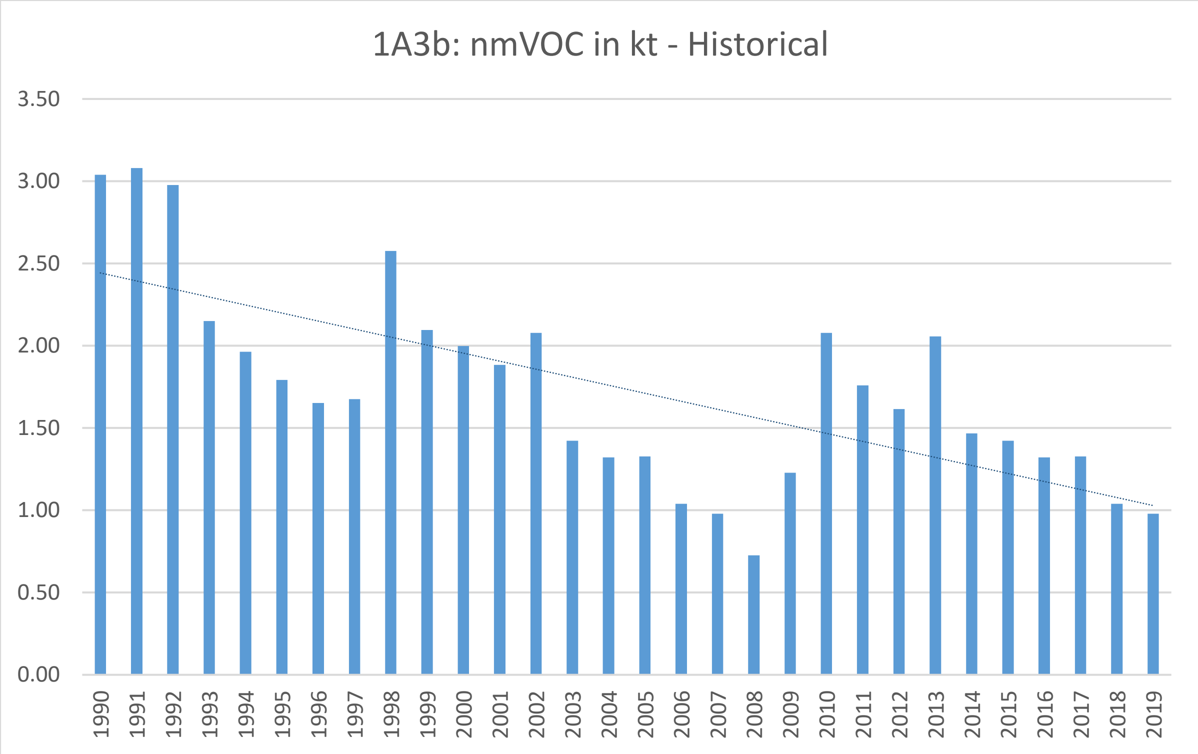

Figure 25: 1A3B: NMVOC IN KT - HISTORICAL

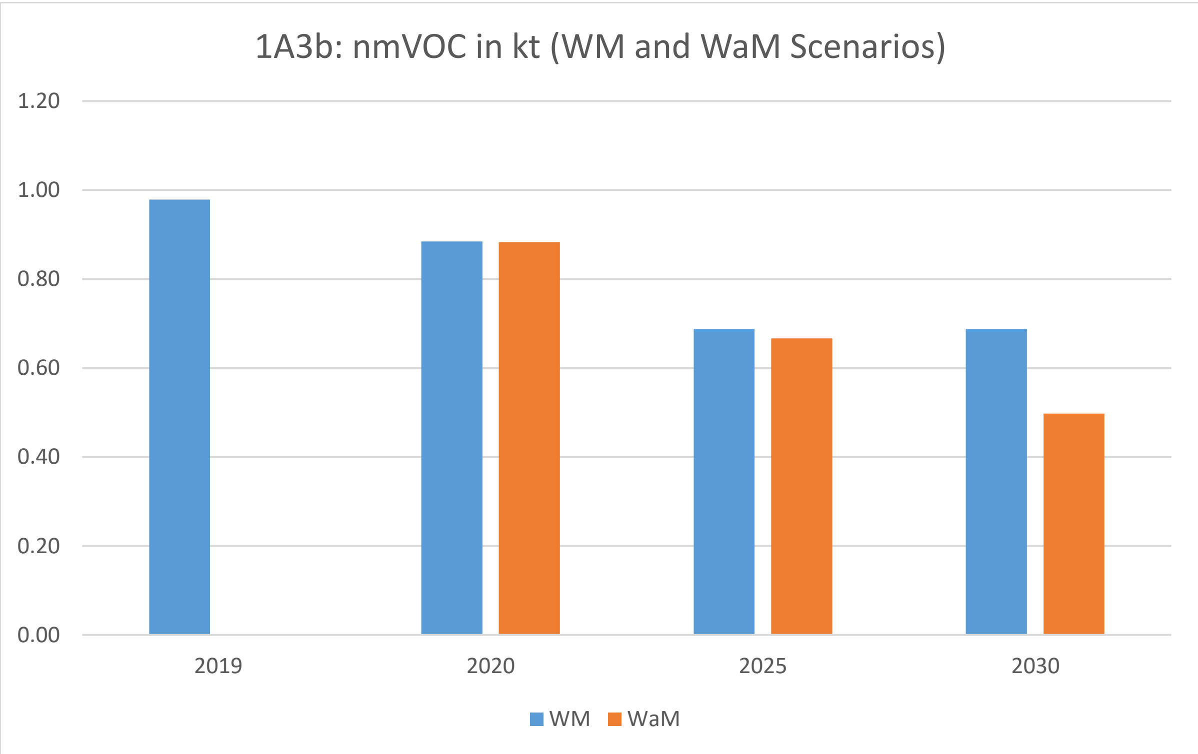

Figure 26: 1A3B: NMVOC IN KT FOR 2018, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

The graph below shows a decreasing trend in SO_x emissions for the historical emissions, closely following the trend of sulphur in fuels presented in figures 19 and 20.

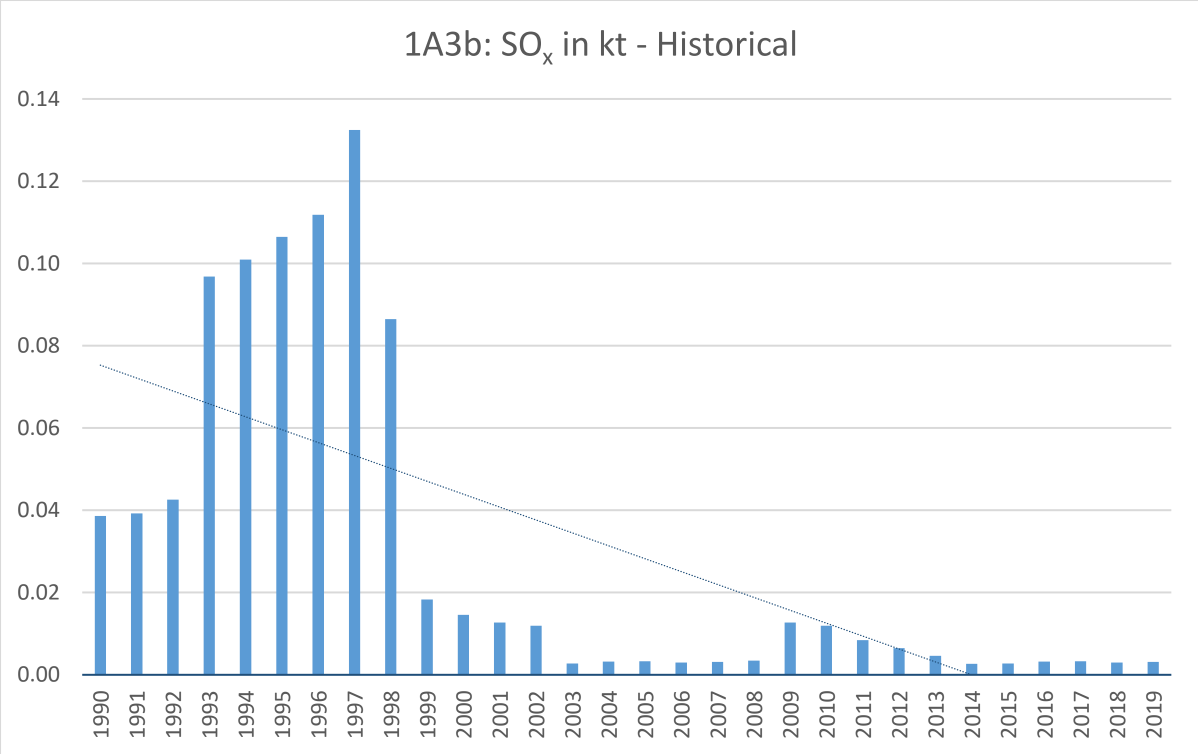

Figure 27: 1A3B: SO_X IN KT - HISTORICAL

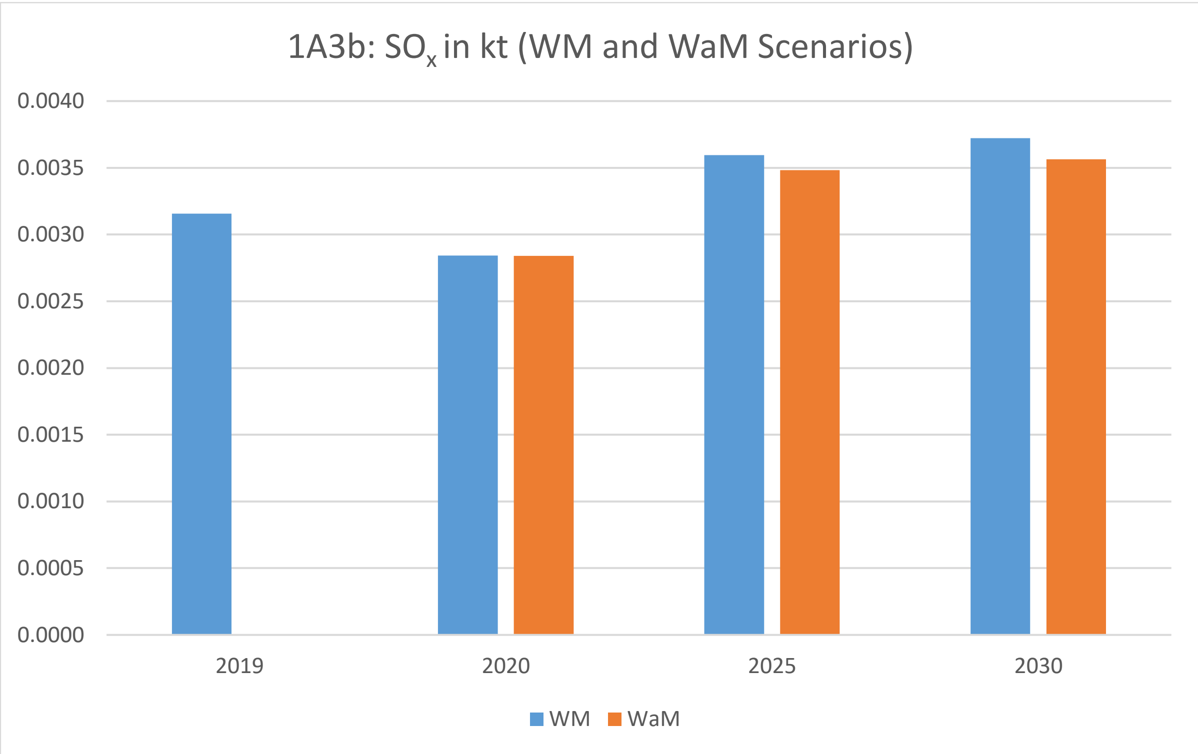

Figure 28: 1A3B: SO_X IN KT FOR 2018, 2020, 2025, 2030 (WM AND WAM)

NH_3 emissions also show a decrease post-2010 in both the historical and projected time series. It is worth noting that the decrease observed in the WM scenario is visibly greater than that under the WM scenario in the projected series.

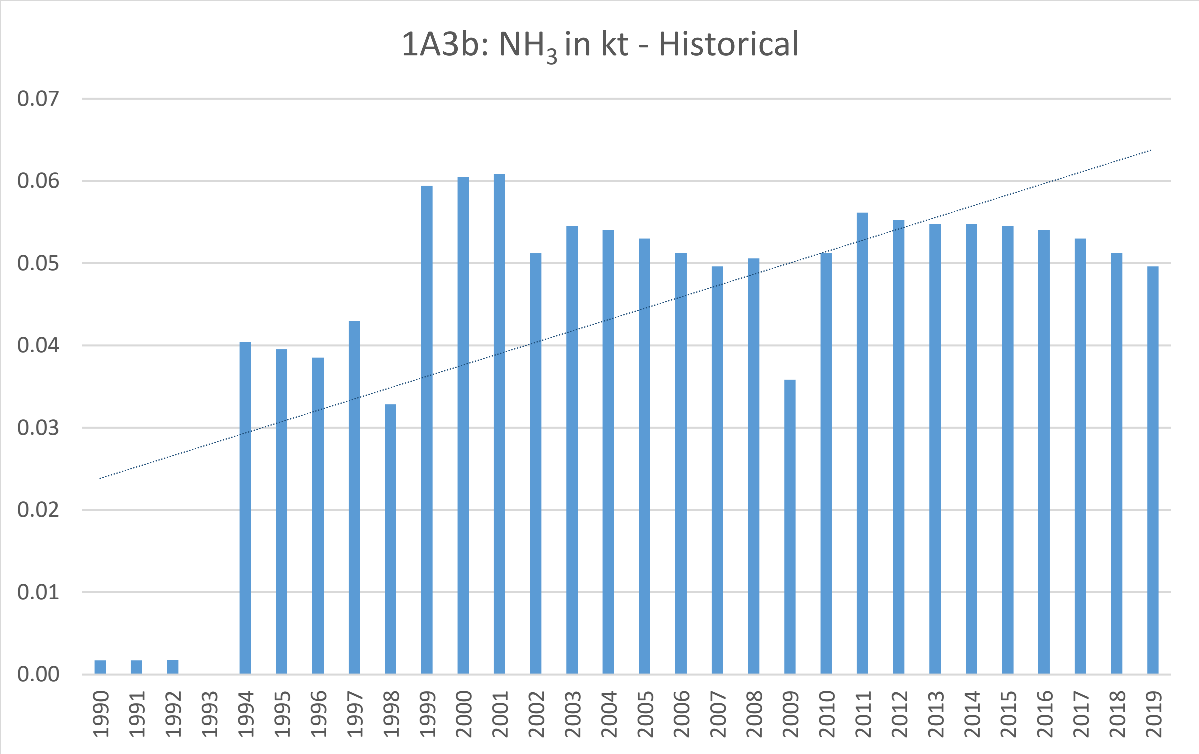

Figure 29: 1A3B: NH_3 IN KT - HISTORICAL

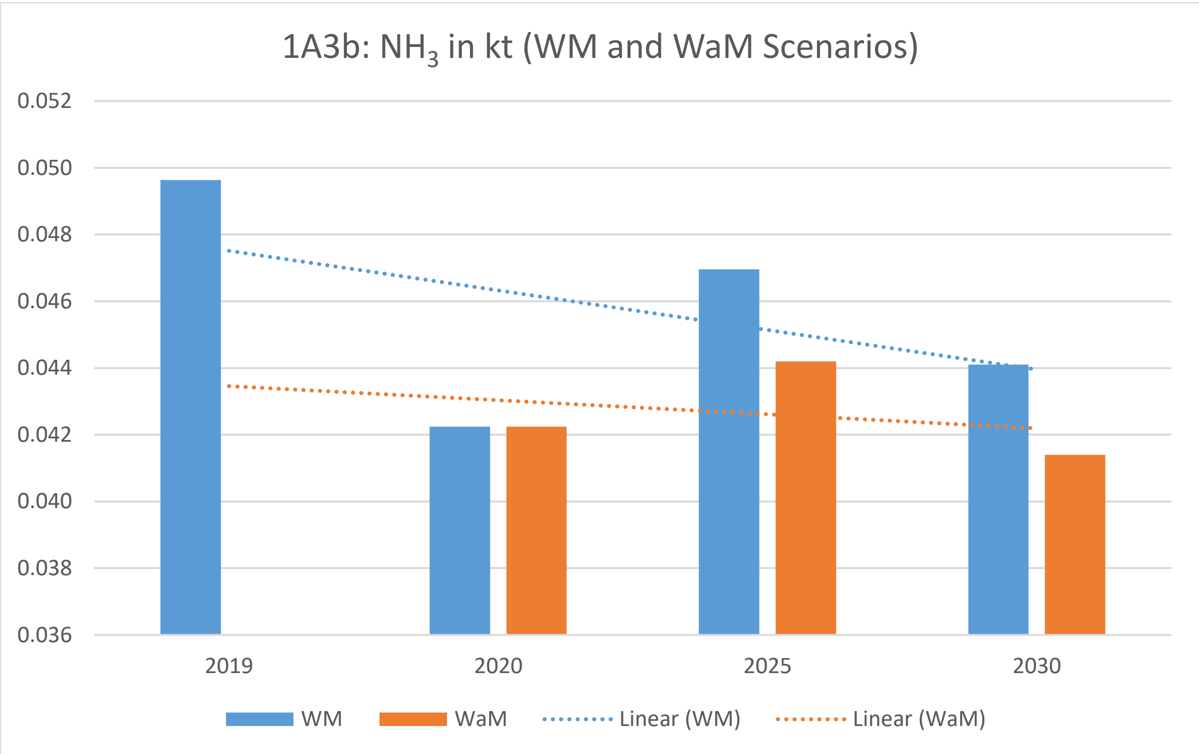

Figure 30: 1A3B: NH_3 IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

$PM_{2.5}$ emissions differ from the other main pollutants, as they are not solely generated through Internal Combustion Engine (ICE) vehicles, as Electric Vehicles (EVs) also generate

$PM_{2.5}$ emissions. One can note a decreasing trend of $PM_{2.5}$ emissions post-2010 within the historical time series, as can be observed from the graph below.

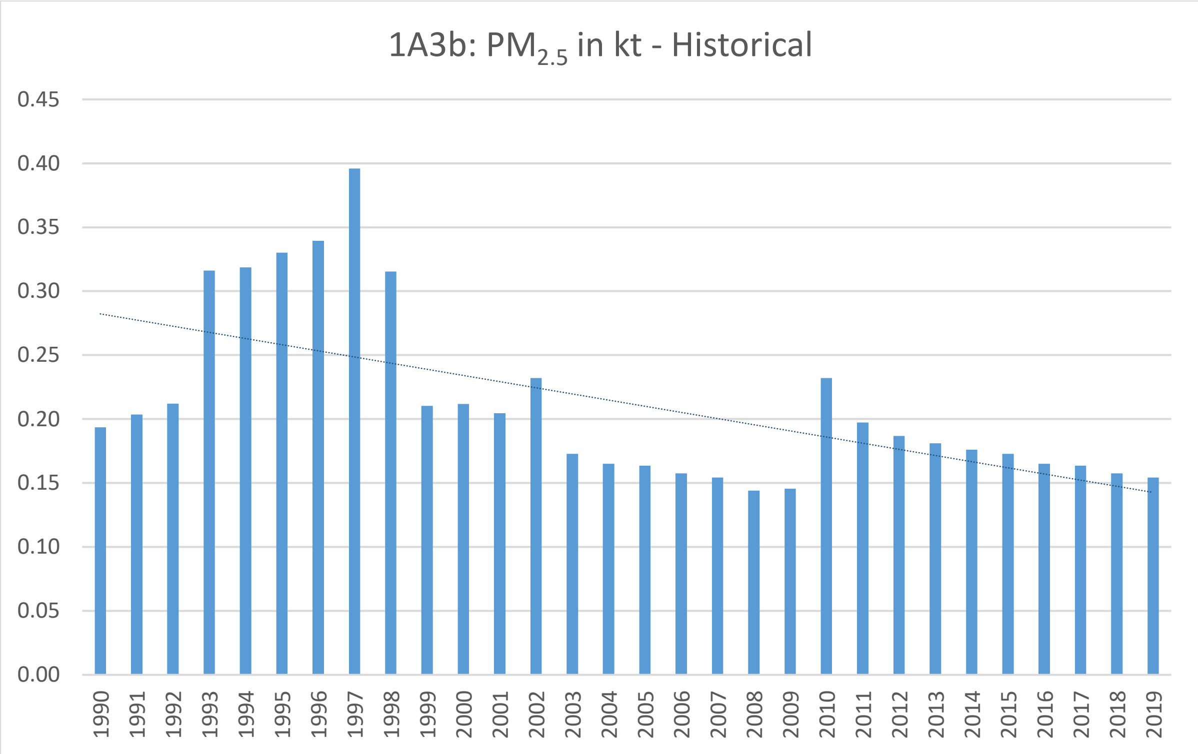

Figure 31: 1A3B $PM_{2.5}$ IN KT - HISTORICAL

The mean mileage was projected for electric vehicles post-2018. Emissions from electric vehicles are attributed to sector '1A.3.b.vi, Automobile Tyre & brake wear', and sector '1.A.3.b.vii, Automobile Road Surface Abrasion'. At present, the COPERT stock dataset template does not include electric vehicles. Thus, in order to include the contribution of electric vehicles in the above mentioned sectors, an alternative methodology was used.

Timmers and Achten (2016) conducted a study on emissions from electric vehicles. The set of default factors made available from this research were used to estimate emissions from this sector.

Table 8: PM EMISSION FACTORS FOR EVS

Pollutants	EVs EF from Tyre Wear	EVs EF from Road Wear
PM_{10}	7.2 mg/Vkm	8.9 mg/Vkm
$PM_{2.5}$	3.7 mg/Vkm	3.8 mg/Vkm

The annual mean mileage of electric vehicles was multiplied by the EFs above, and the results were then added to the emissions of PM_{10} and $PM_{2.5}$ generated by ICE vehicles. The drawback of this approach is that no EFs were available for TSP, and there were no differences in EFs for the different vehicle categories.

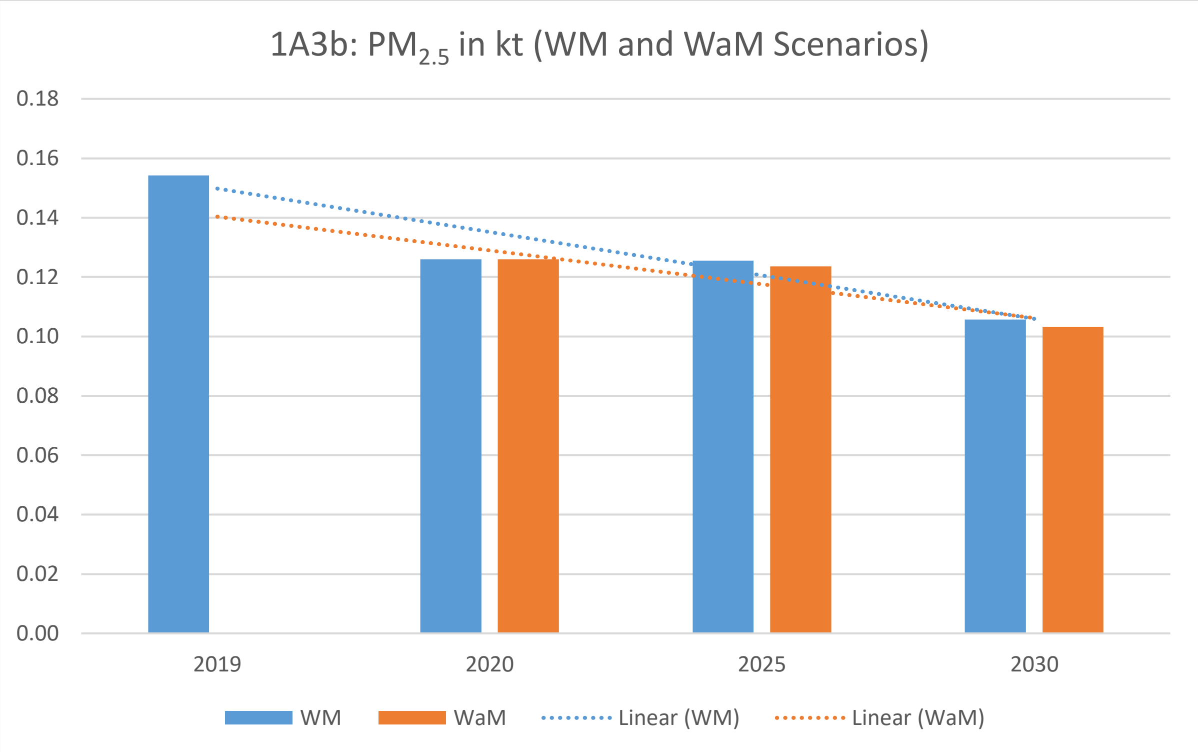

Figure 32: 1A3B: PM2.5 IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

The figure above shows a decreasing trend under both scenarios. It is worth noting that the emissions for the year 2019 onwards include both ICE and EV emissions.

1A3dii National Navigation

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1.A.3dii	National Navigation	2019GB	Eurostat	Tier 1 & 2	NO_x, nmVOC, SO_x, $PM_{2.5}$, As, Ni, Se	2021 submission

This submission includes an update of the National Navigation sector for all years. The main activities comprising this sector in Malta are recreational crafts, and the Gozo channel ferry (main ferry connecting Malta to Gozo). In addition to these activities, two new services will be introduced in future years; a fast ferry, which will start operating in the future for commuters crossing the Maltese Islands, and a tunnel connecting Malta to Gozo which will start operating by the end of 2026 (at which point the fast ferry will cease operations).

The EEA/EMEP model made available in the 2019GB also has the function to generate fuel consumption based on vessel power data. In the past, an attempt was made to calculate emissions through this methodology. However, the resulting fuel consumption differed significantly when compared to the actual fuel data. Hence, the fuel consumption from the national navigation sector was obtained from the Eurostat energy balance sheet (1990 to 2019), while the emission factors were obtained from the 2019GB (Tier 1).

The figures below provide the historical fuel consumption by type for the WM and WaM scenarios. GDO and Diesel are the main fuel sources for this sector.

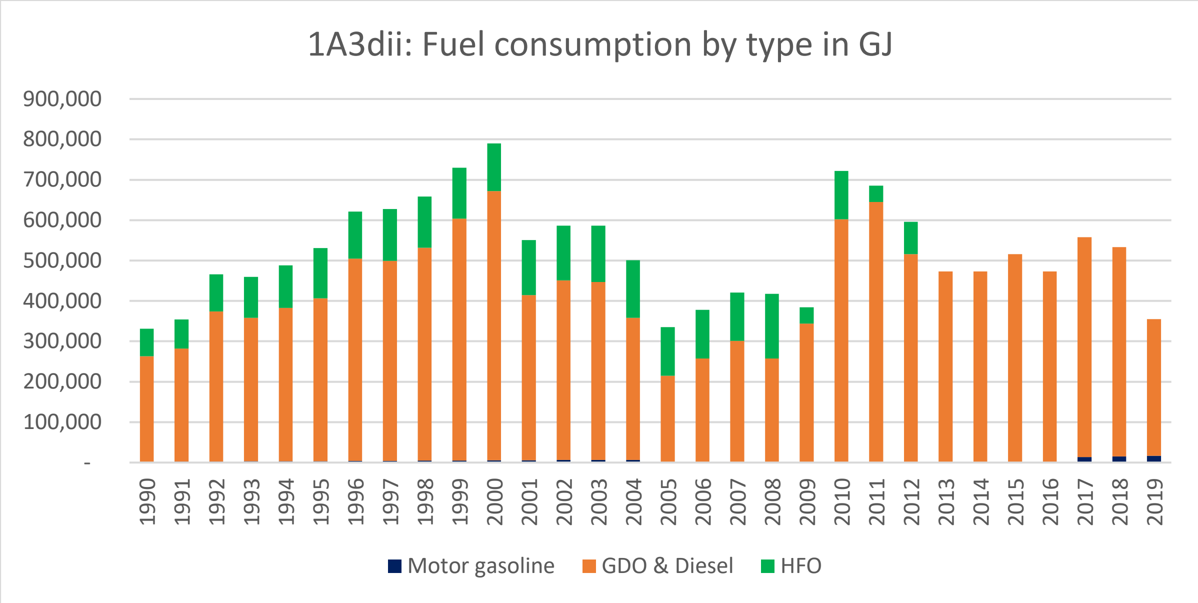

Figure 33: 1A3DII FUEL CONSUMPTION BY TYPE IN GJ

The split between recreational crafts and the Gozo Channel ferry can be visualised in the figure below. Fuel consumption data was not available for the Gozo Channel ferry prior to 2002. Hence, the average proportions of GDO & Diesel used for recreational crafts and the Gozo Channel ferry from 2002-2006, were applied from 1990-2001. From 2002 onwards, the total fuel from the Gozo Channel ferry was provided by the Gozo Channel Operations Ltd. The fuel used by recreational crafts was obtained by subtracting the fuel reported by Gozo Channel from the total fuel reported under Eurostat.

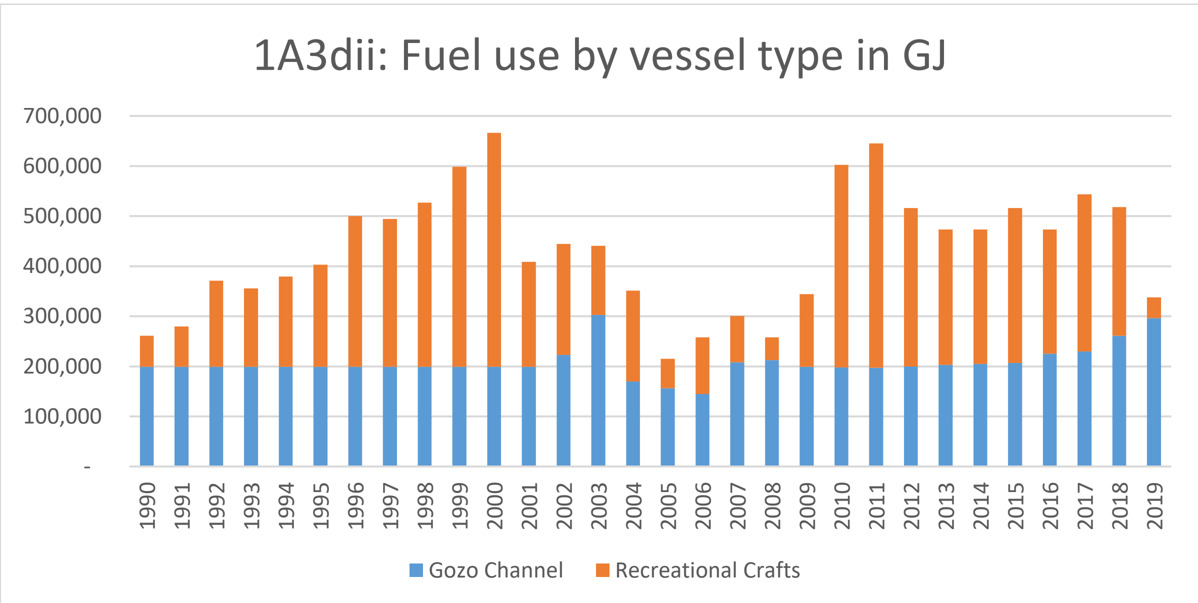

Figure 34: 1A3DII FUEL USE BY VESSEL TYPE IN GJ

Concerning projections, the projected fuel data provided by EWA in 2019 was utilized. This data did not differentiate between the Gozo Channel ferry and recreational crafts. To identify the specific fuel consumption for these two vessel types, under the WM scenario, the mean proportion of fuel consumed by the Gozo Channel ferry and the recreational crafts from 2015-2019 was carried forward for the projected years 2021-2030. To calculate emissions from the WaM scenario, the fuel used for recreational crafts under the WM scenario was assumed to be equal to that in the WaM scenario, since no policy measures addressed a change in fuel usage from recreational crafts. The fuel used for recreational crafts was then subtracted from the total GDO & Diesel used, to obtain the total fuel used by the Gozo Channel and the fast ferry. Concerning 2020 data, the projected fuel under the WaM scenario, as provided by EWA, originally included fuel used by the fast ferry. However, the fast ferry will commence operations after 2020. Therefore, the projected fuel was corrected, by omitting fuel used by the fast ferry.

The main difference between the WM and WAM scenarios is shown in the table below:

Table 9: NATIONAL NAVIGATION (WM AND WAM SCENARIOS)

Activity	WM	WAM
Recreational crafts	Same amount of fuel for both scenarios	
Gozo channel ferry	3 Gozo Channel ferries in operation	1 fast ferry in operation from 2021 till 2026 Reduced operation of the Gozo Channel ferry service as from 2027 (1 Gozo Channel ferry)

The introduction of the fast ferry will result in increased fuel consumption in the WAM scenario, as observed in the Figure below, but this will last only for the duration of its operation, i.e. from 2021 to 2026.

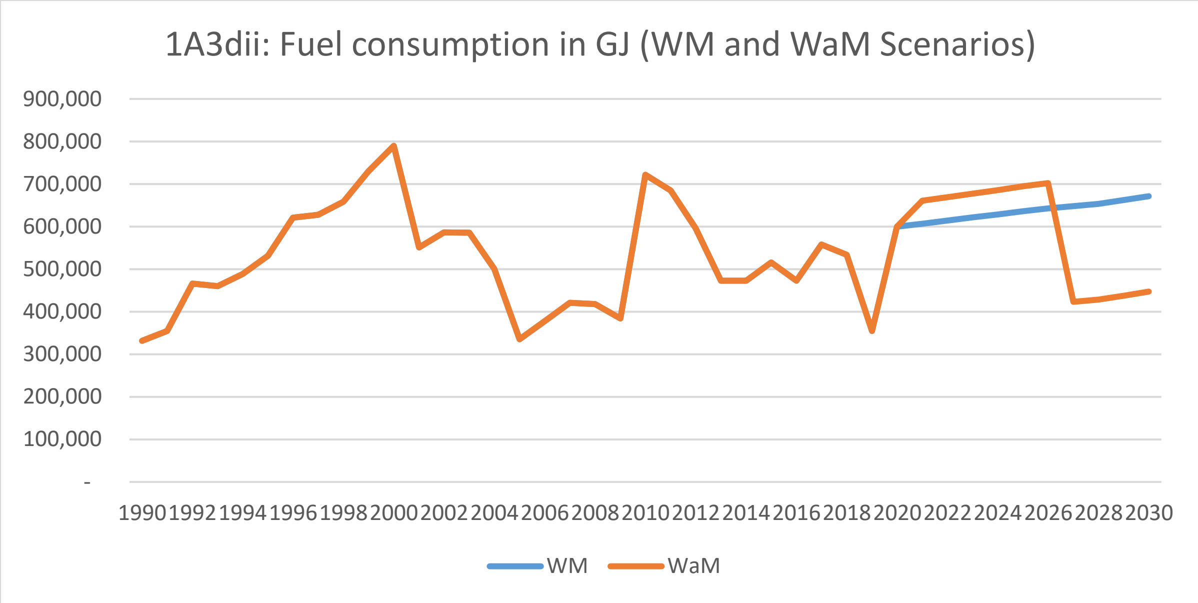

Figure 35: 1A3DII NATIONAL NAVIGATION FUEL CONSUMPTION IN GJ (WM and WAM SCENARIOS)

The operation of the Malta to Gozo tunnel in 2027, will lead to the termination of the fast ferry service, and a reduction in the activity of the Gozo Channel ferry. Therefore, the projected fuel consumption in the WaM scenario is expected to decrease significantly.

The graphs below show that the overall trend of main pollutants across the time series. NO_x, SO_x, and $PM_{2.5}$ tends to follow the general fuel consumption trend. However, the Figure below shows how, unlike other pollutants, nmVOC is heavily influenced by consumption of motor gasoline in particular. The quantities of motor gasoline used is much lower than GDO & Diesel. However, motor gasoline has a much higher EF than the other fuels, and therefore even a moderate increase in the quantity of motor gasoline will result in a considerable nmVOC emission increase. The historical data reported by the Eurostat Energy Balance shows an absence of motor gasoline from 2005 until 2016, which greatly decreases nmVOC emissions.

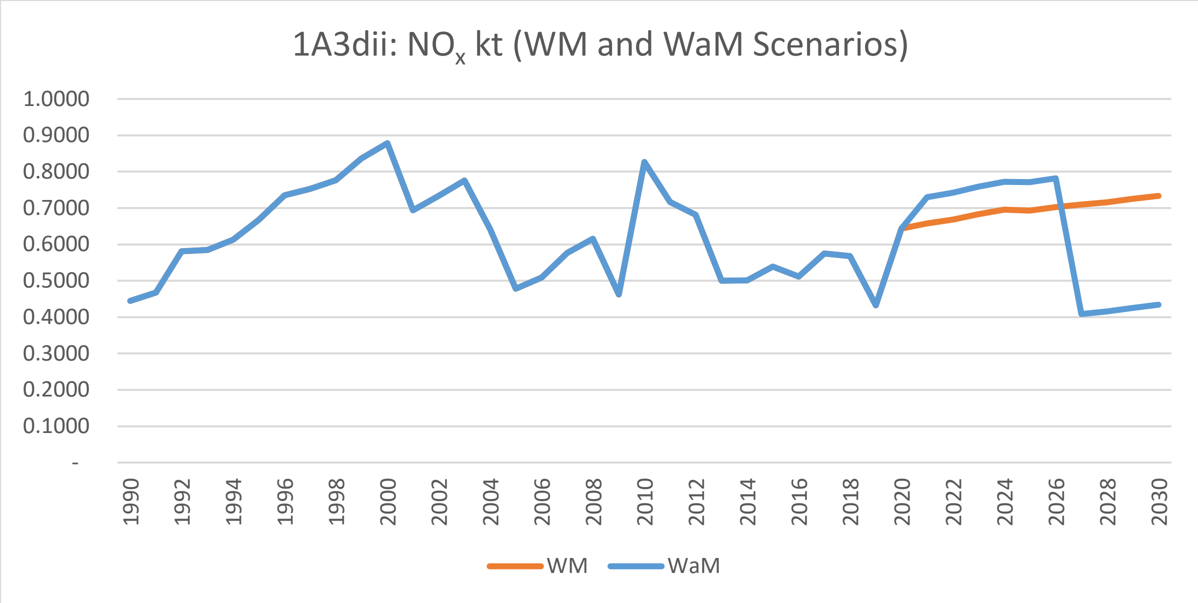

Figure 36: 1A3DII: NOX (AS NO2) IN KT (WM AND WAM SCENARIOS)

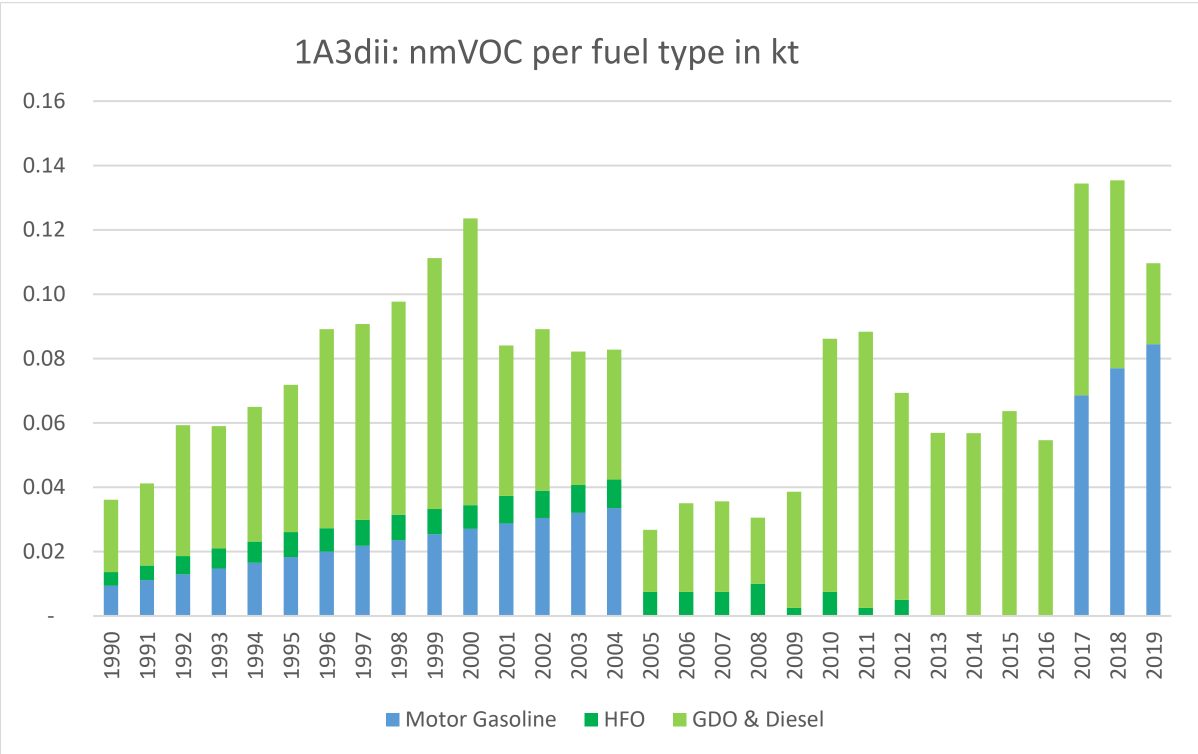

Figure 37: 1A3DII: NMVOC PER FUEL TYPE IN KT

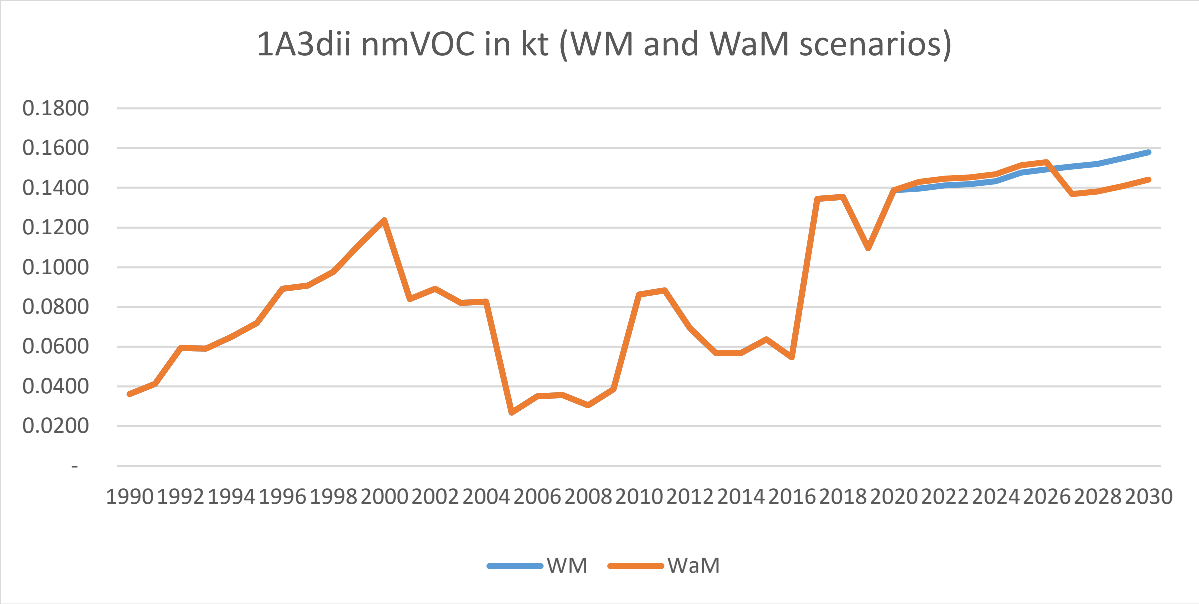

Figure 38: 1A3DII NMVOC IN KT (WM AND WAM SCENARIOS)

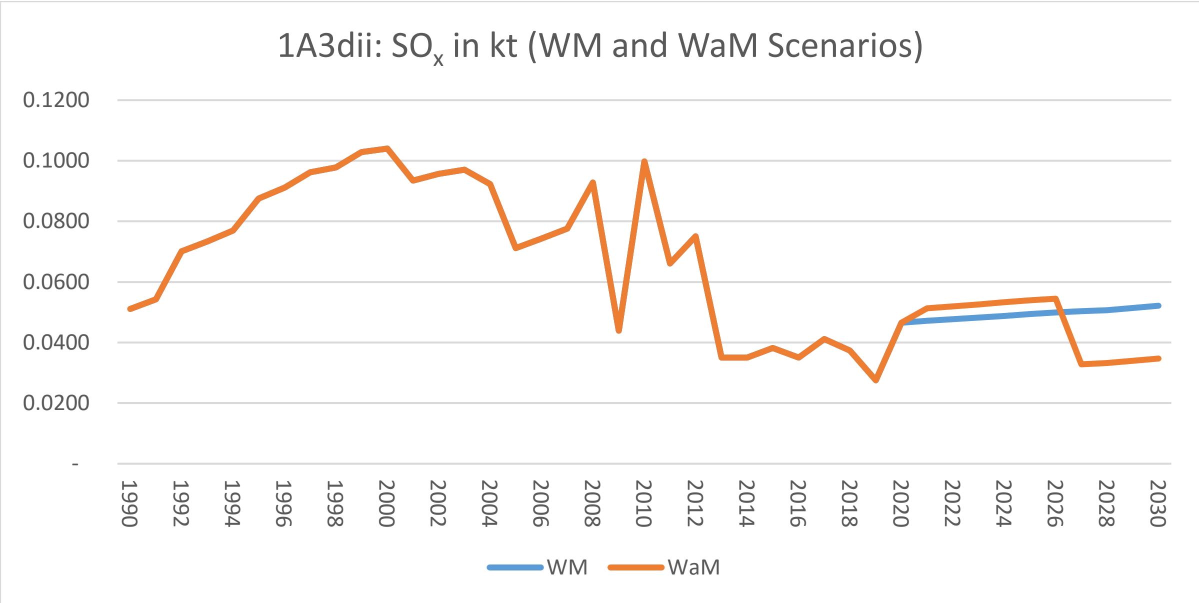

Figure 39: 1A3DII SO_X IN KT (WM AND WAM SCENARIOS)

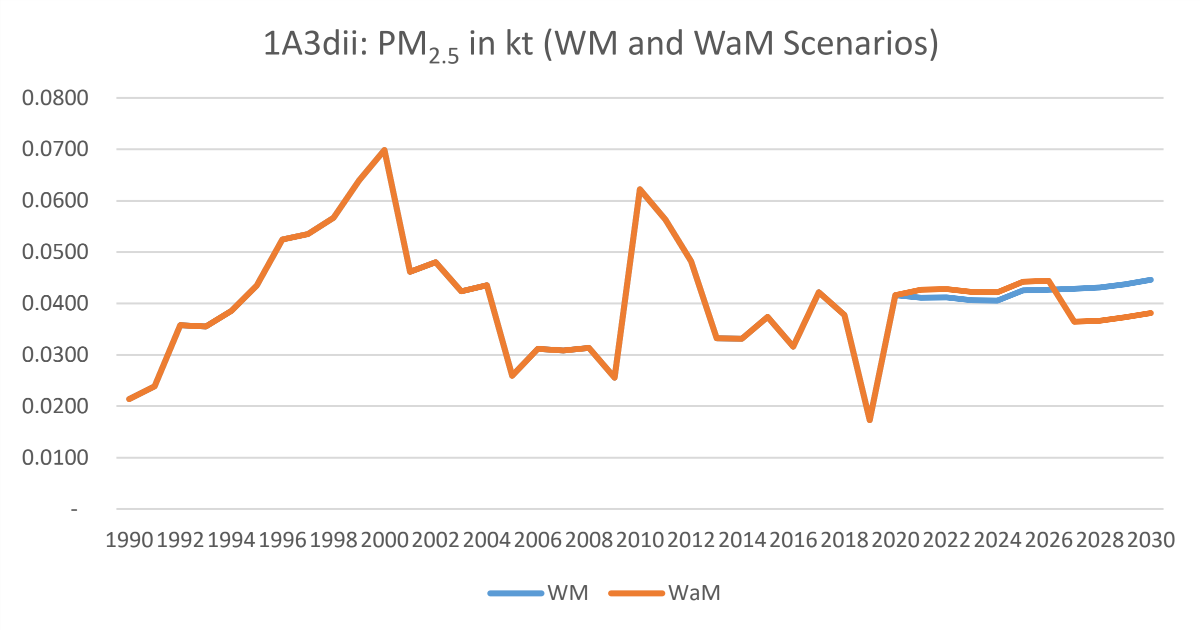

Figure 40: 1A3DII $PM_{2.5}$ IN KT (WM AND WAM SCENARIOS)

1A4ai: Commercial/Institutional: Stationary

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1.A.4.ai	Commercial/institutional: Stationary	2019GB	Eurostat	Tier 1 & 2	NO_x, SO_x, BC, As, Ni, benzo(a)pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene	2021 Submission

Emissions from 'Commercial/institutional: Stationary', and 'Commercial/institutional: Mobile' were reported under group sector 1A.4.ai. Estimates were calculated for the entire time series, i.e. 1990 to 2019 and projected for 2020, 2025 and 2030.

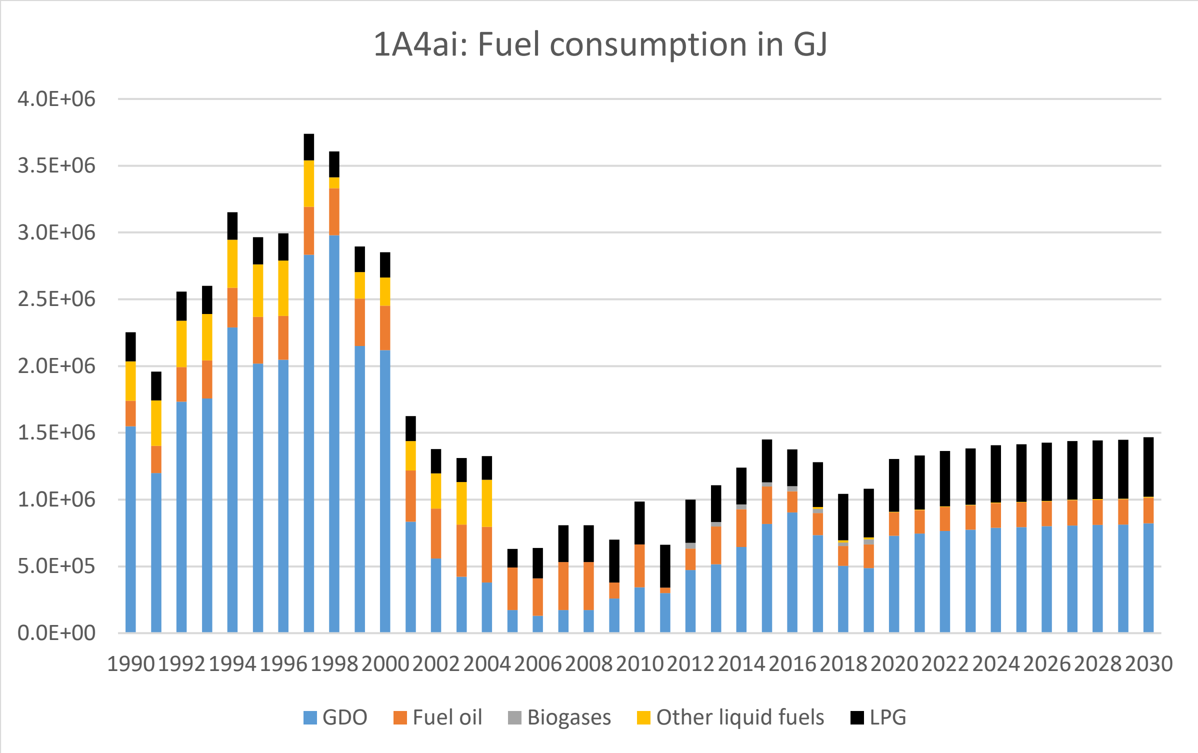

Figure 41: 1A4AI FUEL CONSUMPTION IN GJ

The activity data for estimating historical emissions (1990–2019) was changed in the previous submission. The fuel consumption reported as 'Commercial' within the Eurostat Energy Balance (as observed in the Figure above) is now being used instead of the EWA/NSO fuel survey. The fuel reported for this activity was LPG, motor gasoline, kerosene, gas oil and diesel oil (GDO), fuel oil, and biogas. The sulphur content of gas oil and diesel oil for 2014-2019 was provided by REWS. The average sulphur content for 2014-2019 was then applied to previous years. All the other emission factors were obtained from the 2019GB.

Projected data was supplied by the Energy & Water Agency (EWA) in 2019, as fuel use in Commercial & public services, for the period 2020-2030.

The graphs below show the historical trends and projected emissions for the main key categories. While both NO_x and $PM_{2.5}$ follow the fuel trend, SO_x shows a different trend to that of fuel consumption between the years 2014-2019. The reason for this difference is attributed to the variation of sulphur content in gas oil and diesel oil.

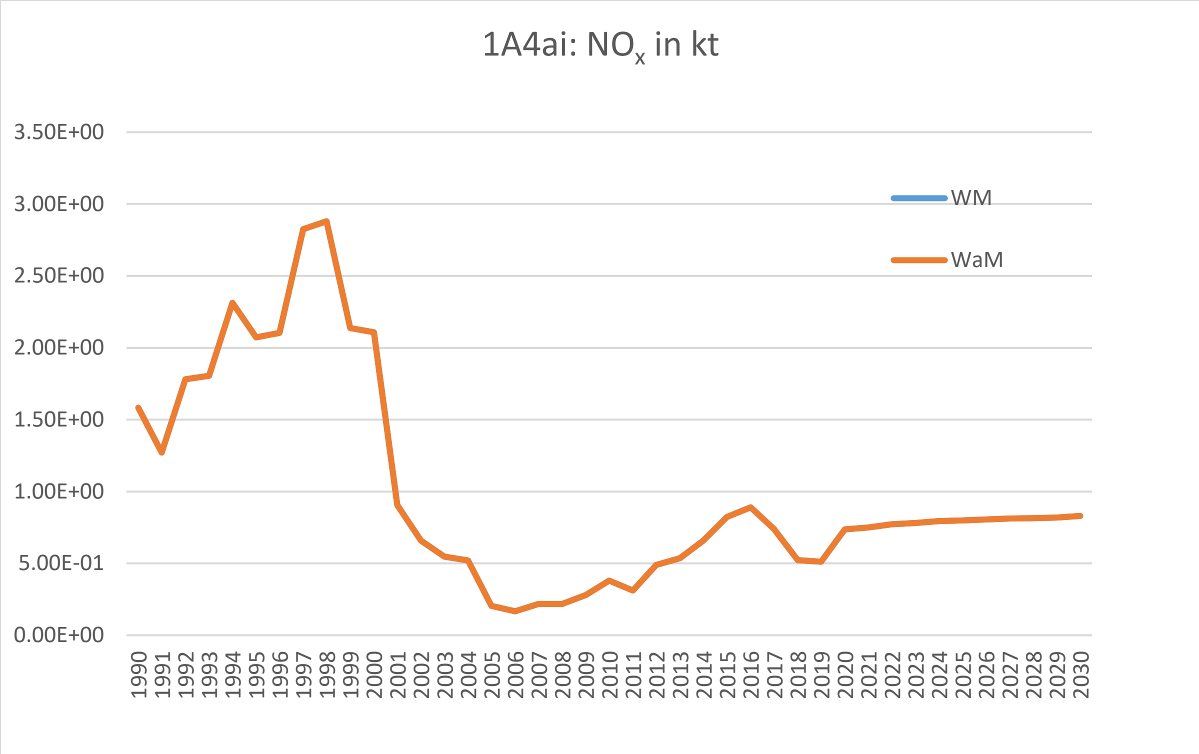

Figure 42: 1A4AI NO_X IN KT

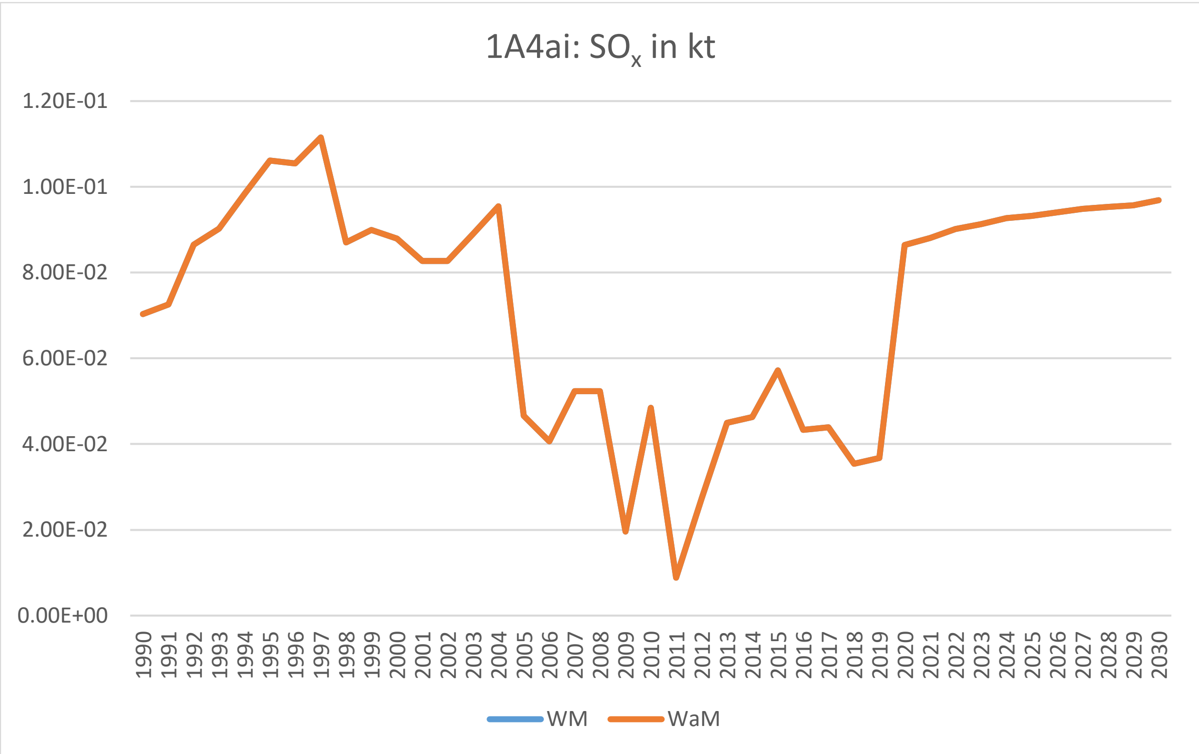

Figure 43: 1A4AI SO_X IN KT

1A4bi: Residential: Stationary

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1A4bi	Residential: Stationary	2019GB	Eurostat	Tier 1	$PM_{2.5}$, PM_{10}, Cd, Zn, Benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene	2021 Submission

Emissions from combustion in the residential sector were reported under NFR code 1A4bi. This sub-category includes emissions from small combustion activities, such as domestic internal heating.

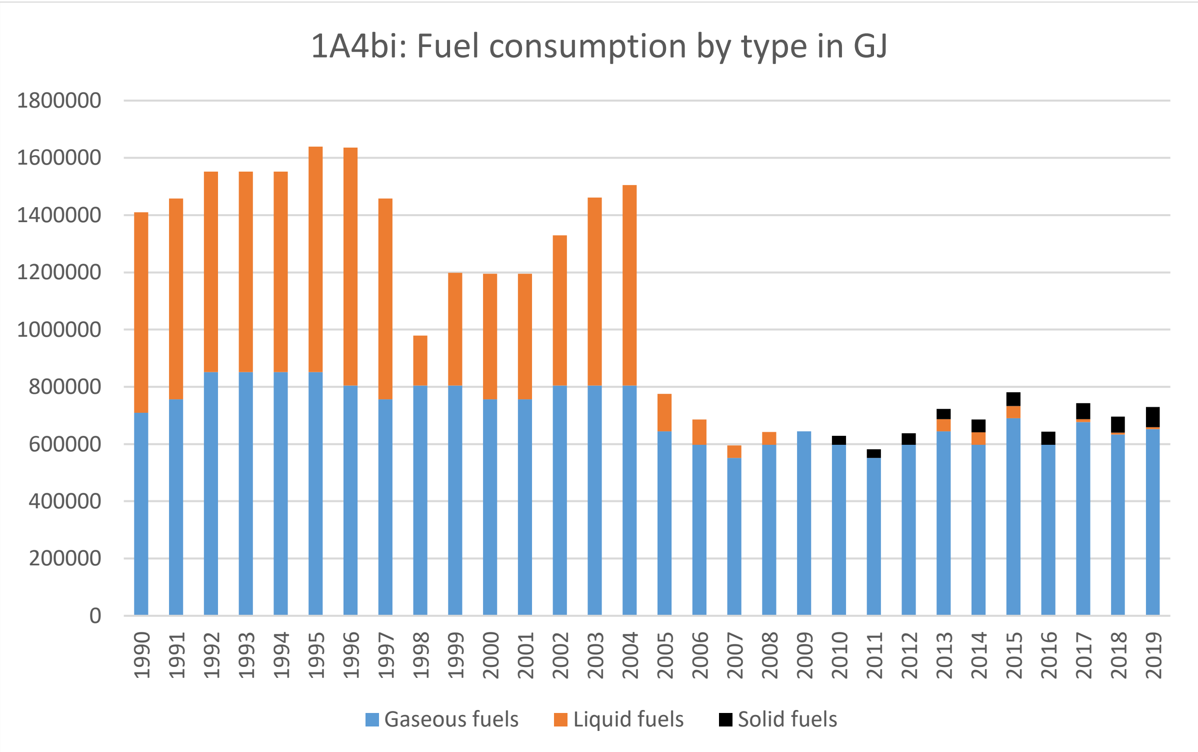

Figure 44: 1A4BI FUEL CONSUMPTION BY TYPE IN GJ

Emission estimates were calculated for the years 1990 to 2019 and projected for 2020, 2025 and 2030. The figure above shows the trend for the different types of fuels consumed across the time series.

The average sulphur content of liquid fuels from 2014 to 2019 was provided by REWS. The average sulphur content for the period 2014-2019 was then applied to previous years. All the other emission factors were obtained from the 2019GB.

Projected data was supplied by the Energy & Water Agency (EWA) in 2019, as fuel use in households for the period 2020-2030.

The figure below shows the trend for $PM_{2.5}$, for which this sector is a key category. The drastic emission increase from 2010 onwards coincides with an increase in the use of solid biofuels. The emissions from these biofuels were estimated by using the EF attributed to solid fuels. Efforts will be made in the future to obtain a more representative EF. No data on solid fuels is currently available pre-2010.

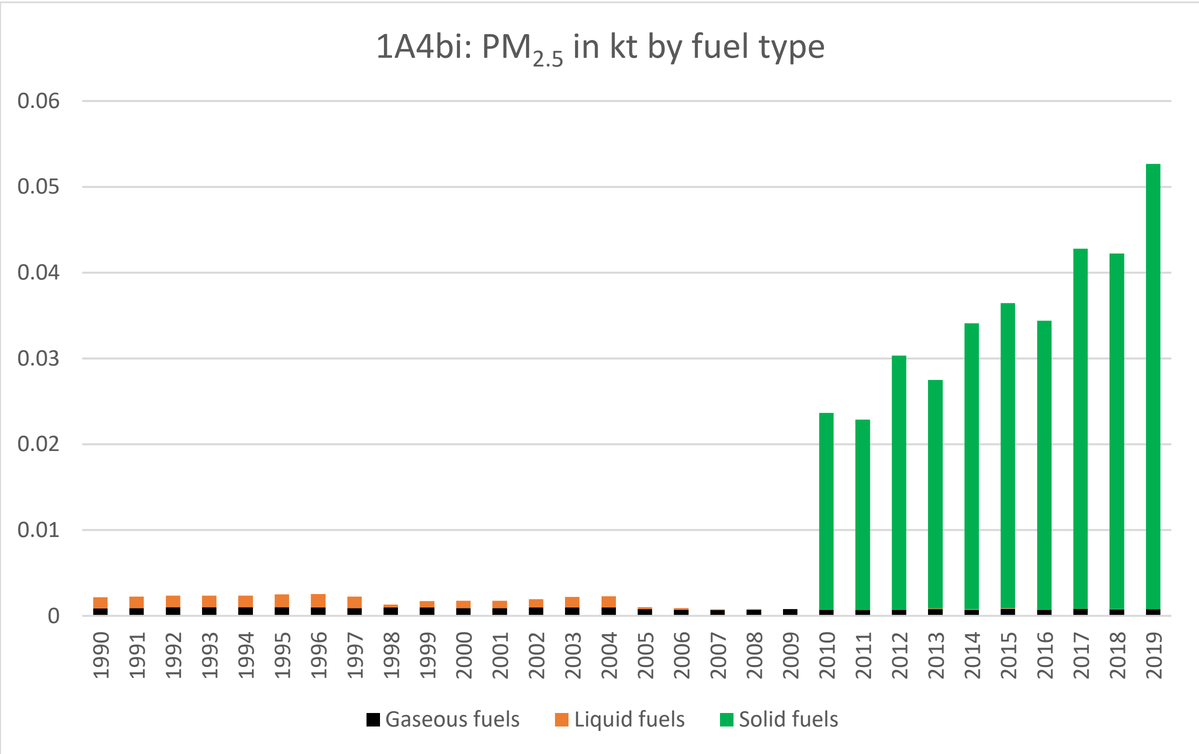

Figure 45: 1A4BI $PM_{2.5}$ IN KT BY FUEL TYPE

1A4cii: Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1.A.4cii	Off-road vehicles and other machinery	2019GB	Eurostat	Tier 1	NA	2021 submission

Estimates were calculated for the entire time series i.e. 1990 to 2019 and projected for 2020, 2025 and 2030. The activity data for estimating historical emissions (1990 – 2019) was changed in the previous submission. The fuel consumption reported as 'Agriculture and Forestry' within the Eurostat Energy Balance is now being used instead of the EWA/NSO fuel survey.

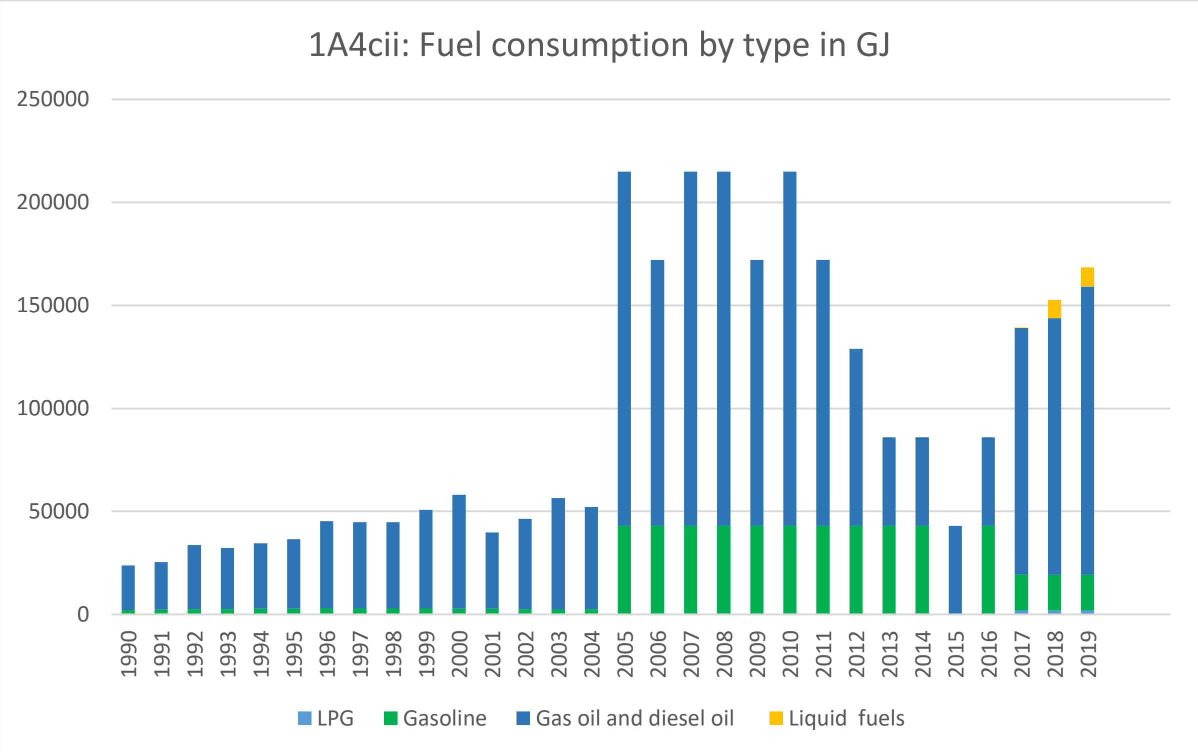

Figure 46: 1A4CII FUEL CONSUMPTION BY TYPE IN GJ

Projected data was supplied by the Energy & Water Agency (EWA) in 2019, as fuel use in Agriculture and Forestry for the period 2020-2030.

1A4ciii: Agriculture/Forestry/Fishing: National Fishing

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1.A.4ciii	National fishing	2019GB	Eurostat	Tier 1	Ni	2021 submission

Estimates were calculated for the entire time series i.e. 1990 to 2019 and projected for 2020, 2025 and 2030. The activity data for estimating historical emissions (1990–2019) was changed in the 2020 submission. The fuel consumption as reported as 'Fishing' within the Eurostat Energy Balance is now being used instead of the EWA/NSO fuel survey.

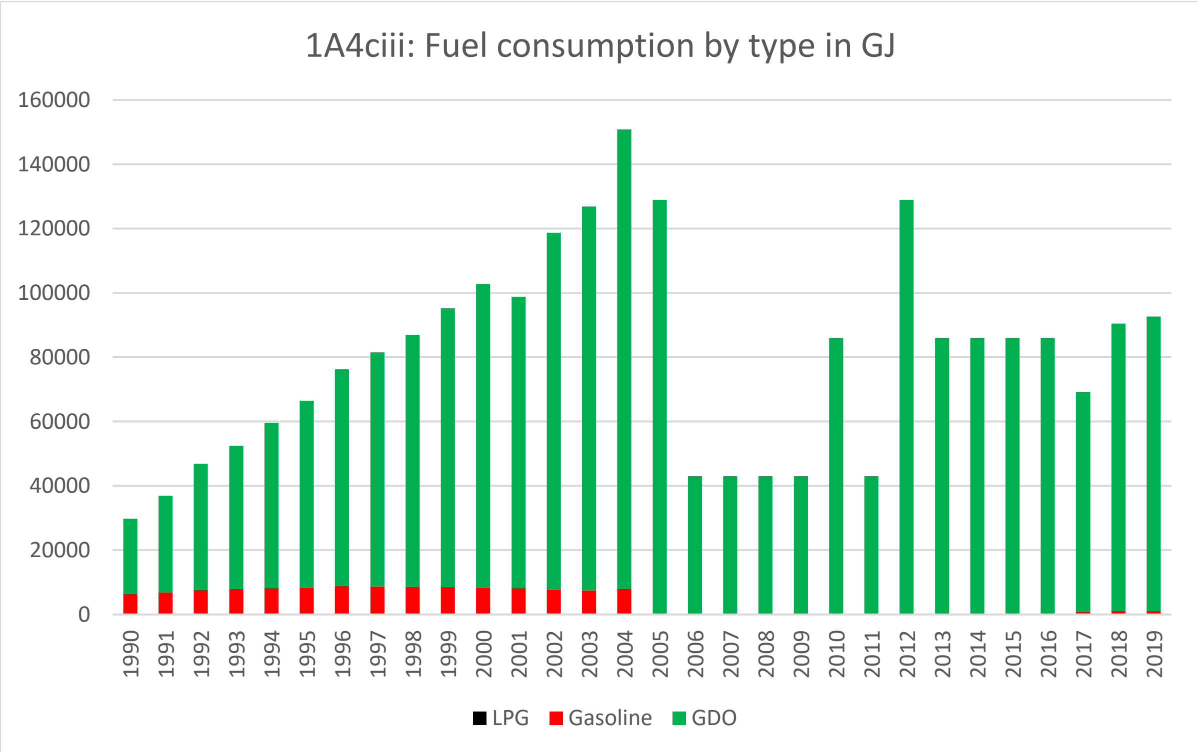

Figure 47: 1A4CIII FUEL CONSUMPTION BY TYPE IN TJ

Projected data was supplied by the Energy & Water Agency (EWA) in 2019, as fuel use in Fishing for the period 2020-2030. The Emission factors were obtained from the 2019GB.

1B2av: Distribution of Oil Products

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
1B2av	Distribution of oil products	2019GB	Eurostat	Tier 1	nmVOC	2021 Submission

Emissions estimated in this sector originated from the gross inland consumption of gasoline (gasoline without bio component and aviation gasoline) consumed locally. This activity data was obtained from Eurostat for 1990 to 2019, and the nmVOC emission factor was obtained from the 2019GB. This approach was suggested by TERT during the 2017 review. No projected values were available, and therefore the 2019 value was carried forward for the projected years 2020, 2025 and 2030.

This category is a key source for nmVOC and the graph below shows the emission profile across the historical and projected time series.

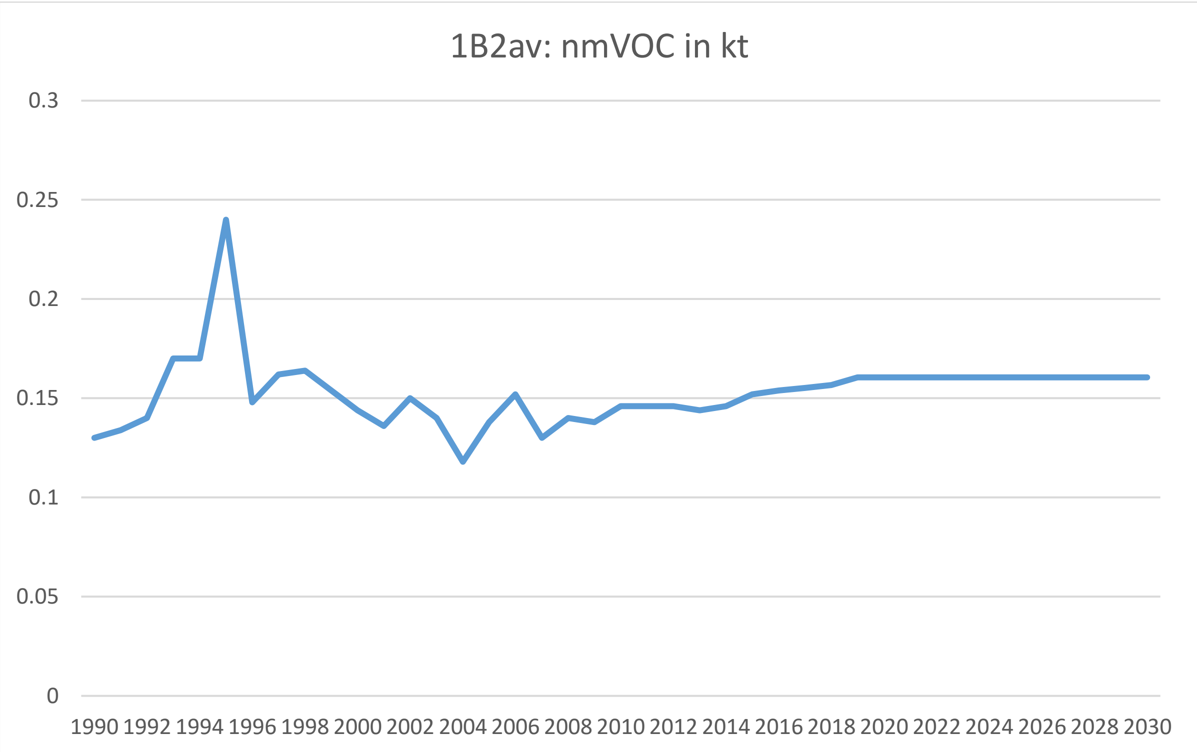

Figure 48: 1B2av nmVOC in kt

4. Industry (NFR 2)

This sector consists of categories generating fugitive or combustion emissions. The sub-categories estimated in this submission are listed below:

Table 10: NFR 2 ESTIMATED SECTORS

Aggregation	Sector	NFR code
Solvents	Domestic solvent use including fungicides	2D3a
	Other product use	2G
Industry	Storage, handling and transport of chemical products	2B10b
	Road paving with asphalt	2D3b
	Food and beverages industry	2H2

The notation key NO was used for the following sectors, as these sectors do not occur locally:

- 2A1 Cement production
- 2A2 Lime production
- 2A3 Glass production
- 2A5a Quarrying and mining of minerals other than coal
- 2A5c Storage, handling and transport of mineral products
- 2A6 Other mineral products (please specify in the IIR)
- 2B1 Ammonia production
- 2B2 Nitric acid production
- 2B3 Adipic acid production
- 2B5 Carbide production
- 2B6 Titanium dioxide production
- 2B7 Soda ash production
- 2B10a Chemical industry: Other (please specify in the IIR)
- 2C1 Iron and steel production
- 2C2 Ferroalloys production
- 2C3 Aluminium production
- 2C4 Magnesium production
- 2C5 Lead production

- 2C6 Zinc production
- 2C7a Copper production
- 2C7b Nickel production
- 2C7c Other metal production (please specify in the IIR)
- 2C7d Storage, handling and transport of metal products
- 2D3c Asphalt roofing
- 2H1 Pulp and paper industry
- 2H3 Other industrial processes (please specify in the IIR)
- 2I Wood processing
- 2J Production of POPs
- 2K Consumption of POPs and heavy metals
- 2L Other production, consumption, storage, transportation or handling of bulk products

The notation key NE was used for the following sectors, as no activity data was available:

- 2A5b Construction and demolition
- 2D3d Coating applications
- 2D3e Degreasing
- 2D3f Dry cleaning
- 2D3g Chemical products
- 2D3h Printing

The pollutants covered in this chapter are: NO_x, nmVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/ PCDF, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene.

Of these pollutants, this sector is a key category for nmVOC, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn.

The relevant pollutant trends for key categories, as well as the methodologies used are explained in the sections below:

2B10a: Storage, Handling and Transport of Chemical Products

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
2.B.10.a	Storage, handling and transport of chemical products	NA	NA	NA	NA	NA

This sector generates nmVOC emissions, which have been carried forward from previous submissions. Efforts will be made to update this sector in the future.

2D3a: Domestic Solvent Use Including Fungicides

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
2.D.3.a	Domestic solvent use including fungicides	2019GB	World Bank	Tier 1	nmVOC, Hg	2021 submission

Emissions from 'Domestic Solvent use including fungicides' were reported under group sector 2.D.3.a. Emissions estimated in this sector were calculated by multiplying the total population of the Maltese Islands with an emission factor for nmVOC (1.2kg/capita, 2019GB). This approach was suggested by the TERT during the 2017 review. Efforts are being made to improve on the current methodology.

The chart below shows the emission load for nmVOC across the time series:

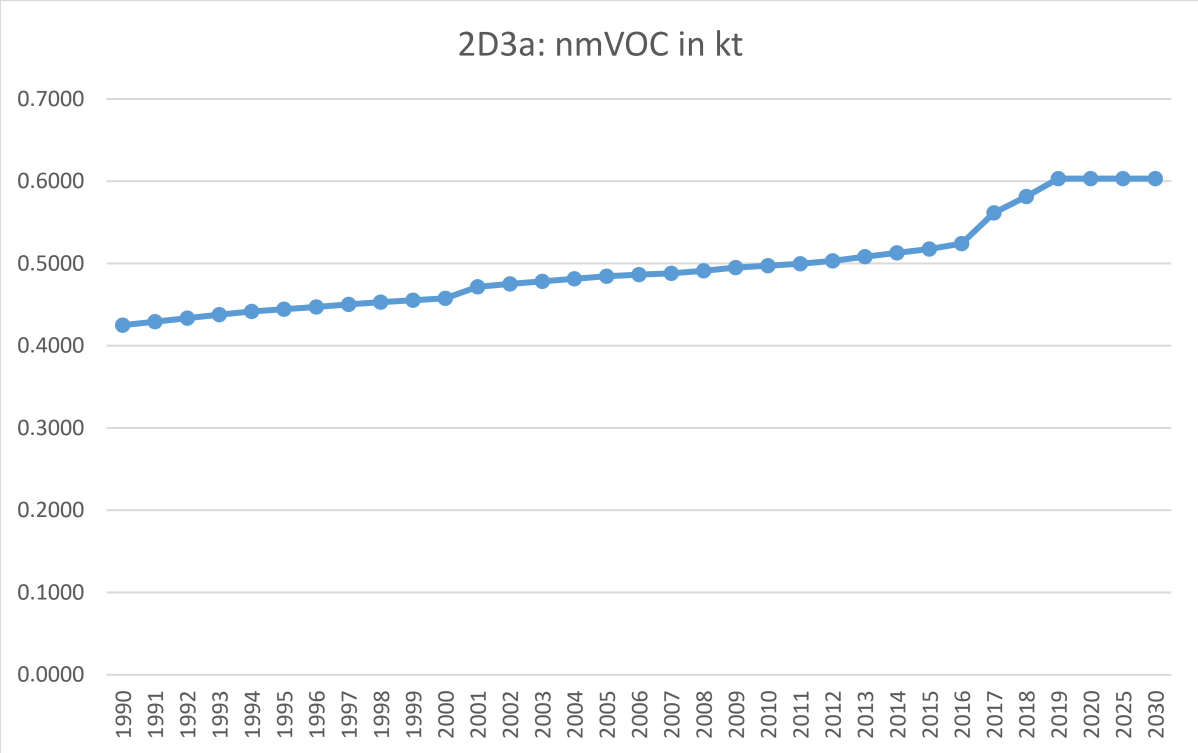

Figure 49: 2D3A NMVOC IN KT

Since no projected activity data was available, the 2019 value was carried forward for the projected years 2020, 2025, and 2030.

2D3b: Road Paving with Asphalt

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
2.D.3.b	Road paving with asphalt	2019GB	Transport Malta (2000-2010), Infrastructure Malta (2018-2019)	Tier 1	$PM_{2.5}$, PM_{10}, TSP	2021 submission

Emissions estimated in this sector originate from the asphalt utilised locally for road paving. This sector generates nmVOC, TSP, PM_{10}, $PM_{2.5}$ and BC emissions. Emissions of TSP, PM_{10}, $PM_{2.5}$, and BC were estimated for the first time in this submission.

Data for this sector for the years 2000 to 2010 was provided by Transport Malta. The 2010 activity data was then carried forward as a static value between 2011 and 2017, as activity data was not available for these years. Data for 2018 and 2019 was provided by Infrastructure Malta. The emission factor used to calculate emissions for all five pollutants mentioned above was taken from the 2019GB. No projected data was available, so the 2019 values were carried forward. Efforts are being made to update this sector.

The graph below shows the $PM_{2.5}$ trend in the time series:

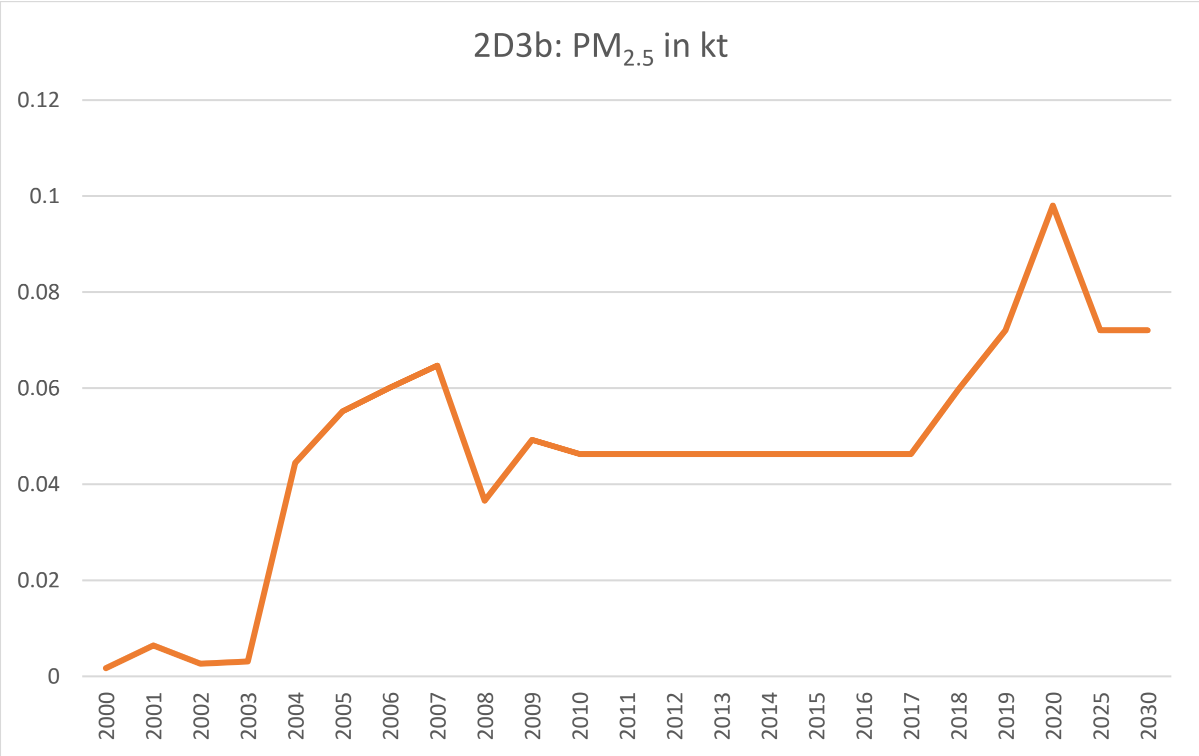

Figure 50: 2D3B $PM_{2.5}$ IN KT

2G. Other product use (NFR 2)

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
2G	Other product use; Use of fireworks, Tobacco combustion	Scientific paper by Camilleri. R and Vella (2016) and AFM (Fireworks) and 2019GB (Tobacco)	Armed forces of Malta (fireworks), and Eurostat (tobacco & fireworks)	Tier 2	$PM_{2.5}$, PM_{10}, BC, Pb, Cd, As	2021 Submission

Emissions from 'Use of fireworks' and 'Tobacco combustion' were reported collectively under sector 2G: Other Product Use. No projected activity data was available, and therefore the 2019 emission load was carried forward for 2020, 2025 and 2030.

1. Use of Fireworks

Fireworks are commonly let off during local village feasts. Most fireworks are manufactured locally by using raw materials, purchased from the Armed Forces of Malta. The rest are imported from foreign countries.

The data on imported fireworks and flares was obtained from Eurostat, rather than the NSO. Following communication with the NSO, it was established that the NSO provides general trade statistics, whereas Eurostat provides special trade statistics. The use of special trade statistics was preferred, as general trade statistics may include products that have not yet, and may not, be placed on the market. The total mass of materials used was calculated by subtracting the mass of exports by the total imports of the following CN codes:

- 36041000 (fireworks)
- 36049000 (Signalling flares, rain rockets, fog signals and other pyrotechnic articles (excl. fireworks and cartridge blanks)

Finally, the total mass of pyrotechnical products was multiplied by the EF provided within the 2019GB.

The amount of fireworks manufactured locally was not available. Hence, the amount of raw material used to manufacture them had to be used, and this was provided by the Armed Forces of Malta. This amount was then estimated through the methodology used within a national study by Camilleri and Vella (2016).

The data for potassium chlorate and potassium nitrate was available from 2011 to 2017. Data for previous years, and for 2018-2019, was extrapolated. Missing quantities for aluminium powder were replaced with a two-year annual average available in the study by Camilleri and Vella (2016), and this value was applied for the entire time series.

Table 11: ANNUAL AVERAGE OF IMPORTED OXIDANTS & FUELS IN FIREWORK MANUFACTURING FROM 2012-2014

Potassium Chlorate in kg	Q1	15050
Aluminium in kg	Q2	2035
Potassium Nitrate in kg	Q3	60325

The list of equations below was used to estimate quantities of flash crackers, coloured stars and black powder in Malta:

Table 12: CALCULATIONS AND ASSUMPTIONS FOR ESTIMATING THE YEARLY AVERAGE QUANTITIES OF FLASH CRACKERS, COLOURED STARS AND BLACK POWDER USED IN MALTA FROM 2012-2014

Type of firework	Equation to determine annual quantities in kg each firework type
Flash Crackers in kg	Q4=Q2/0.3
Flash Crackers in kg	Q4=Q2/0.3
OX used for flash comp in kg	Q5=0.7Q4
OX used for star comp in kg	Q6=Q1-Q5
OX used for red STARS in kg	Q7= Q6/3
OX used for blue STARS in kg	
OX used for green STARS in kg	
Red stars in kg	Q8=Q7/0.7
Blue stars in kg	Q9=Q7/0.65
Green stars in kg	Q10=Q7/0.833
Black Powder	Q11=Q3/0.75
OX used for flash comp in kg	Q5=0.7Q4
OX used for star comp in kg	Q6=Q1-Q5
OX used for red STARS in kg	Q7= Q6/3
OX used for blue STARS in kg	

OX used for green STARS in kg	Q8=Q7/0.7
Red stars in kg	Q9=Q7/0.65
Blue stars in kg	Q10=Q7/0.833
Green stars in kg	Q11=Q3/0.75

Once the total quantity of manufactured and imported fireworks was calculated, these were multiplied by the respective 2019GB EFs. The 2019 emissions estimates were assumed to remain the same in 2020, 2025 and 2030.

2. Tobacco Combustion

The methodology to estimate emissions from tobacco combustion was obtained from the 2019GB. The quantity of tobacco combusted locally was obtained from Eurostat, rather than the NSO. As with fireworks and flares, it was established that the NSO provides general trade statistics, whereas Eurostat provides special trade statistics. The use of special trade statistics was preferred, since general trade statistics may include products that have not yet, and may not, be placed on the market. The CN codes related to this activity were:

- 24022090 (cigarettes, containing tobacco (excl. containing cloves))
- 24021000 (cigars, cheroots and cigarillos containing tobacco)
- 24022000 (cigarettes containing tobacco)
- 24029000 (cigars, cheroots, cigarillos and cigarettes consisting wholly of tobacco substitutes).

The total amount of exports was subtracted from the imports, and the result was assumed to be equal to the amount of tobacco combusted locally. Emission factors from the 2019GB were used to estimate emissions. The 2019 emissions estimates were assumed to remain the same in 2020, 2025 and 2030.

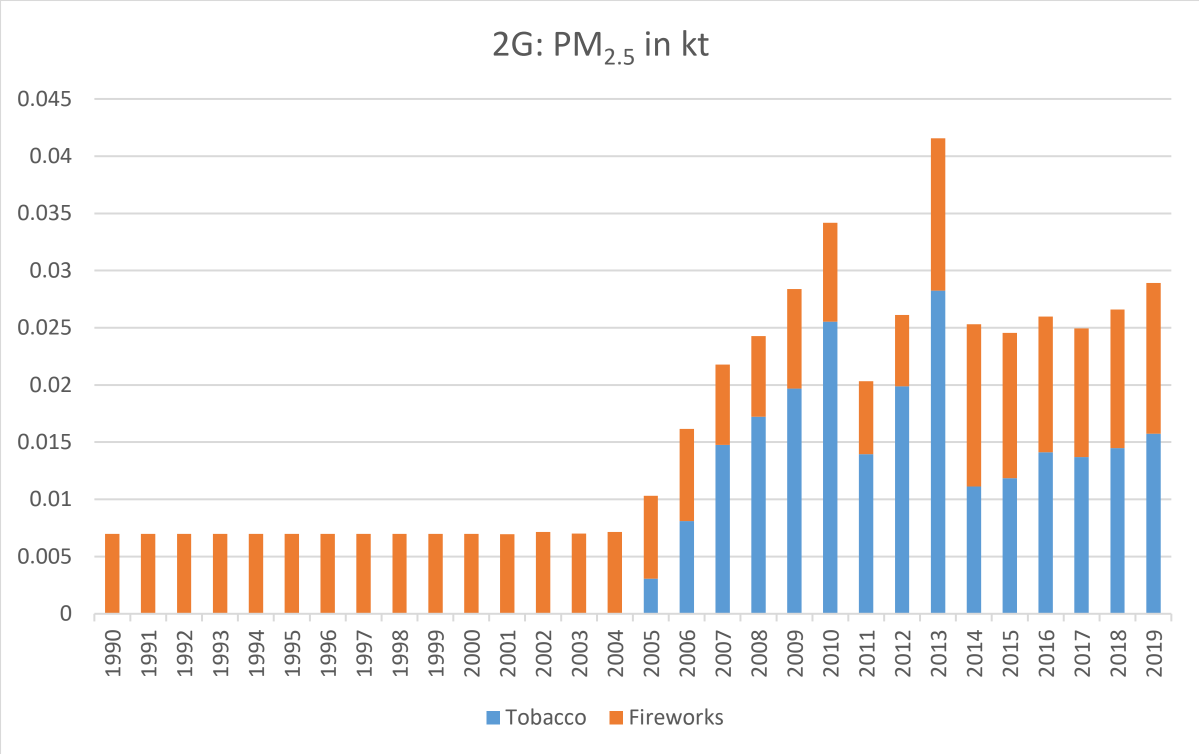

Figure 51: 2G $PM_{2.5}$ IN KT

2H2. Industrial Processes and Product Use (NFR 2)

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
2H2	Food & Beverages Industry	2019GB	NSO	Tier 2	nmVOC	2021 submission

The National Statistics Office provided most of the activity data, in particular:

- Production of home killed meat (1995-2019)
- Production of poultry meat (1995-2019)
- Total fish, and for seafood landed (1995-2019)
- Total production of compound feedstuffs for cattle, pigs, poultry and other animals (2003-2019)

The total mass of bread produced was not available. Hence, the total imported flour of common wheat and spelt and rye flour were used to calculate the mass. In this respect, data on flour was only available from 2004-2019. Previous communication with the Malta Bakers'

Cooperative had established that a sack of flour weighing 50kg would produce approximately 100 loaves. In turn, each baked loaf weighs around 540g. The calculation can be visualised below:

First, the weight of flour per loaf was calculated:

$$1\ sack = \frac{50kg\ of\ flour}{100\ loaves} = 500g\ of\ flour\ per\ loaf$$

Equation 4: EQUATION TO CALCULATE THE WEIGHT OF FLOUR PER LOAF

Then, the number of loaves was calculated:

$$Number\ of\ loaves = \frac{x\ kg\ of\ flour}{500g\ of\ flour}$$

Equation 5: EQUATION TO CALCULATE THE NUMBER OF LOAVES

Finally, the mass of bread was calculated:

$$Mass\ of\ bread\ produced = number\ of\ loaves * 540g\ (mass\ per\ loaf)$$

Equation 6: EQUATION TO CALCULATE THE MASS PER LOAF

Concerning beverages, no information was available on the amount of beer produced locally due to the confidentiality of the activity data. However, the volume of wine produced in wineries from 2004-2019, was also provided by the NSO. The wine production prior to 2004 was extrapolated through a 5 year moving average.

The data used in missing years, for all categories, was extrapolated by using a moving average. The chart below shows the trend for nmVOC from 1990 until 2019. The main two sources of emissions are the production of production of bread and the production of animal feed. Animal feed production emissions have steadily increased during the time series, yet emissions from bread production have increased since 2006. As a result, the total emissions from the food & beverage sector have increased slightly since the last submission.

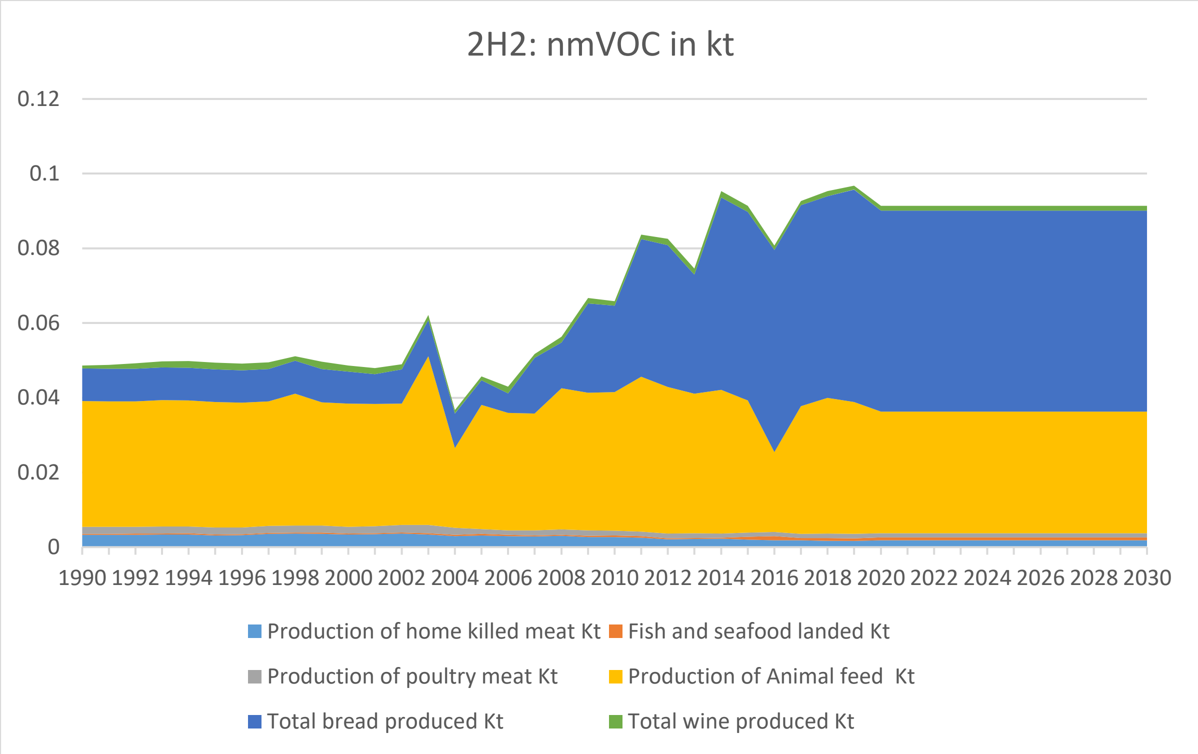

Figure 52: 2H2 NMVOC IN KT

No projected data was available for the years 2020-2030. A relationship was sought between historical data and past GDP and population data; however, there was no relationship between the food and beverage sector, and either one of these variables. Since there was a significant variability in the activity data, an average emission from 2015-2019 was carried forward for the projections.

5. Agriculture (NFR 3)

The agricultural chapter (NFR 3) includes emissions from sub-chapters:

- 3B Manure Management
- 3D Crop production and agricultural soils
- 3F Field burning of agricultural residues.

The annotation key 'NE' was assigned to sub-chapter 3Df Pesticides, as no activity data was available. Sector 3I Agriculture other was classified as 'NO', since no activity takes place locally. The table below provides a breakdown of the sectors covered:

Table 13: NFR 3 ESTIMATED SECTORS

Aggregation	Sector	NFR code
AgriLivestock	Manure management - Dairy cattle	3B1a
	Manure management - Non-dairy cattle	3B1b
	Manure management - Sheep	3B2
	Manure management - Swine	3B3
	Manure management - Goats	3B4d
	Manure management - Horses	3B4e
	Manure management - Laying hens	3B4gi
	Manure management - Broilers	3B4gii
	Manure management - Other poultry	3B4giv
	Manure management - Other animals (please specify in the IIR)	3B4h
AgriOther	Inorganic N-fertilizers (includes also urea application)	3Da1
	Animal manure applied to soils	3Da2a
	Farm-level agricultural operations including storage, handling and transport of agricultural products	3Dc
	Cultivated crops	3De
	Field burning of agricultural residues	3F

The pollutants covered in this sector are NO_x, nmVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO. Of these pollutants, the agricultural sector is a key category for nmVOC, NH_3 and PM_{10}. The relevant pollutant trends for key categories, as well as the methodologies used, are explained in the sections below.

3B: Manure Management

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
3B1a, 3B1b, 3B2,3B3,3B4d, 3B4e,3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h	AgriLivestock	2019GB	NSO	Tier 1, 2	nmVOC, NH_3, PM_{10}	2021 submission

NH_3 emissions from sub-chapter 3B were recalculated through the Manure Management N-flow tool, as provided within the 2019GB. The previous submission also made use of the Tier 2 N-flow tool, however, the EFs for this chapter have been updated due to the IPCC 2019 refinement. A number of comparative graphs are presented later in this section, to explain the effect of these recalculations.

The notation key NO was provided for the following categories: 3B4a 'Buffalo', 3B4f 'Mules and Asses', and 3B4giii 'Turkeys', since there was no activity data. The graph below shows a decreasing trend in NH_3 emissions across the time series, because of a decrease in livestock numbers (AAP).

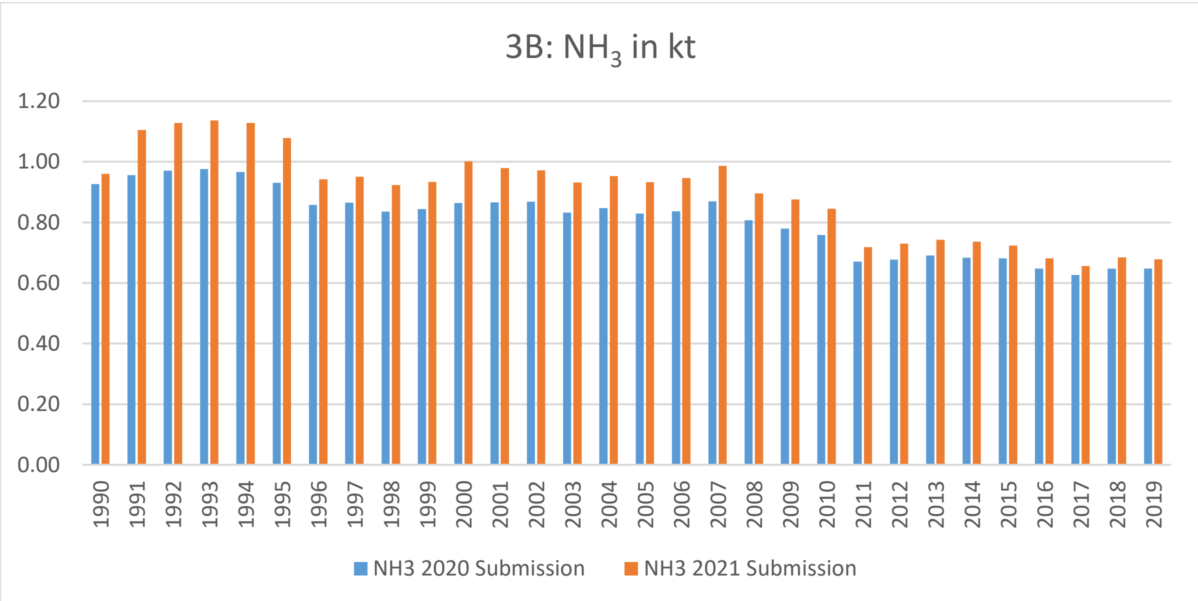

Figure 53: 3B NH_3 IN KT

The number of animal heads was provided by the NSO and is in line with the climate change (MRA) model. The data for livestock was more detailed than that requested by the 2019GB. Non-dairy cattle, sheep, and swine were further subdivided into different categories. The total number of non-dairy cattle and sheep was obtained by summing up the different sub-categories. However, swine have a different EF according to whether they are classified as either sows, or fattening pigs. Therefore, the different sub-categories had to be classified as pertaining to either one of these classifications. The table below shows how these sub-categories were assigned to sows and fattening pigs respectively.

Table 14: SWINE CLASSIFICATION - SOWS AND FATTENING PIGS

Sows	Fattening pigs
• Piglets <20kgs • Breeding females - breeding sows	• Young pigs 20-50kgs • Fattening pigs>50kgs • Breeding females – gilts • Breeding boars

The animal weight for cattle, sheep, swine, horses, and goats was provided by Koperattiva Produtturi tal-Ħalib (KPH). The default weight as provided in the 2019GB was used for the other livestock categories.

The Malta Resources Authority and the Environment and Resources Authority, make use of data originating from the following institutions:

- National Statistics Office for the number of animal heads, and the total cow and milk produced
- Malta Dairy Products (MDP) provides the cow milk fat content (%)
- The KPH (Milk breeders' co-operative) provides the animal weight for cattle, sheep, goats, and the protein content (%) in the feed
- The Pig Breeders Co-operative provides the animal weight for swine
- Agricultural Department provides the proportion of solid/slurry that is either stored or spread, and the proportion of housed livestock

The table below shows country-specific activity data for animal weight, compared with the default factors in the EEA Guidebook. A weighted average was used to calculate the average weight of non-dairy cattle, sheep, swine (finishing pigs), and swine (sows), as each of these livestock types was further subdivided into livestock categories.

Table 15: ANIMAL WEIGHT PER LIVESTOCK TYPE

Livestock type	MT: Animal weight (kg)	2019GB: Animal weight (kg)	Source
Dairy cattle	550	600	KPH (Milk breeders co-operative)
Non-dairy cattle	510.5	340	KPH (Milk breeders co-operative)
Non-dairy cattle (calves)	200	150	KPH (Milk breeders co-operative)
Sheep	48	50	KPH (Milk breeders co-operative)
Swine (finishing pigs)	59.6	65	Pig Breeders Co-operative
Swine (sows)	60.4	225	Pig Breeders Co-operative
Goats	35	50	KPH (Milk breeders co-operative)
Horses	550	500	EEA Guidebook
Laying hens	2.2	2.2	EEA Guidebook
Broilers	1	1	EEA Guidebook
Other poultry	3.5	3.5	EEA Guidebook
Other animals (fur animals)	1.6	1.6	EEA Guidebook

Following communication with the Agricultural Directorate, it was assumed that according to S.L. 549.66 all animal holdings and passageways are to be covered at all times, indicating that livestock is constantly kept under housing. However, 9% of beef cattle, and 35% of sheep and goats, are exempt from the regulation, and are thus kept in yards. Hence, the total housing period is assumed to be 365 days for all livestock types. Nevertheless, the proportion of manure excreted in yards is modified to reflect the local situation. The parameters used can be observed in the two tables below:

Table 16: HOUSING PERIOD PER LIVESTOCK TYPE

Livestock type	MT: Housing period (days)	2019GB: Housed period (days)	MT source
Dairy cattle	365	180	Agricultural Department
Non-dairy cattle	365	180	Agricultural Department
Sheep	365	30	Agricultural Department
Swine (finishing pigs)	365	365	Agricultural Department
Swine (sows)	365	365	Agricultural Department
Goats	365	30	Agricultural Department
Horses	365	180	Agricultural Department
Laying hens	365	365	Agricultural Department
Broilers	365	365	Agricultural Department
Other poultry	365	365	Agricultural Department
Other animals (fur animals)	365	365	Agricultural Department

Table 17: PROPORTION OF MANURE EXCRETED ON YARDS

Livestock type	MT: Proportion excreted on yards	2019GB: Proportion excreted on yards	MT source
Dairy cattle	0	0.25	Agricultural Department
Non-dairy cattle	0.09	0.1	Agricultural Department
Sheep	0.35	0.02	Agricultural Department
Swine (finishing pigs)	0	0	Agricultural Department
Swine (sows)	0	0	Agricultural Department
Goats	0.35	0	Agricultural Department
Horses	0	0	Agricultural Department
Laying hens	0	0	Agricultural Department
Broilers	0	0	Agricultural Department
Other poultry	0	0	Agricultural Department

Other animals (fur animals)	0	0	Agricultural Department

Moreover, the manure type produced per livestock type was determined following consultation with the Department of Agriculture and is shown below:

Table 18: PROPORTION OF MANURE TYPE BY LIVESTOCK

Livestock	Manure type	Proportion by manure type
Cattle	solid	50%
	slurry	50%
Fattening pigs	solid	5%
	slurry	95%
Sows	solid	5%
	slurry	95%
	outdoor	N/A
Layers	(Semi) solid	100%

In this submission, the Nitrogen excretion rates (Nex) were updated according to the 2019 revision of the 2006 IPCC guidelines. The table below compares the Nex values (2020 submission) and the revised data (2021 submission). The local values for Nex of 0.87kg N/place, were taken from the Sustech (2008) report for laying hens, as with previous submissions. Nex for broilers was previously obtained from this local study, but the value is now obtained from the IPCC guidelines (2019). The Sustech report provided a large value range, whereas the IPCC provided a set value, and thus the IPCC value was deemed more appropriate.

The update in Nex rates included a noticeable decrease for the sheep and goats categories. Furthermore, major differences are also noticeable for non-dairy cattle and swine. The effect of these updated values will be observed in the reported emissions for manure management later in this chapter. The changes in Nex values can be observed in the table below:

Table 19: NITROGEN EXCRETION BY MASS OF ANIMAL

Animal type	Unit	2020 submission	2021 submission
Dairy cattle	kg N/1000 kg animal mass day-1	0.48	0.5
Non-dairy cattle	kg N/1000 kg animal mass day-1	0.33	0.42
Non-dairy cattle (calves)	kg N/1000 kg animal mass day-1	0.33	0.42
Sheep	kg N/1000 kg animal mass day-1	0.85	0.36
Swine (finishing pigs)	kg N/1000 kg animal mass day-1	0.51	0.76
Swine (sows)	kg N/1000 kg animal mass day-1	0.42	0.38
Goats	kg N/1000 kg animal mass day-1	1.28	0.46
Horses	kg N/1000 kg animal mass day-1	0.26	0.26
Laying hens	kg N/1000 kg animal mass day-1	0.87	1.08
Broilers	kg N/1000 kg animal mass day-1	1.1	1.1
Other poultry	kg N/1000 kg animal mass day-1	0.83	0.83
Other animals (rabbits)	kg N/1000 kg animal mass day-1	13.87	13.87

The proportions of solid manure and slurry that are stored, or spread are provided by the Agricultural Department. The proportion of manure diverted to the anaerobic digester is not known, so it is assumed to be 0. All slurry is assumed to be stored, since slurry spreading is prohibited under S.L. 549.66. Concerning solid manure, S.L. 549.66 states that manure has to be stored between the 16th October and the 14th of March, and that manure can be applied from the 15th of March till the 15th of October. Hence, manure is stored for 5 months a year (41.7%), and spread for 7 months a year (58.3%).

A breakdown of the key source categories for this chapter is displayed in the table below:

Table 20: BREAKDOWN OF KEY CATEGORIES IN THE AGRICULTURE SECTOR

nmVOC	3B1a	Manure management - Dairy cattle
	3B4gii	Manure management - Broilers
NH_3	3Da2a	Animal manure applied to soils
	3B3	Manure management - Swine

	3B4h	Manure management - Other animals (rabbits)
	3B1a	Manure management - Dairy cattle
	3B1b	Manure management - Non-dairy cattle

The graphs below show the trend of emissions for each key source:

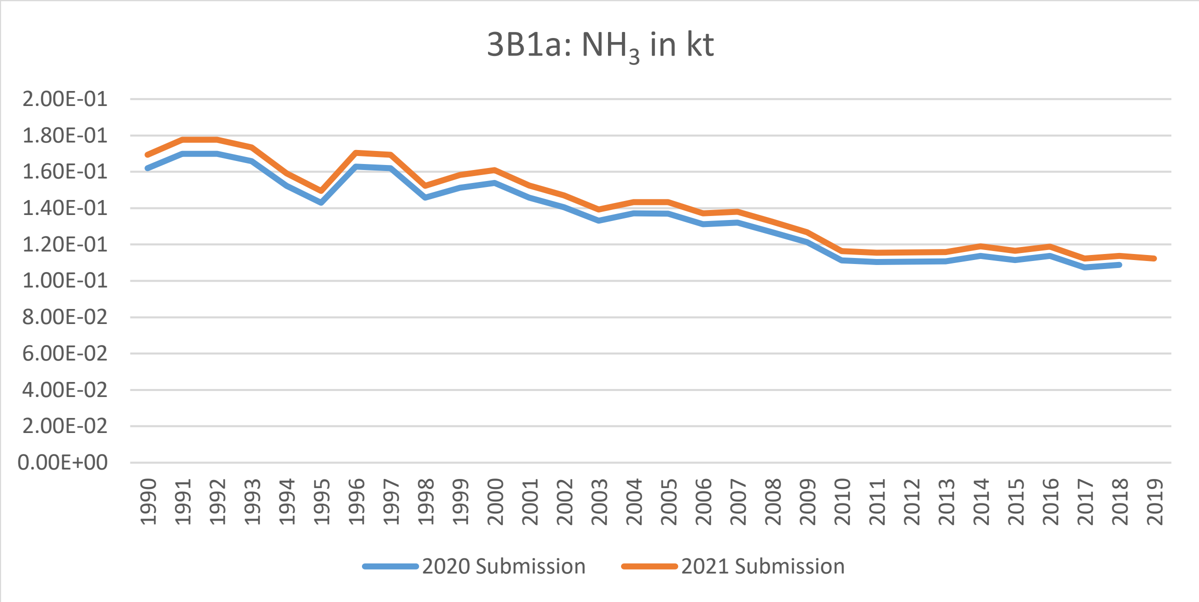

Figure 54: 3B1A NH_3 TREND IN KT

NH_3 emissions from dairy cattle have decreased across the time series. A small increase in emissions is observed in 2021 due to an increase in the Nex value.

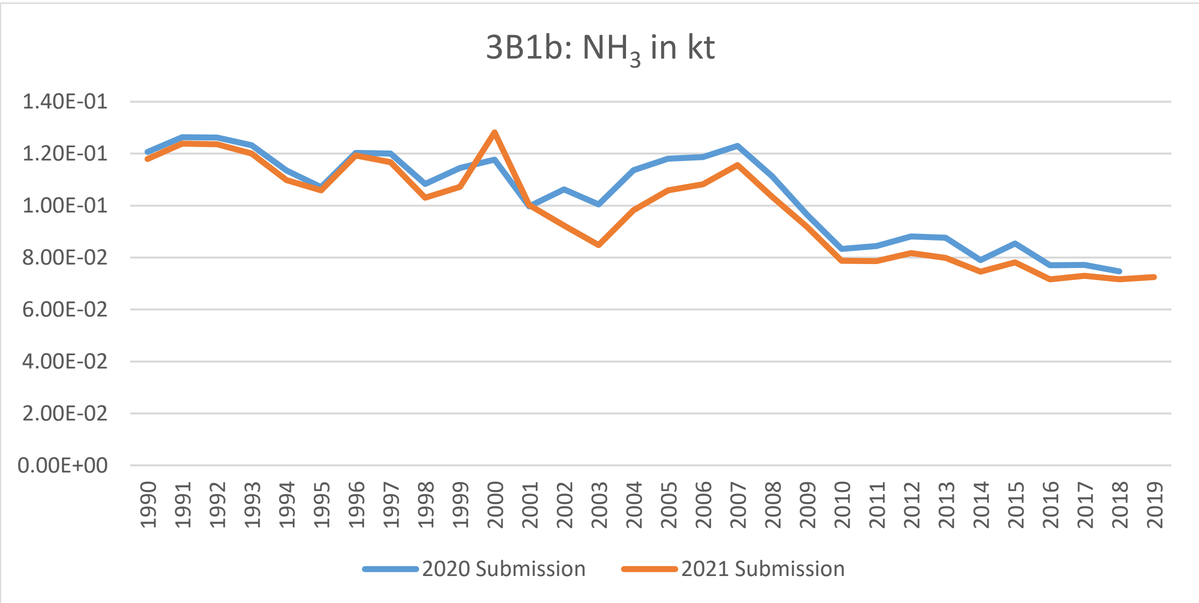

Figure 55: 3B1B NH_3 TREND IN KT

The trend for non-dairy cattle NH_3 emissions is similar to the one for dairy cattle. Overall, a decrease is observed across the time series. The decrease in emissions in the 2021 submission is due to a reduction in the Nex values for this livestock category.

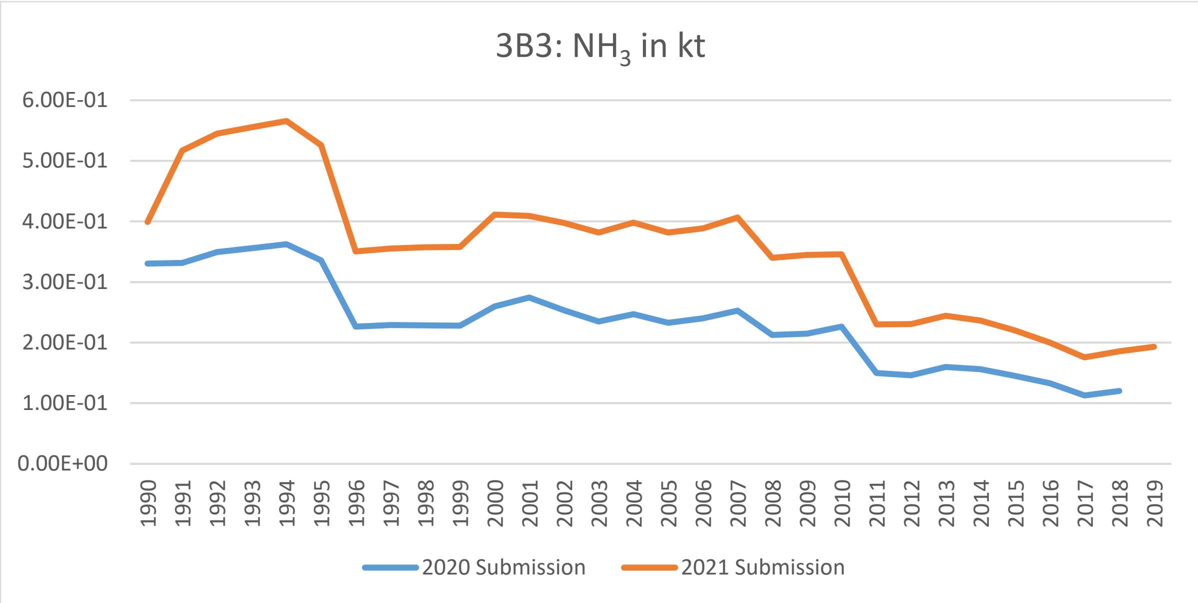

Figure 56: 3B3 NH_3 TREND IN KT

Swine NH_3 emissions have decreased along the time series. The increase in emissions in the 2021 submission is due to changes in the Nex values.

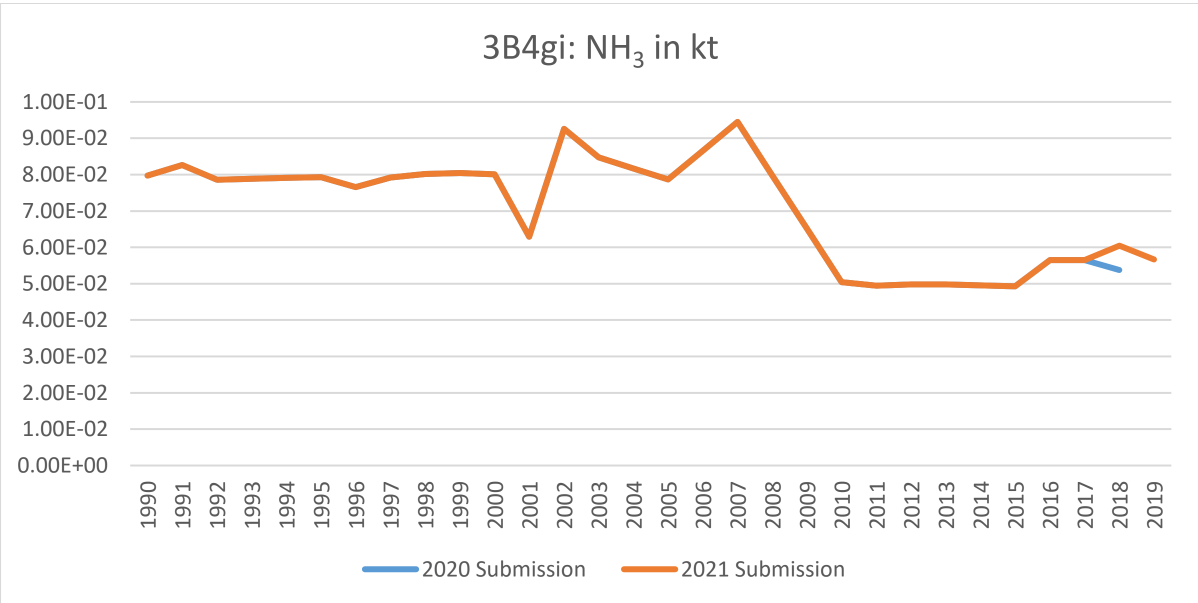

Figure 57: 3B4GI NH_3 TREND IN KT

NH_3 emissions from laying hens decreased overall across the time series. The values for both submissions were identical, apart from a small difference in the number of animal heads in 2018.

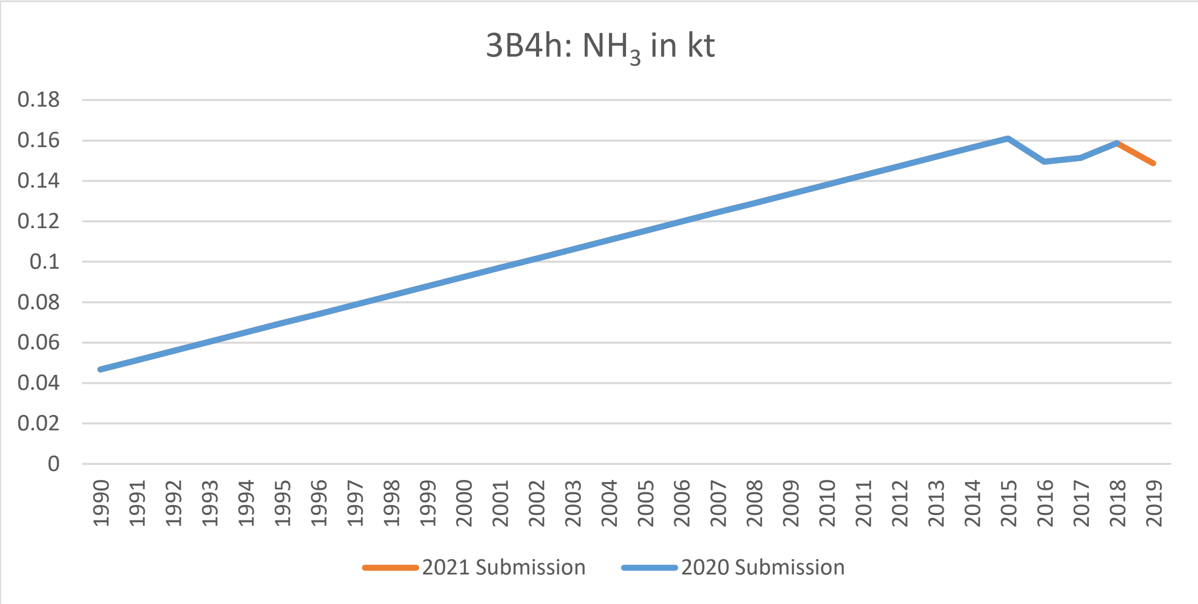

Figure 58: 3B4H NH_3 TREND IN KT

NH_3 emissions from other animals refer to emissions from rabbits. The trend shows an increasing trend across the time series. The methodology used in the 2021 submission produced the same values as the previous submission.

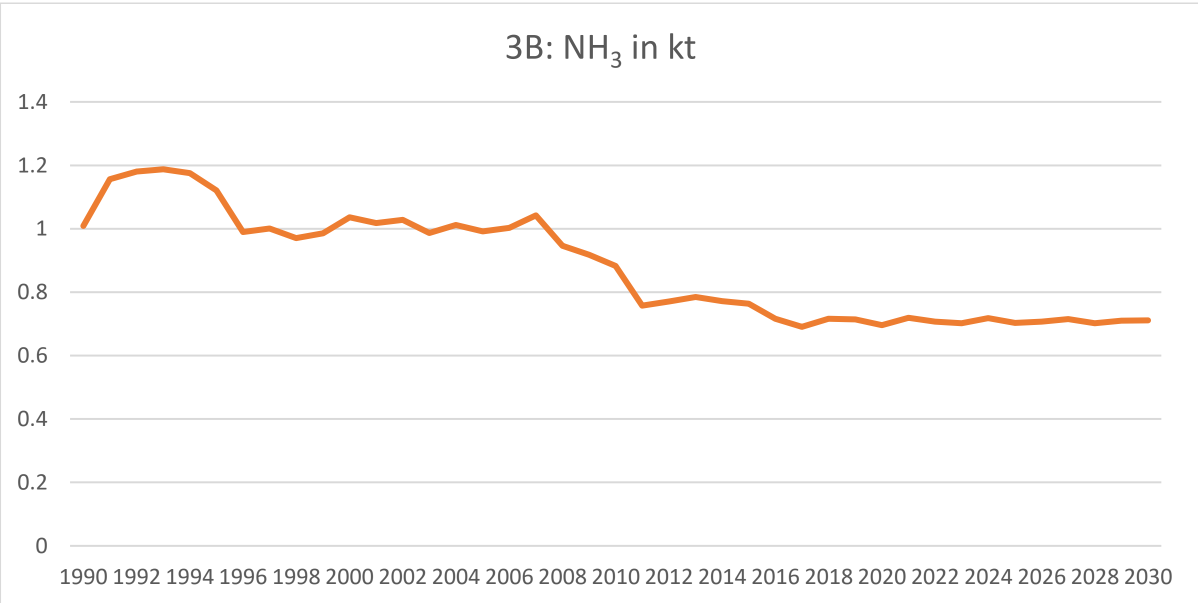

Figure 59: 3B NH_3 IN KT (WM AND WAM)

Concerning projections, Chapter 3B was a key category for NH_3. No projected activity data was available. Therefore, the historical activity data, such as livestock numbers and Nex values, was extrapolated in line with the climate change (MRA) model. Furthermore, the WM and WAM scenarios were assumed to be identical, as there was no projected activity data. The graph above shows a stable trend for NH_3 emissions.

nmVOC emissions from sub-chapter 3B Manure Management were calculated through a Tier 1 and 2 methodologies provided in the 2019GB, as shown in the tables below:

Table 21: 3B NMVOC TIER USED

NFR	Description	Tier
3B1a	Dairy Cows	Tier 2
3B1b	Non-dairy cows	Tier 2
3B2	Sheep	Tier 1
3B3	Swine – Sows	Tier 2
3B3	Swine - Fattening pigs	Tier 2
3B4a	Buffalo	NO
3B4d	Goats	Tier 1
3B4e	Horses	Tier 1
3B4f	Mules and Asses	NO
3B4gi	Laying hens	Tier 2
3B4gii	Broilers	Tier 2
3B4giii	Turkeys	NO
3B4giv	Other Poultry	Tier 1
3B4h	Other animals (Rabbits)	Tier 1

Both Tier 1 and Tier 2 calculations make use of the number of animal heads, which as mentioned previously, are provided by the NSO. In addition, Tier 2 calculations take into consideration other parameters, including the assumption that no grazing takes place locally, and livestock housing period is provided within tables 17 and 18. No activity data on silage was available, and thus it was assumed to be 0. The Gross Feed Intake (GE) for cattle was provided by the NSO, while the Volatilized Solids (VS) for the remaining livestock types were taken from the UNFCCC guidelines. Both these values were in line with the climate change model.

Dairy cattle and broilers were the key categories for nmVOC. The emissions were calculated through a Tier 2 methodology, and the trends for these two categories can be observed below:

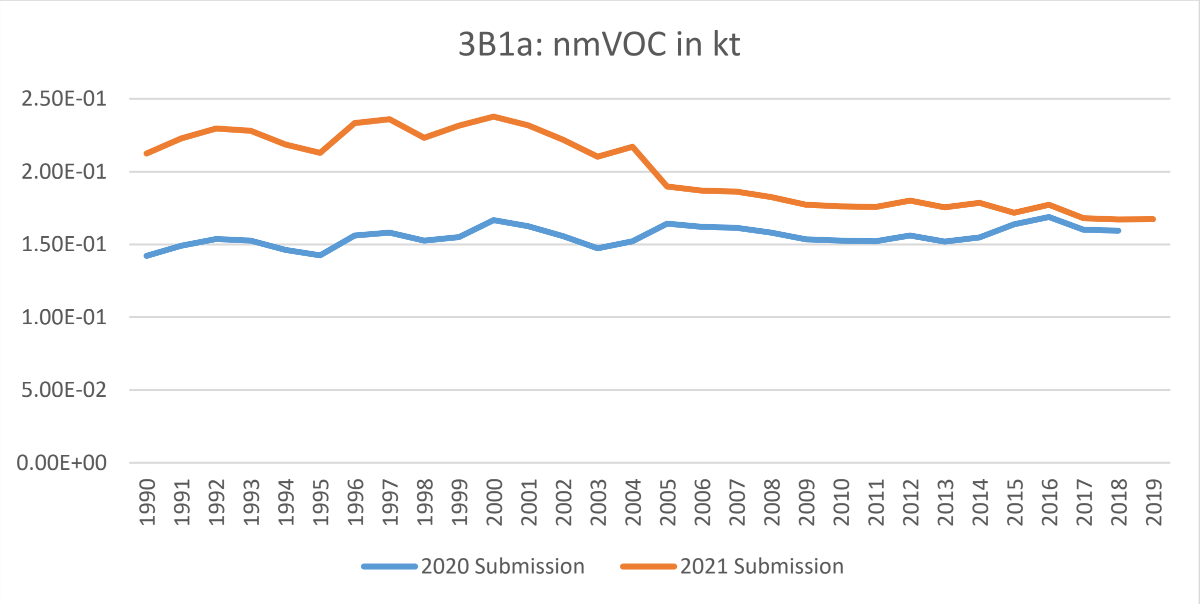

Figure 60: 3B1A NMVOC IN KT

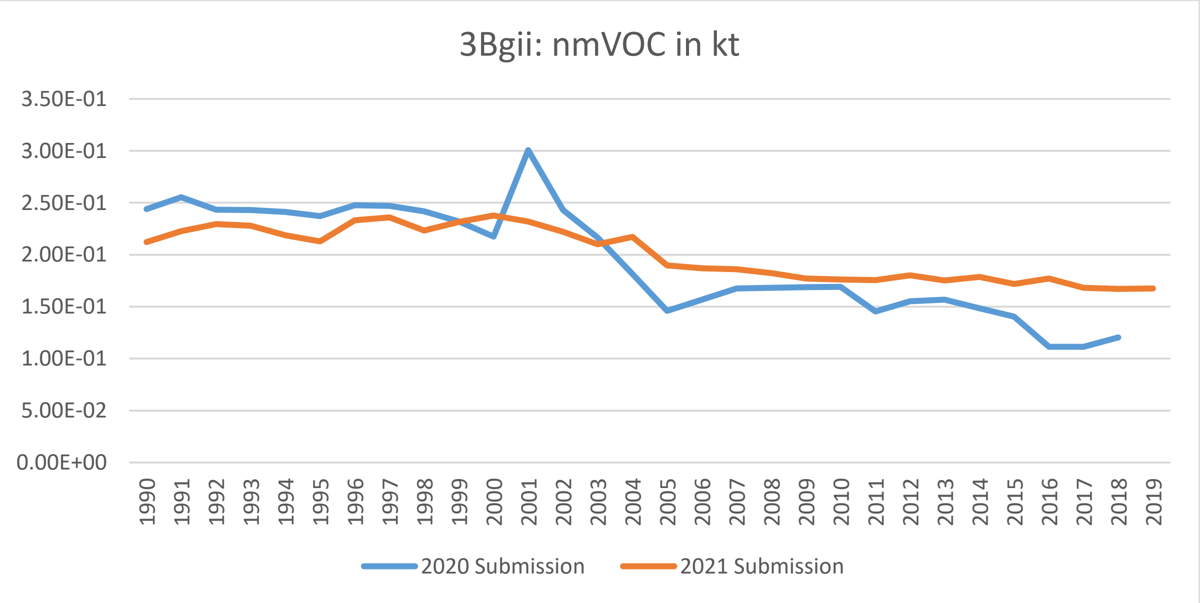

Figure 61: 3BGII NMVOC IN KT

3D: Crop Production and Agricultural Soils

NFR-Code	Name of Category	Method	Activity Data	EF	Key Category	Year of last update
3Da1, 3Da2a, 3Da2b, 3Da2c, 3Da3, 3Da4, 3Db, 3Dc, 3Dd, 3De	AgriOther	2019GB	NSO	Tier 1, 2	NH_3, PM_{10}	2021 submission

Emissions from sector 3Dc 'Farm-level agricultural operations, including storage, handling and transport of agricultural products', and 3De 'Cultivated crops', were estimated through a Tier 2 methodology in line with the 2019GB. Sector 3Da2a 'Livestock manure applied to soils' was also estimated through a Tier 2 methodology, by the Manure Management N-flow tool provided within the 2019GB. Furthermore, sector 3Da1 'Inorganic N fertilisers (includes urea) was calculated using a Tier 1 methodology.

Sector 3Da2c 'Other organic fertilisers applied to soils' was classified as IE, as these are sent to a landfill, and are thus covered under chapter 5A 'Biological treatment of waste - Solid waste disposal on land'. The annotation 'NO' was used for sector 3Da2b 'Sewage sludge applied to soils', as sewage sludge is not applied to soil in Malta. Similarly, emissions from 3Da3 'Urine and dung deposited by grazing animals' were also classified as NO, since grazing activity is negligible. Furthermore, 3Da4 'Crop residues applied to soils', 3Db 'Indirect emissions from managed soils', and 3Dd 'Off-farm storage, handling and transport of bulk agricultural products' were classified as NA, as no methodology was available.

3Da1: Inorganic N fertilisers (Includes Urea)

This sector was calculated through a Tier 1 methodology provided within the 2019GB. The nitrogen input to soil from synthetic fertilisers was required as activity data, and the main pollutants emitted from this sub-category were NH_3 and NO_x.

Regarding activity data, synthetic fertiliser application rates were not available over a time series. However, an annual figure was obtained through an estimation carried out within the climate change (MRA) model. The NSO study on the Gross Nitrogen Balance for Malta conducted in 2007 served to provide the N input from synthetic fertilisers for that year, and the study used as a basis for estimating the N input across the entire time series. The utilised agricultural area (UAA), as provided by NSO, is available for the entire time series. Hence, an average value of N input of 60.3 kg N per ha of UAA in 2007 was applied across the entire time series, and then modified according to fertiliser consumption rates. The average N input value for a specific year is then multiplied by the UAA. Nevertheless, it is worth noting that the UAA, which is provided by the NSO through its Farm Survey, is only available from 2001 onwards. Furthermore, it is only calculated every 2 or 3 years. FAOSTAT data is used for filling of gaps in the 1990-2000 period. Interpolation is used for years where no statistics are available.

3Da2a: Livestock Manure Applied to Soils

This sector was recalculated to a Tier 2 level through the Manure Management N-flow tool. The activity data used within the N-flow tool, and the relevant explanations are presented in Chapter 3B: Manure Management.

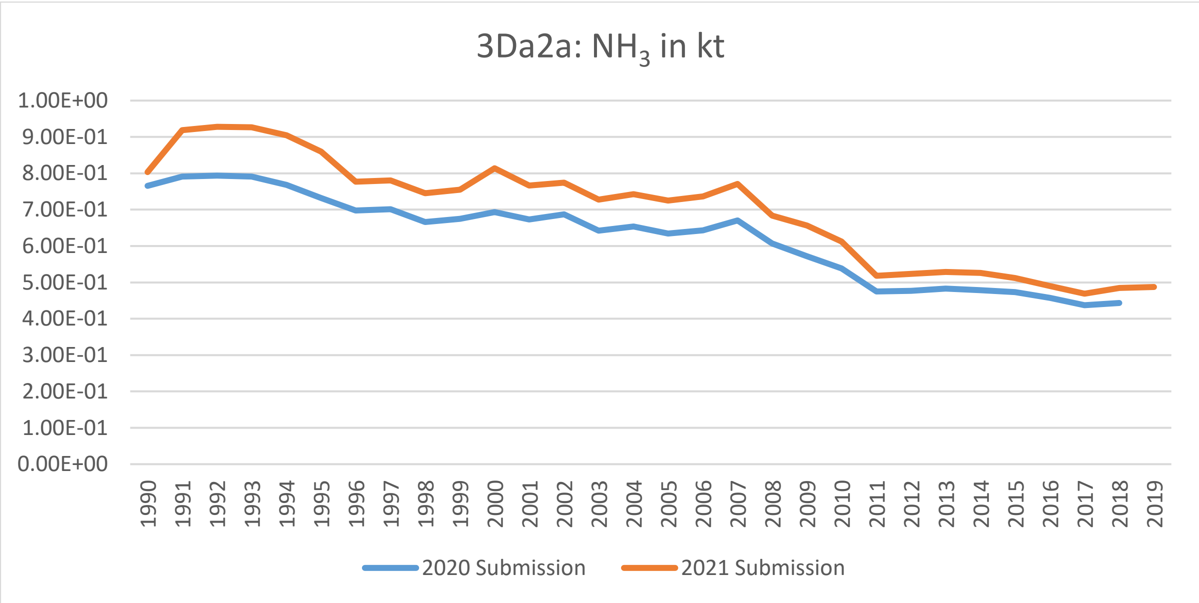

Figure 62: 3DA2A NH_3 RECALCULATION IN KT

The figure above shows a steady decrease of NH_3 emissions across the time series, which is attributed to a decrease in livestock numbers. A small increase in emissions reported across the time series, between the 2020 and the 2021 submission can be seen in the above graph, due to an increase in the Nex value for the aforementioned livestock categories.

3Dc: Farm-level Agricultural Operations Including Storage, Handling and Transport of Agricultural Products

$PM_{2.5}$, PM_{10} and TSP emissions from this sector were calculated through the Tier 2 methodology provided by the 2019GB. The land area by crop type was provided by NSO &

FAOSTAT and is in line with the climate change (MRA) model. The table below shows how local crop types are classified according to the categories provided within the 2019GB. The dry climate EFs were used, as Malta has a semi-arid climate (Galdies, 2011).

Table 22: CROP TYPE FOR EACH CATEGORY UNDER 3DC

Category in 2019GB	Crop type
Wheat	Land area under wheat
Barley	Land area under barley
Other arable	Land area under bean, potato, carrot, clover + vetch (sulla)
Grass	Land area under fodder + other fodder

3De: Cultivated Crops

nmVOC emissions from this sector were calculated through the Tier 2 methodology presented in the 2019GB. The land area by crop type was provided by NSO & FAOSTAT and is in line with the climate change (MRA) model. The table below shows how local crop types are classified according to the categories provided within the 2019GB. The EF for Grass 25°C was used to better represent Malta's Mediterranean climate (Galdies, 2011).

Table 23: CROP TYPE FOR EACH CATEGORY UNDER 3DE

Category in 2019GB	Crop type
Wheat	Land area under wheat
Other arable	Land area under barley, bean, potato, carrot, clover + vetch (sulla)
Grass 25°C	Land area under fodder + other fodder

3D: Projections - Plant Production and Agricultural Soils

Categories under Chapter 3D: Crop production and agricultural soils are all reported under Chapter 3D: Plant production and agricultural soils. This sector is a key category for NH_3 across the projected time series. The chapter covered all the sectors used for estimating historical emissions. As for Chapter 3B, no projected activity data was available this chapter. The historical data such as livestock numbers, nitrogen excretion (Nex) values, and the utilised agricultural area (UAA), was extrapolated in line with the climate change (MRA) model. Furthermore, since no projected data was available, the WM and WAM scenarios were assumed to be equal. The figure below shows a stable trend from 2019 to 2030.

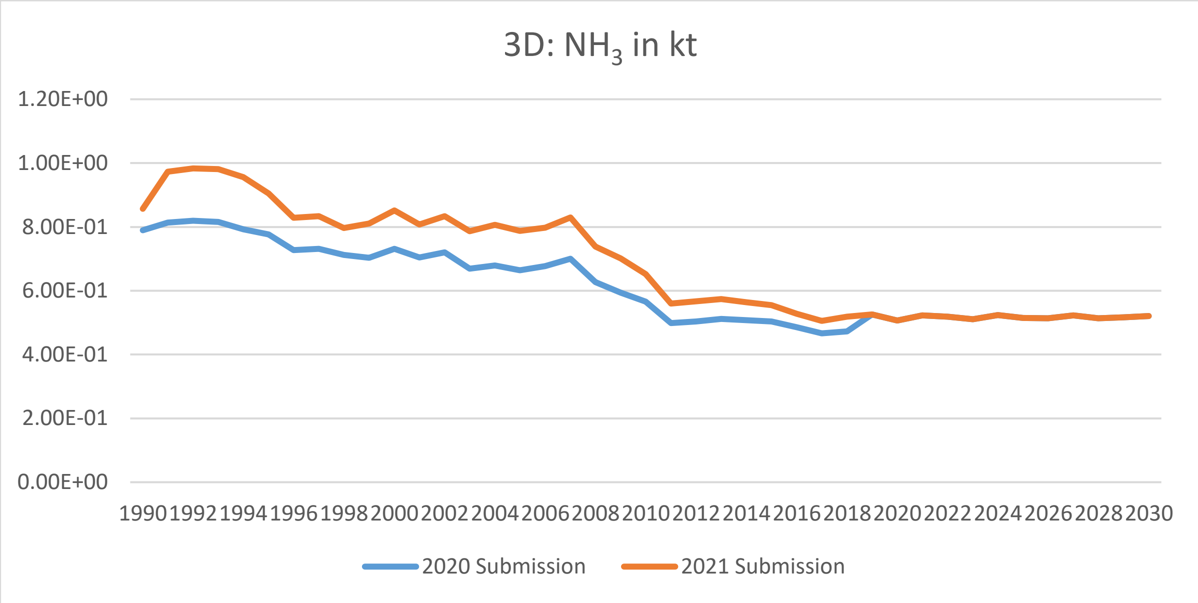

Figure 63: 3D NH_3 IN KT

3F: Field Burning of Agricultural Residues

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
3.F	Field burning of agricultural residues	NA	NA	NA	NA	NA

NOx, nmVOC, SO_x, NH_3, and CO emissions are reported under this sector. At present, no activity data is available. Therefore, the values reported under this sector are recurring figures from previous submissions.

6. Waste (NFR 5)

The waste chapter (NFR 5) includes emissions from the sectors in the table below. The notation key 'NO' was used for sector 5B1: Biological treatment of waste – Composting, 5C1biv: Sewage sludge incineration, and 5C1bvi: Other waste incineration, since these activities do not take place locally.

Table 24: NFR 5 ESTIMATED SECTORS

Aggregation	Sector	NFR code
Waste	Biological treatment of waste - Solid waste disposal on land	5A
	Biological treatment of waste - Anaerobic digestion at biogas facilities	5B2
	Cremation	5C1bv
	Open burning of waste	5C2
	Other wastewater handling	5D3
	Other waste	5E

The pollutants covered in this chapter are NO_x, nmVOCs, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/ PCDF, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PCBs.

Of these pollutants, the waste sector is a key category for: nmVOC, Se, PCDD/PCDF, benzo(k) fluoranthene, HCB, and PCBs.

The relevant pollutant trends for key categories, as well as, the methodologies used are explained in the sections below:

5A: Biological Treatment of Waste – Solid Waste Disposal

NFR-Code	Name of Category	Method	Activity Data	EF	Key Category	Year of last update
5A	Waste	2019GB	AER	Tier 3	nmVOC	2021 submission

nmVOC emissions were recalculated through a methodology proposed by the TERT, which based its estimation on the CH_4 emissions reported in the UNFCCC Framework. CH_4 emissions were provided by the MRA. The volume of CH_4 in m^3 was then calculated through the equation below:

$$Total\ CH4\ emitted\ *\ CH4\ molecular\ density\ (0.714) = Volume\ of\ CH4$$

Equation 7: CALCULATE VOLUME OF CH_4

The volume of biogas in m^3 was then calculated through the equation below, whereby the fraction of CH_4 in biogas was taken from the IPCC 2006 Guidebook:

$$\frac{Volume\ of\ CH4}{Fraction\ of\ CH4\ in\ biogas\ (50\%)} = Volume\ of\ biogas$$

Equation 8: CALCULATING VOLUME OF BIOGAS

Finally nmVOC was calculated through the equation below, the fraction of nmVOCs was taken from the 2019GB:

$$Volume\ of\ biogas * Fraction\ of\ nmVOCs\ in\ biogas\ (5.65g/m3) = NMVOC\ emissions$$

Equation 9: CALCULATING NMVOC EMISSIONS

Since this sector is a key category for nmVOC emissions, a graph below shows the trends for this pollutant across the time series. This graph below shows the historical and projected trends for sector 5A. There is a significant downward trend in the WaM scenario due to the commencement of operations of the new WtE plant in 2024. The changes in projected landfilling rates will be described in the projections section of this chapter.

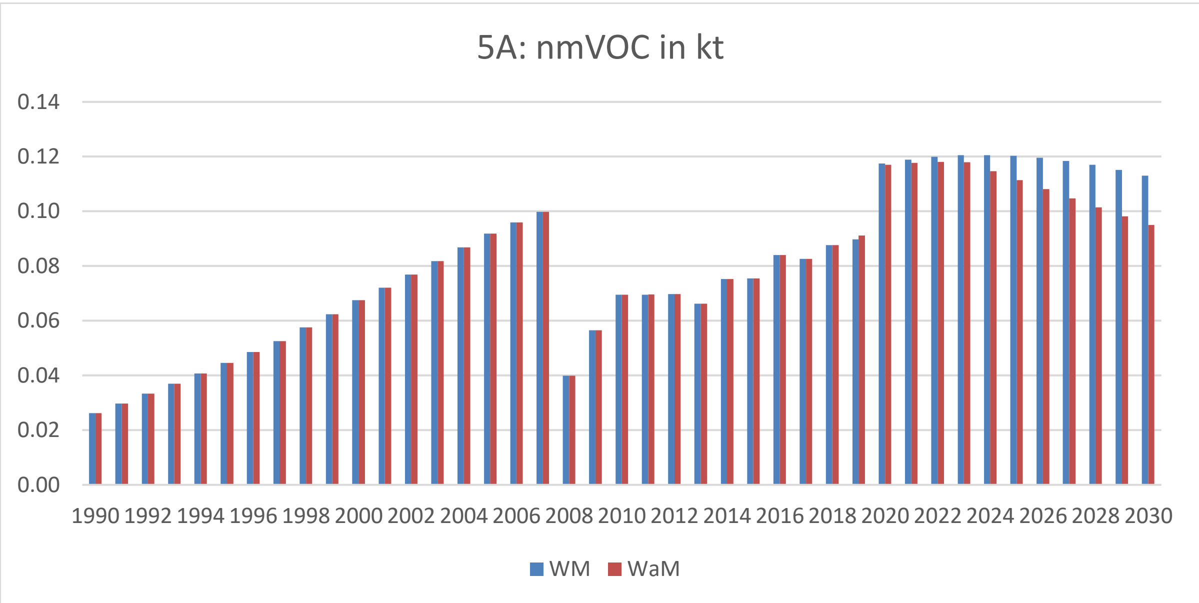

Figure 64: 5A NMVOC IN KT

Concerning emissions from $PM_{2.5}$, PM_{10}, and TSP, these were calculated through the Tier 3 methodology as used in previous submissions. The activity data consists of all waste disposed of in landfills, excluding anaerobic digestate and animal manure. The emissions from these two contributions were already estimated in other sectors. The Waste Team at the Environment & Resources Authority (ERA) provided this data. Additionally, the mean wind speed was taken from a study by Galdies (2011), and a default factor provided in the 2019GB was used for the moisture content of the materials landfilled.

5B2: Biological Treatment of Waste – Anaerobic Digestion at Biogas Facilities

NFR-Code	Name of Category	Method	Activity Data	EF	Key Category	Year of last update
5B2	Waste	2019GB	AER	Tier 2	NA	2021 submission

This submission includes NH_3 emissions from biological treatment of waste - anaerobic digestion (AD) at biogas facilities for the period ranging from 2011 to 2019. The Waste Team at the Environment & Resources Authority (ERA) provided this data. The Sant'Antnin Waste treatment facility (SAWTP) was established in 2010; however, no data for that year was made available, and therefore emissions were calculated as from 2011. In conjunction to the SAWTP, the Malta North Waste treatment facility commenced operations in 2016; however, data was made available as from 2017.

A tier 2 methodology based on the 2019GB was used to estimate emissions. The following equation was used to estimate NH_3 emissions:

$$E_{NH3} = AR_{feedstock} * \sum_{stages} EF_{NH3\text{-}N,\ stage\ I} * 17/14$$

Equation 10: EQUATION TO CALCULATE NH_3 EMISSIONS FROM ANAEROBIC DIGESTION

Where, *AR feedstock* refers to the total annual amount of N in feedstock (organic fraction entering the biogas facility). This was estimated by multiplying the organic fraction made available in the AER with the respective N content default factor made available in the 2019GB. Emission factors of NH_3, *stage i* refers to NH_3 emission factors at different stages. The pre-storage and storage of non-separate digestate were the only two stages considered to be relevant for local practices. This sector is not a key source to any of the pollutants in the national emission inventory.

The organic fraction entering the Anaerobic Digester was provided for 2011-2017 at Sant' Antnin waste treatment facility, and for all years at Malta North waste treatment facility. The 2018 and 2019 figures at Sant' Antnin were estimated by taking an average fraction of the total waste from the Dry MTP that entered the AD for the years 2011-2017, and then applying that fraction to the total weight of waste entering the Dry MTP. The total amount of waste entering the AD for both Sant' Antnin and Malta North, under both WM and WaM scenarios, can be observed in the graph below:

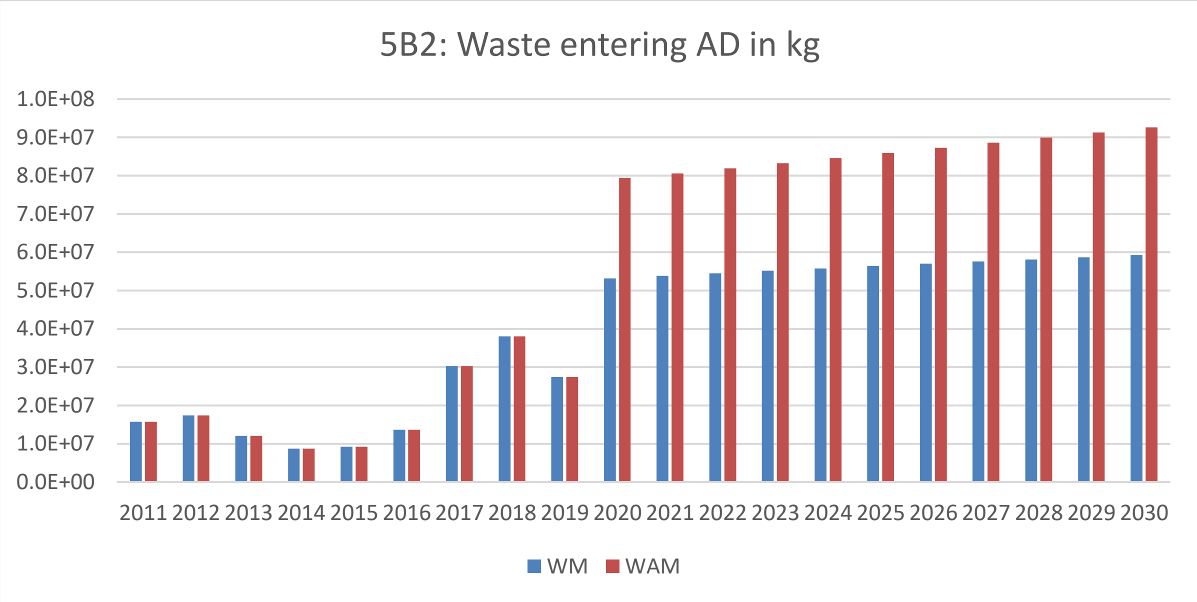

Figure 65: 5B2 WASTE ENTERING ANAEROBIC DIGESTER IN KG

5C1bv: Cremation

NFR- Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
5C1bv	Waste	2019GB	AER	Tier 1, 3	Se, PCDD/PCDF, HCB, PCBs	2021 Submission

Waste covered in the following categories within the 2019GB: Municipal Solid Waste (5C1a); Industrial Waste (5C1b); Clinical waste (5C1biii); and Cremation (5C1bv) are incinerated together within the Marsa Thermal Treatment Facility (MTTF). Thus, the emissions were all added to the Cremation sector (5C1bv), and the other categories, namely: 5C1a, 5C1b, and 5C1biii are all classified as IE.

The facility commenced its operation in late 2007; however, the first activity data available is from 2009. The Waste Team at the Environment & Resources Authority (ERA) provided the activity data, while the emissions from continuous monitoring were made available through the AERs. A Tier 3 methodology was used for the following pollutants, as the emissions were directly measured at the site: NO_x, nmVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Cr, Ni, PCDD/PCDF. Certain pollutants had missing data for some years. In these cases, a country-specific emission factor was calculated, by obtaining an average emission load per mass of waste entering the facility. The mass of waste entering the facility in a year was then multiplied by the country-specific emission factor.

No direct emissions data was available for other pollutants, and thus these emissions had to be calculated through the Tier 1 methodology provided in the 2019GB. The pollutants include: BC, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB, and PCBs.

The total waste entering the facility was classified according to the EWC codes. The EWC codes were then used as a guidance, to separate the waste into four categories: Municipal solid waste (5C1a), Industrial waste (5C1b), Clinical waste (5C1biii), and Cremation (5C1bv). The mass of waste from each category was then multiplied by the relevant emission factor, as provided within the 2019GB. The emissions from the four categories were summed to obtain a single emission load per pollutant.

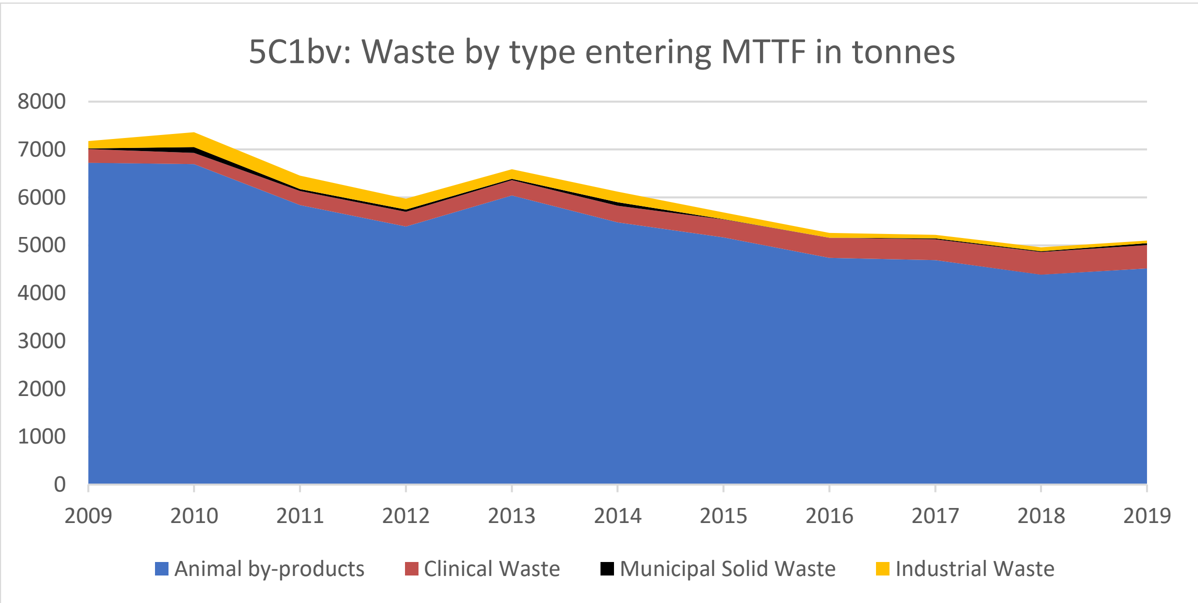

Figure 66: 5C1BV WASTE TYPE ENTERING THE THERMAL TREATMENT FACILITY

The chart above shows the total waste entering the MTTF, as classified by waste type. The greatest fraction of waste entering the MTTF is animal waste. As there is no specific EF for the cremation of animal by products, the EF for the cremation of human bodies (Cremation sector (5C1bv)) has been used to calculate emissions for this sector.

Clinical waste is the second largest source of waste, while municipal solid waste and industrial waste make up significantly smaller fractions. The general trend shows a decrease in waste entering the facility, mostly attributed to a decrease in the cremation sector. In contrast, clinical waste has increased across the time series.

5C2: Open burning of waste

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
5C2	Waste	2019GB	AER	Tier 1	benzo(k) fluoranthene	2021 Submission

Emissions from open burning of waste have been estimated since the 2020 submission. The amount of waste burnt is not currently available. However, the 2019GB provides a Tier 1 methodology that estimates the total waste burnt by multiplying the total arable area by a factor of 25kg/ha. The arable area was assumed to be equal to the UAA, which was previously described in Chapter 3D.

5D: Wastewater handling

NFR- Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
5D	Waste	2019GB	AER	Tier 1	NA	2021 Submission

This section covers emissions from treated wastewater, as estimated through a Tier 1 methodology provided in the 2019GB. The activity data consisted of the total wastewater treated annually from 1990-2019 at four facilities: Ta’ Barkat, Iċ-Ċumnija, Sant’ Antnin (Malta) and Ras il-Ħobż (Gozo). The Water Services Corporation (WSC) provided the activity data. This sector generates nmVOC emissions, and these were calculated by multiplying the activity data with the Tier 1 emission factors in the 2019GB. This sector is not a key source for any of the pollutants in the national emissions inventory.

5E: Other Waste

NFR- Code	Name of sub-Category	Method	Activity Data	EF	Key Category	Year of last update
5E	Waste	2019GB	Civil Protection Department (CPD)	Tier 2	NA	2021 Submission

The Civil Protection Department (CPD) provided the activity data from 2000-2019. Data for the remaining historical years was extrapolated. The tier 2 approach provided in the 2019GB was used, and this sector was not a key source for any pollutant.

The activity data made available did not differentiate between different types of dwellings. Hence, the share of dwellings provided within the NSO (2011) census was used to determine the share of detached houses, undetached houses, and apartments catching fire. Furthermore, no EF was provided for hotels, therefore the EF for apartments was used, since hotels tend to comprise of small rooms that are most similar to apartments. The number of car and industrial building fires was provided directly by the CPD.

The CPD indicated that when a fire takes place, only 1 or 2 rooms actually catch fire. Additionally, the entire car tends to be burnt in the event of a fire, whereas 60% of an industrial building tends to catch fire. Considering this information, and taking the average number of rooms as provided by the 2011 NSO census, the average area percentage of cars and buildings burnt during a fire, was calculated as shown below:

Table 25: 5E SHARE OF VEHICLES & BUILDINGS BURNT

Parameter	Rooms burnt	Number of rooms	% of vehicle/building burnt
Car	N/A	N/A	100.0%
Undetached house	2	9	22.2%
Detached house	2	12	16.6%
Apartment	2	5	40.0%

Hotel/Guest house	2	112	1.8%
Industrial building	N/A	N/A	60.0%

Waste Projections

Projections from all waste categories are reported together under Chapter 5: Waste. The projected activity data for: 5A, 5B2, and 5C1bv was provided by the Ministry for the Environment, Climate Change and Planning (MECP). These projections were last updated in 2019. Projected activity data for 5D was provided by the Water Services Corporation (WSC), and these projections were last updated in 2020. No projected activity data was available for sectors 5C2 and 5E. The UAA for chapter 5C2 was projected forward through a moving average, to be consistent with the projections carried out in the climate change model by the MRA. In contrast, the 2019 value for 5E was carried forward for all projected years.

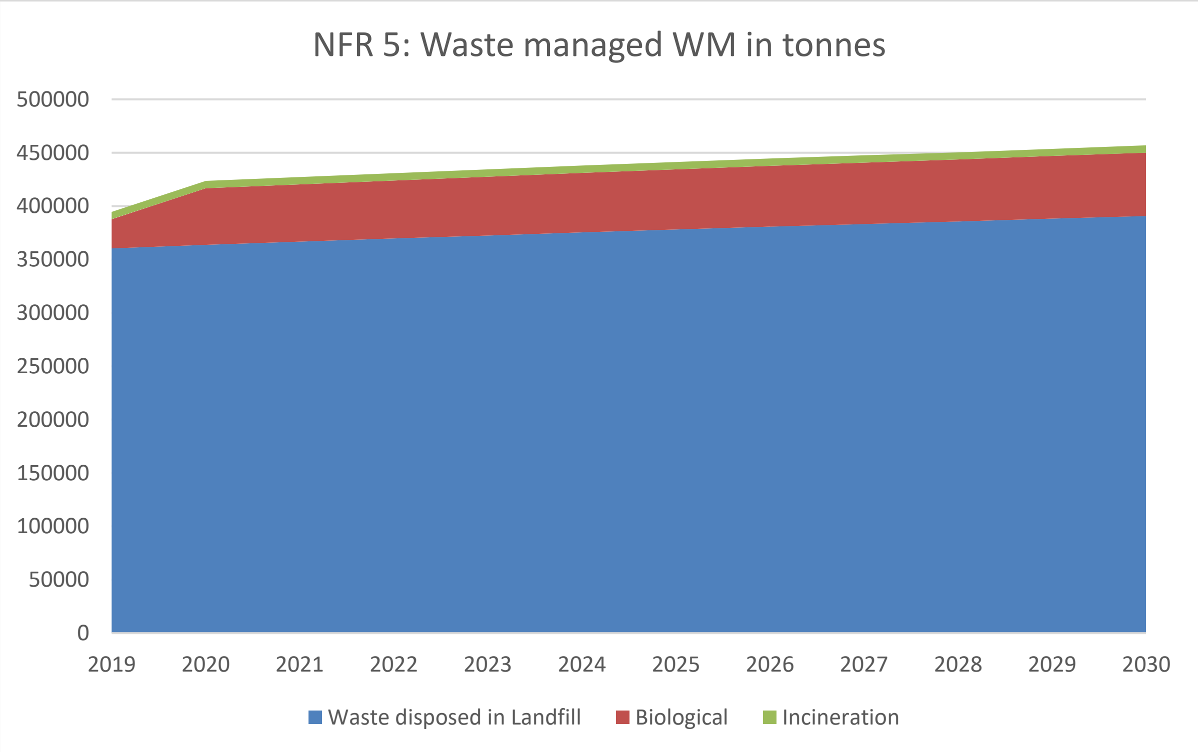

Figure 67: NFR 5 WASTE MANAGED IN DIFFERENT WASTE FACILITIES WM

The chart above for the With-Measures (WM) scenario shows a moderate increase for all three waste categories.

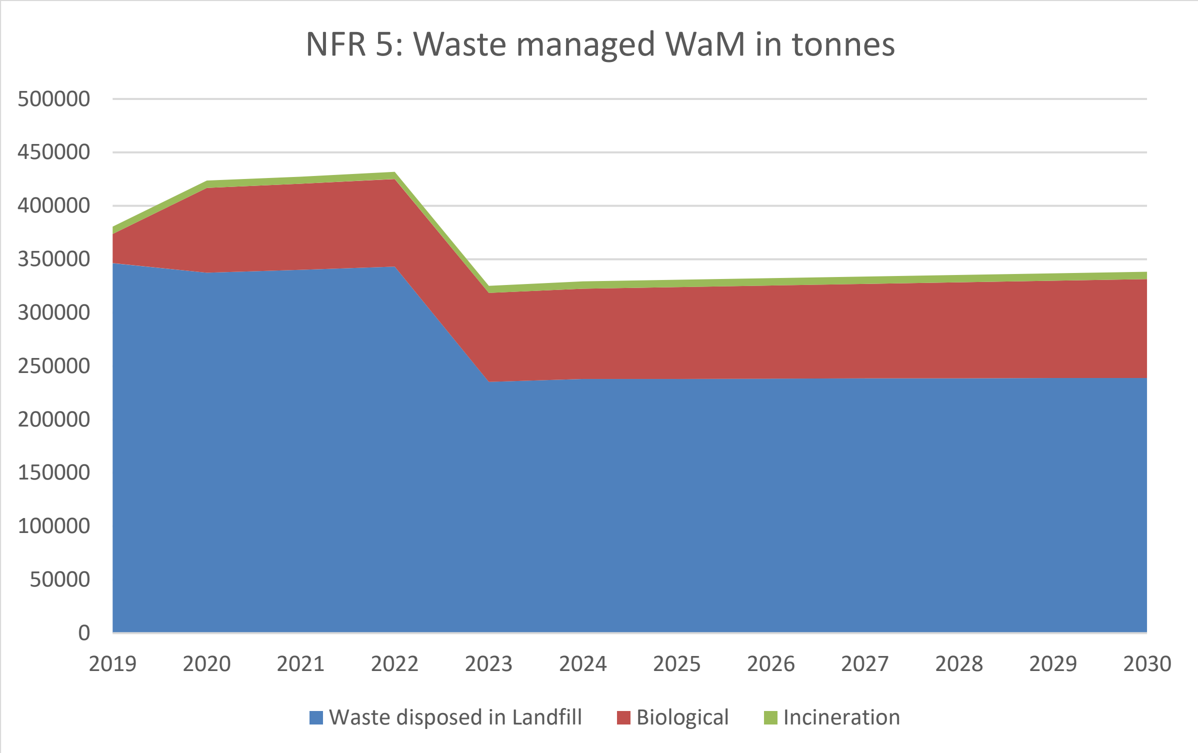

Figure 68: NFR 5 WASTE MANAGED TIME SERIES WAM

In contrast, the with-additional-measures (WaM) scenario shows a sudden decrease in landfilling in 2023, since it is planned that a significant amount of previously landfilled waste will start entering a newly constructed Waste-to-Energy Facility.

The amount of waste incinerated will remain consistent with that in the WM scenario, since incineration refers to waste entering the MTTF.

Treated wastewater (sector 5D3) projected by WSC assumes that all wastewater will be treated prior to discharge to sea as required by the Urban Wastewater Treatment Directive. Moreover, the with-measures (WM) and with-additional-measures scenario (WaM) are identical.

7. Gridded emissions

7.1 Background information

This chapter provides a summary of input data and methodologies of Malta's gridded emissions for the year 2019. The deadline for reporting was the 1st of May 2021. A summary of the results is included further down in this publication.

Pursuant to the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTP), and Directive (EU) 2016/2284 on the reduction of national emission of certain atmospheric pollutants (NECD), countries are to compile and report spatial emissions every four years starting from 2017 onwards. Member States shall report for the year x-2 national gridded data emissions by source category (GNFR) and Large Point Source emissions.

All substances referred to in paragraph 7 of the Reporting Guidelines (UNECE, 2015) were included, namely; SOx as SO_2, NOx as NO_2, NH_3, BC, NMVOCs, CO, $PM_{2.5}$, PM_{10}, Cd, Pb, Hg, PAHs: benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, and indeno(1,2,3_cd)pyrene, PCDD/F, PCBs and HCB. Gridded data was reported using the NFR2014 reporting table: ANNEX V - Template file for gridded sector data for each of the relevant aggregated Gridding NFR sectors (GNFR), whilst emissions from Large Point Sources (LPS) were submitted using the NFR2014 reporting table: ANNEX VI - Template for LPS data for each relevant aggregated Gridding NFR sectors (GNFR).

7.2.1 Gridded emissions data

In line with the requirements of the EMEP/EEA Air Pollutant Emissions Inventory Guidebook emission data was spatially allocated in the EMEP grid with a resolution of 0.1 x 0.1 degree longitude/latitude grid. Under the EMEP domain, Malta's geographical area is covered by 10 grids, each having an area of approximately $100km^2$. In order to spatially disaggregate emissions, Malta downloaded the EMEP ESRI shapefile with the grid definition. One is to note that no emissions were generated on the islet of Filfla in Grid 0, since this is an uninhabited marine protected area. In this context, no gridded emissions data was attributed to this particular grid.

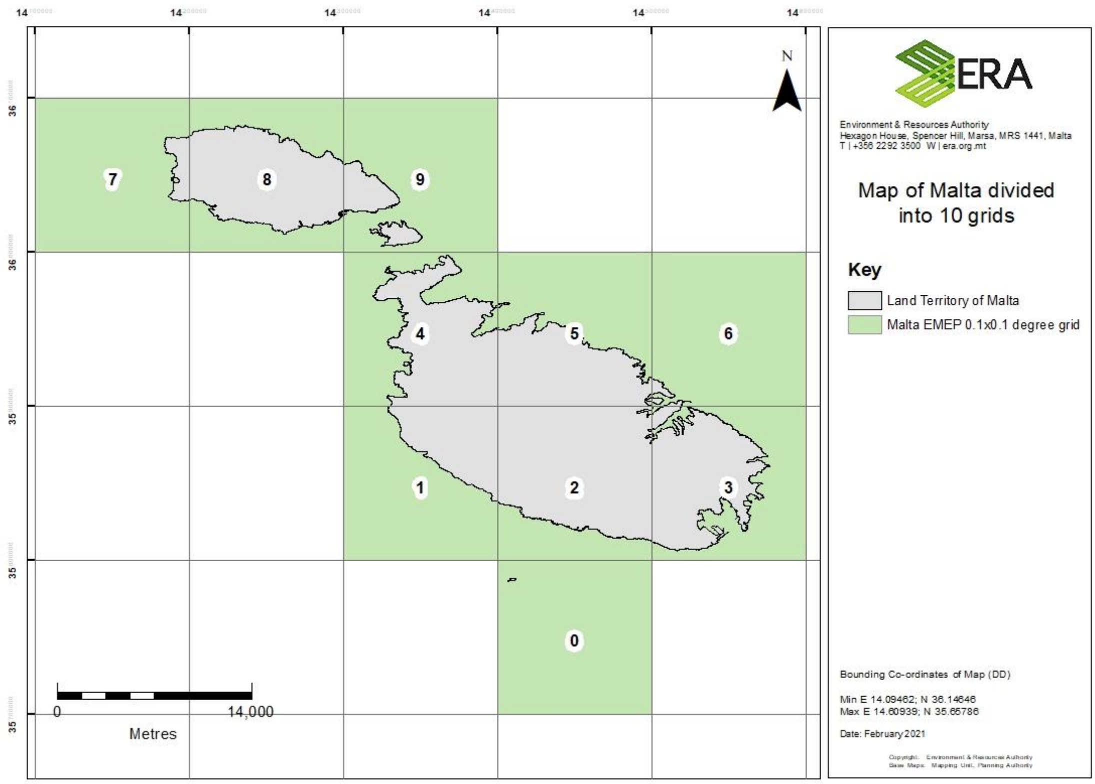

Figure 69: THE MALTESE ISLANDS (GREY) SPATIALLY ALLOCATED IN THE EMEP GRID (IN GREEN)

Malta calculated gridded emissions using the *Malta Emission Gridding Tool* version 1.0 created by Aether Ltd., world experts in environmental data analysis and interpretation, particularly in the field of air quality and climate change emissions. This tool makes use of the inventory submitted in February and through the use of a geographic information system (GIS) software (ArcMap 10.8.1), Malta estimated the proportion of emissions falling with each grid for each GNFR as per table 26 below.

Table 26: GNFR CATEGORIES AND CORRESPONDING NFR CATEGORIES IN MALTA'S GRIDDED EMISSION INVENTORY.

NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Description**
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction
	2H2	Food and beverages industry
B_Industry	2B10b	Storage, handling and transport of chemical products (please specify in the IIR)

	2D3b	Road paving with asphalt
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary
	1A4bi	Residential: Stationary
D_Fugitive	1B2av	Distribution of oil products
E_Solvents	2D3a	Domestic solvent use including fungicides
	2D3i	Other solvent use
	2G	Other product use
F_RoadTransport	1A3bi	Road transport: Passenger cars
	1A3bii	Road transport: Light duty vehicles
	1A3biii	Road transport: Heavy duty vehicles and buses
	1A3biv	Road transport: Mopeds & motorcycles
	1A3bv	Road transport: Gasoline evaporation
	1A3bvi	Road transport: Automobile tyre and brake wear
	1A3bvii	Road transport: Automobile road abrasion
G_Shipping	1A3dii	National navigation (shipping)
H_Aviation	1A3ai(i)	International aviation LTO (civil)
	1A3aii(i)	Domestic aviation LTO (civil)
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
	1A4ciii	Agriculture/Forestry/Fishing: National fishing
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land
	5C2	Open burning of waste

	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities
	5D3	Other wastewater handling
	5E	Other waste (cars + buildings)
K_AgriLivestock	3B1a	Manure management - Dairy cattle
	3B1b	Manure management - Non-dairy cattle
	3B2	Manure management – Sheep
	3B3	Manure management – Swine
	3B4d	Manure management – Goats
	3B4e	Manure management – Horses
	3B4gi	Manure management - Laying hens
	3B4gii	Manure management – Broilers
	3B4giv	Manure management - Other poultry
	3B4h	Manure management - Other animals
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)
	3De	Cultivated crops
	3Da2a	Animal manure applied to soils
	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
	3F	Field burning of agricultural residues

7.2.2 Methods and data for disaggregation of emission data

The Maltese emission inventory covers point, line and area sources. However, where no spatial information on emission sources was available, Malta assumed an equal share of emissions for each grid, based on the share of land area within each grid.

Concerning point sources, emissions were allotted to the corresponding geographical coordinates of the sectors included in the national inventory. In this context, when gridded, the emissions resulting from point data were classified under their respective grid.

Emissions from area sources were not allocated to a particular local administrative boundary (i.e. local regions) but to the respective grid they belong to as per figure 69. In cases where polygon data was used, Malta followed the guidelines stipulated in Chapter 7, Section 3.4.2 of the Guidebook.

Furthermore, line data was only used for the *F_RoadTransport* sector, particularly 1A3bi to 1A3biv, 1A3bvi and 1A3bvii, as well as the *B_Industry* sector, namely *2D3b – Road paving with asphalt*, whereby emissions generated from this sector were considered to be originating from diffused sources.

The various spatial dataset shapefiles (point, line, area) used for the compilation of the gridded emission inventory were inputted into a geographic information systems (GIS) software (ArcMap 10.8.1) superimposed on the EMEP Grid shapefile (0.1° x 0.1° longitude/latitude). Table 28 below, provides an exhaustive list of all the GNFR categories and the NFR codes used for the reporting of the 2021 gridded emission data for reference year 2019 as well as a summary of the various methodologies used for such gridded emission reporting.

7.3 Large Point Sources (LPS) Data

Large Point Sources (LPS) refer to facilities whose combined emissions, exceed the pollutant emission thresholds stipulated in Regulation (EC) No. 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC (EPRTR Regulation). These facilities are considered individually in Malta's emission inventory. Emissions from LPS were submitted using the NFR2014 reporting table: ANNEX VI - Template for LPS data for each relevant aggregated Gridding NFR sectors (GNFR). Malta reports two sectors under the LPS report as highlighted in table 27 below.

Table 27: GNFR CATEGORIES AND CORRESPONDING NFR CATEGORIES IN MALTA'S LARGE POINT SOURCES INVENTORY.

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Description
A_PublicPower	1A1a	Public electricity and heat production
J_Waste	5C1bv	Cremation

Table 28: TABLE HIGHLIGHTING THE METHODOLOGY MALTA INTENDS USING FOR THE 2021 GRIDDING EMISSIONS INVENTORY FOR REPORTING YEAR 2019.

GNFR sector	NFR sector	NFR sector name	Type of Emissions	Methodology
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction	Area	The number of businesses falling within the NACE categories B to F (Industry) were identified and attributed to their respective grid. In view that data on the size of businesses was not available, emissions were shared equally amongst all businesses and emissions within each grid were attributed according to the number of businesses within the grids.
	2H2	Food and beverages industry	Area	Data with NACE codes; *10.1, 10.20, 10.91, 10.7 and 11.02* was used for this production sector. All businesses, except those under *NACE 10.20*, were then allocated to each grid. Concerning the latter, no company data was available and therefore emissions from this sub-sector were distributed according to land area per grid. With regards to PM_{10} emissions, there was no data available for the total weight of agricultural products and therefore emissions of this nature were based on land area using the methodology established in Chapter 7, Section 3.4.2 of the Guidebook.

	2B10b	Storage, handling and transport of chemical products	Area	Emissions were divided based on the land area within each grid. In this case Malta was construed as one polygon and the methodology established in Chapter 7, Section 3.4.2 of the Guidebook was used.
	2D3b	Road paving with asphalt	Line	Emissions were estimated based on asphalt applied in road paving. Data was provided by Infrastructure Malta (IM) in the form of a list of asphalted roads together with the area covered by asphalt for each road. In the absence of spatial data, each road was mapped out on Google Earth and the following assumptions were considered: (i) The entire road was considered as having undergone works, therefore the entire road was mapped out; (ii) Double entries within the list were combined under one road and the area asphalted was summed up; (iii) Roads which could not be found on the map were assigned to the locality they are located in. In cases where localities share multiple grids, the locality was assigned to the grid containing most of the locality area;

				(iv) Roads sharing more than one grid were classified under the grid containing the majority of the road.
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary	Area	The number of businesses falling within the NACE categories G to S (Commercial Services) were attributed to their respective grid. In view that data on the size of businesses was not available, emissions were shared equally amongst all businesses and emissions within each grid were attributed according to the number of businesses within the grids.
	1A4bi	Residential: Stationary	Area	Emissions from this sector were based on 2018 residential population data provided by the Water Services Corporation (WSC) with the following assumptions: (i) 2018 water meter household data was used to determine the number of households and people living in each household within each grid cell. (ii) Non-residential dwellings and null figures were removed from the dataset to cater solely to the domestic sector.

				The share of residents within each grid was used to estimate the percentage share from the total population and allocated that percentage to the National Statistics Office population for 2019. This was done in order to estimate the population within each grid cell using official demographics data. An equal share of emissions derived from this sector was assigned to each person and multiplied by the number of persons within in grid.
D_Fugitive	1B2av	Distribution of oil products	Area	Emissions were divided based on the land area within each grid. In such cases Malta shall be construed as one polygon and the methodology established in Chapter 7, Section 3.4.2 of the Guidebook was used.
E_Solvents	2D3a	Domestic solvent use including fungicides	Point	Emissions from this sector were based on 2018 residential population data provided by the Water Services Corporation (WSC) with the following assumptions: (i) 2018 water meter household data was used to determine the number of households and people living in each household within each grid cell.

				(ii) Non-residential dwellings and null figures were removed from the dataset to cater solely to the domestic sector. The share of residents within each grid was used to estimate the percentage share from the total population and allocated that percentage to the National Statistics Office population for 2019. This was done in order to estimate the population within each grid cell using official demographics data. An equal share of emissions derived from this sector was assigned to each person and multiplied by the number of persons within each grid.
	2D3i	Other solvent use	Area	Spatially disaggregated emissions for this sector were based on the number of registered cars. In order to calculate the number of cars within each grid, the number of registered vehicles per locality was used. This data was derived from the National Statistics Office (NSO) published report; *Transport Statistics 2019: reference year 2018.* 2019 data was not yet published so 2018 data was used as a proxy. The locality's area was then taken into consideration in order to calculate the number of cars within each grid with

				the assumption that the number of cars per locality were spread equally across the locality. The total emissions generated from this sector were divided equally between all registered vehicles, so the methodology does not differentiate between vehicle category, fuel type or vehicle Euro standard.
	2G	Other product use	Area	Emissions were divided based on the land area within each grid. In such cases Malta was construed as one polygon and the methodology established in Chapter 7, Section 3.4.2 of the Guidebook was used.
F_RoadTransport	1A3bi	Road transport: Passenger cars	Line	The total emissions from road transport were aggregated according to each road segment using the *Base Year 2017 scenario provided by Transport Malta (TM)*. Annual average daily traffic together with the length of link was used to determine the road transport derived emissions for each vehicle category, distributed within each grid cell using the following calculation: $$aVKM_x = (AADT_x * l * 365\ days)$$ Where:
	1A3bii	Road transport: Light duty vehicles	Line	
	1A3biii	Road transport: Heavy duty vehicles and buses	Line	
	1A3biv	Road transport: Mopeds & motorcycles	Line	

				aVKM = annual vehicle kilometre travelled for each vehicle category (x) AADT = Average Annual Daily Traffic for each vehicle category (x l = length of link (in km) x = vehicle category Road links were then allocated to their respective grid cell and the annual vkm for each link within each individual grid was summed up. This was done for every vehicle category. Furthermore, the methodology stipulated in Chapter 7, Section 3.4.3 of the Guidebook was used for roads that shared multiple grids. Emissions from these sub-sectors were then divided according to the total vkm of each grid.
	1A3bv	Road transport: Gasoline evaporation	Line	In order to calculate the number of cars within each grid, the number of registered vehicles per locality was used. This data was derived from the National Statistics Office (NSO) published report; *Transport Statistics 2019: reference year 2018.* 2019 data was not yet published so 2018 data was used as proxy. The locality's area was then taken into consideration in order to calculate the number of cars within each grid. The number of cars per locality were assumed to be spread

				equally across the locality. The total emissions generated from this sub-sector were divided equally between all registered vehicles, so the methodology does not differentiate between vehicle category, fuel type or vehicle Euro standard.
	1A3bvi	Road transport: Automobile tyre and brake wear	Line	The total emissions from road transport were aggregated according to each road segment using the *Base Year 2017 scenario*. Annual average daily traffic was provided by Transport Malta (TM) and together with the length of link, was used to determine the total road transport derived emission, distributed within each grid cell using the following calculation: $$aVKM_y = (AADT_y * l * 365\ days)$$ Where: aVKM = annual vehicle kilometre travelled for all vehicle categories AADT = Average Annual Daily Traffic for all vehicle categories l = length of link (in km) y = all vehicle categories Road links were then allocated to their respective grid cell and the annual vkm for each link within each individual grid
	1A3bvii	Road transport: Automobile road abrasion	Line	

				was summed up. Emissions from these two sub-sectors were then divided according to the total vkm of each grid.
G_Shipping	1A3dii	National navigation (shipping)	Point	Emissions from the ferry link between the two sister islands of Malta and Gozo were divided equally between the two ports located in grid 4 and grid 9. Furthermore, for the recreational portion of vessels within the national navigation sector, Malta acquired data on the number of berths within each port and marina and assigned an equal share of emissions to all vessel types. In this context, Malta assigned an emission to each berth and multiplied this figure by the number of berths within a particular location. Emissions within each grid depended on the number of berths assigned to marinas and ports.
H_Aviation	1A3ai(i)	International aviation LTO (civil)	Point	Malta only has one airport located within one grid. As a result, emissions generated from both sectors were assigned to grid 2.
	1A3aii(i)	Domestic aviation LTO (civil)	Point	
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Area	The number of businesses falling within the NACE category A (Agriculture and Fisheries) were attributed to each grid.

				No distinction as to the size of the business was made as this data was not available. In this context, emissions were divided equally amongst all business and emissions within each grid were attributed according to the number of businesses within the grids.
	1A4ciii	Agriculture/Forestry/Fishing: National fishing	Area	Data for this sector was based on the number of fishing trips over a one year period, as provided by the Department of Fisheries and Aquaculture. The number of trips were allocated to the port of origin and emissions were divided equally amongst all trips. Therefore there was no distinction made between vessel size, fuel type, length of trip and destination.
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land	Point	Malta only has only two permitted landfills within the Magħtab Complex and both fall within grid 5. Therefore, emissions generated from the disposal on land were assigned in that grid.
	5C2	Open burning of waste	Area	Emissions derived from this sector were divided according to the share of utilised agricultural area (Aggregated Land Cover data (2021), ARPA) pertaining to each grid.

	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	Point	Emissions from the two anaerobic digestion facilities were allocated according to their location and respective grid cell.
	5D3	Other wastewater handling	Point	Emissions from wastewater treatment were divided according to the share of wastewater treated at each facility and allocated to their respective grid.
	5E	Other waste (cars + buildings)	Point	Data on the burning of cars and buildings were obtained from the office of the Civil Protection Department (CPD). Every event registered was assigned to the CPD office that responded to the call. Given that each office has jurisdiction over several localities (split over multiple grids), Malta first identified the portion of land area covered by every office for every grid. The number of cases for every office were then split according to the land area within that grid.
K_AgriLivestock	3B1a	Manure management - Dairy cattle	Area	The National Statistics Office (NSO) provided the number of animal heads registered per locality and these were assumed to be spread equally across each respective locality. In this context, the locality's land area was assigned to the grid and the number of animals per grid was assumed to be equal to the summation of areas of all localities within the grid, using the following methodology:
	3B1b	Manure management - Non-dairy cattle	Area	
	3B2	Manure management - Sheep	Area	
	3B3	Manure management - Swine	Area	
	3B4d	Manure management - Goats	Area	

				$$TA = \left(LA * \left(\frac{aL}{TaL}\right)\right)$$ Where: TA = total number of animals within an area LA = number of animals for every locality aL = the area of a locality within a grid TaL = total area of the respective locality
	3B4e	Manure management - Horses	Area	Emissions were divided based on the land area within each grid, since the number of animal heads was not available. In such cases Malta was construed as one polygon and the methodology established in Chapter 7, Section 3.4.2 of the Guidebook was used.
	3B4gi	Manure management - Laying hens	Area	The National Statistics Office (NSO) provided the number of animal heads registered per locality and these were assumed to be spread equally across each respective locality. In this context, the locality's land area was assigned to the grid and the number of animals per grid was assumed to be equal to the summation of areas of all localities within the grid, using the following methodology: $$TA = \left(LA * \left(\frac{aL}{TaL}\right)\right)$$ Where: TA = number of animals within an area LA = number of animals for every locality
	3B4gii	Manure management - Broilers	Area	

				aL = the area of a locality within a grid TaL = total area of the respective locality
	3B4giv	Manure management - Other poultry	Area	Emissions were divided based on the land area within each grid, since the number of animal heads was not available. In such cases Malta was construed as one polygon and the methodology established in Chapter 7, Section 3.4.2 of the Guidebook was used.
	3B4h	Manure management - Other animals	Area	
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)	Area	Emissions derived from this sector were divided according to the share of utilised agricultural area (Aggregated Land Cover data (2021), ARPA) pertaining to each grid.
	3De	Cultivated crops	Area	
	3Da2a	Animal manure applied to soils	Area	
	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Area	
	3F	Field burning of agricultural residues	Area	

8. Projections

The projections for this submission are based on the projections used in the National Energy and Climate Plan (NECP) for Malta, which was released in 2019. As explained in previous sections, the impact of COVID-19 in 2020 was reflected in the road transport and international aviation sectors. The same macro-economic parameters as those used in the NECP scenario were used. It is understood that following the pandemic, those parameters would need to be revised. Whenever revised parameters are available, projected data on fuel used will be made available for eventual calculation of emission projections.

Hence, projections post-2020 do not reflect the impact of the COVID-19 pandemic on pollutant emissions. Efforts will be made to update the projections in future submissions.

8.1. Trends for Nitrogen Oxides (NO_x)

NO_x emissions are projected to decrease from 2019 to 2030, with the greatest decrease being emissions in the road transport sector (1A3b). The projections show that NO_x emissions under both the WM and WaM scenarios, will be lower than the 2020 ceiling but significantly higher than the 2030 ceiling.

There is a considerable decrease of emissions in 2020 attributed to a decrease in LTOs for the aviation sector and a decrease in vehicle kilometres travelled in the road transport sector. Both of these decreases were caused by the partial lockdown carried out during the COVID-19 pandemic.

In projected year 2025, there is a small difference between the WM and WaM scenarios due to policy measures implemented in the national navigation sector. This difference in scenarios increases in 2030 due to a projected decrease in fuel use in the mentioned sector.

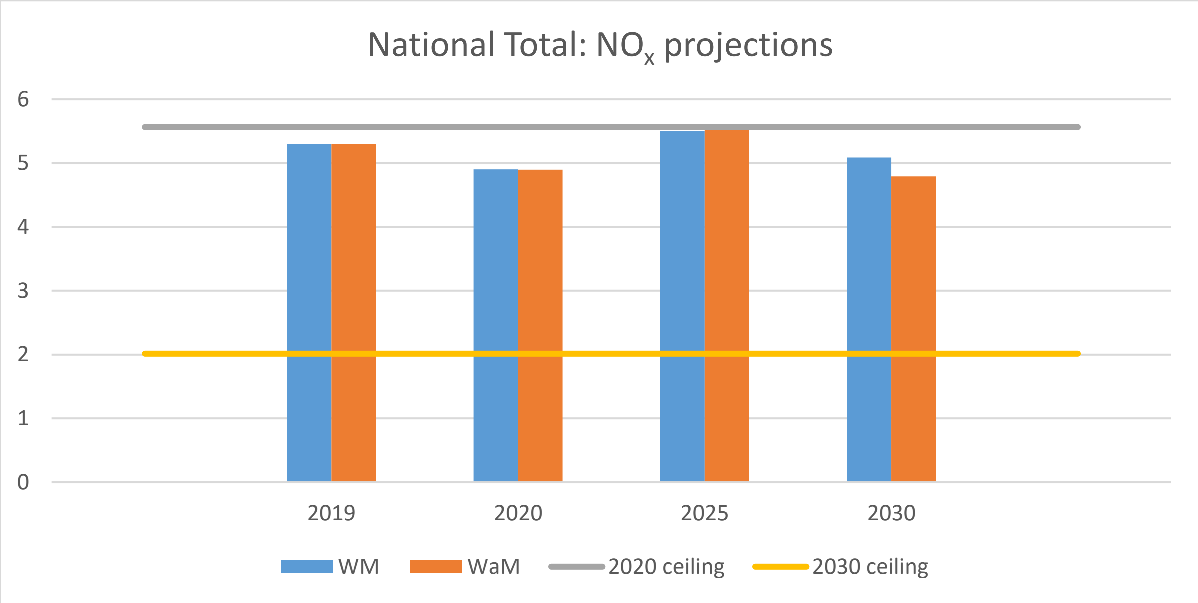

Figure 70: PROJECTIONS FOR NO_X IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

8.2. Trends for Non-Methane Volatile Organic Compounds (nmVOC)

nmVOC emissions are projected to decrease from 2019 until 2030, with the greatest decrease in emissions from the road transport sector (1A3b). The projections show that nmVOC emissions, under both the WM and WaM scenarios, will be higher than both emission ceilings.

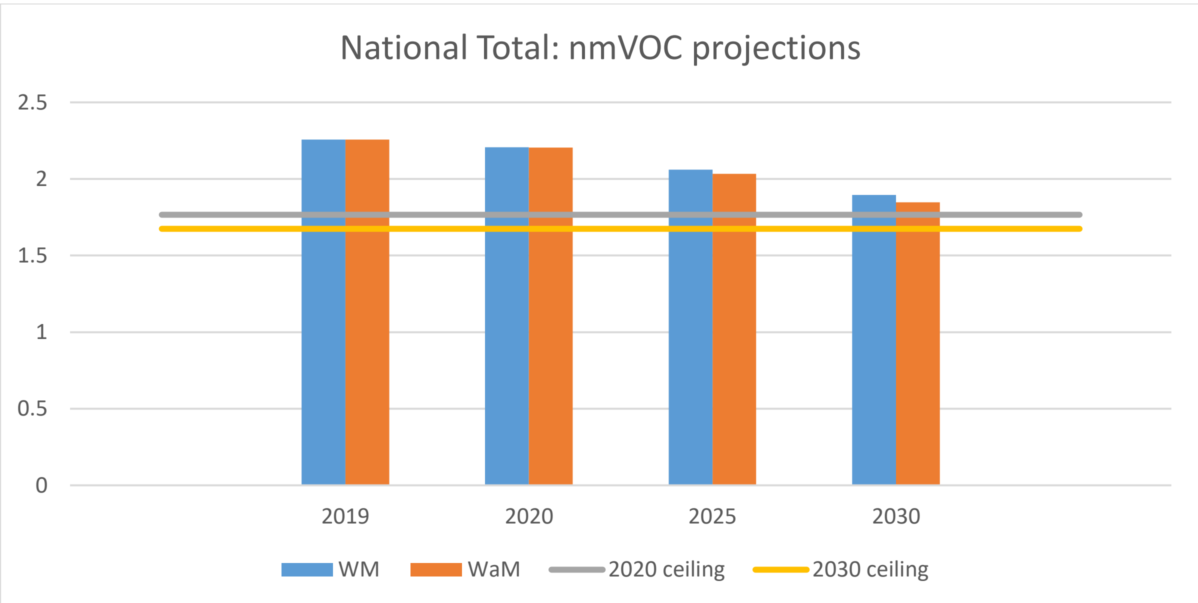

Figure 71: PROJECTIONS FOR NMVOC IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

8.3. Trends for Sulphur Oxides (SO_x)

SO_x emissions are projected to remain stable across the time series. The projections show that SO_x emissions, will be significantly lower than both the 2020 and 2030 ceilings, under both the WM and WaM scenarios.

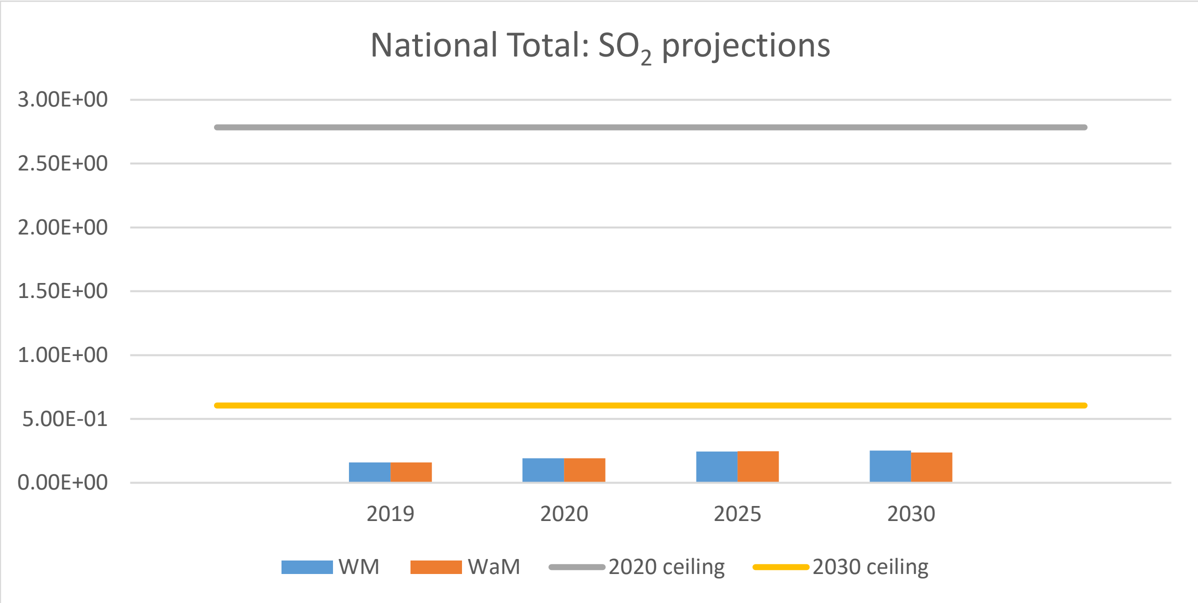

Figure 72: PROJECTIONS FOR SO_X IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

8.4. Trends for Ammonia (NH_3)

NH_3 emissions are projected to remain stable across the time series, as the livestock numbers are projected to remain stable. The projections show that NH_3 emissions will be lower than both the 2020 and 2030 ceilings, under both the WM and WaM scenarios. A small increase in emissions in the WaM scenario occurs from the 2025 projected year due to the commencement of operations of the WtE facility.

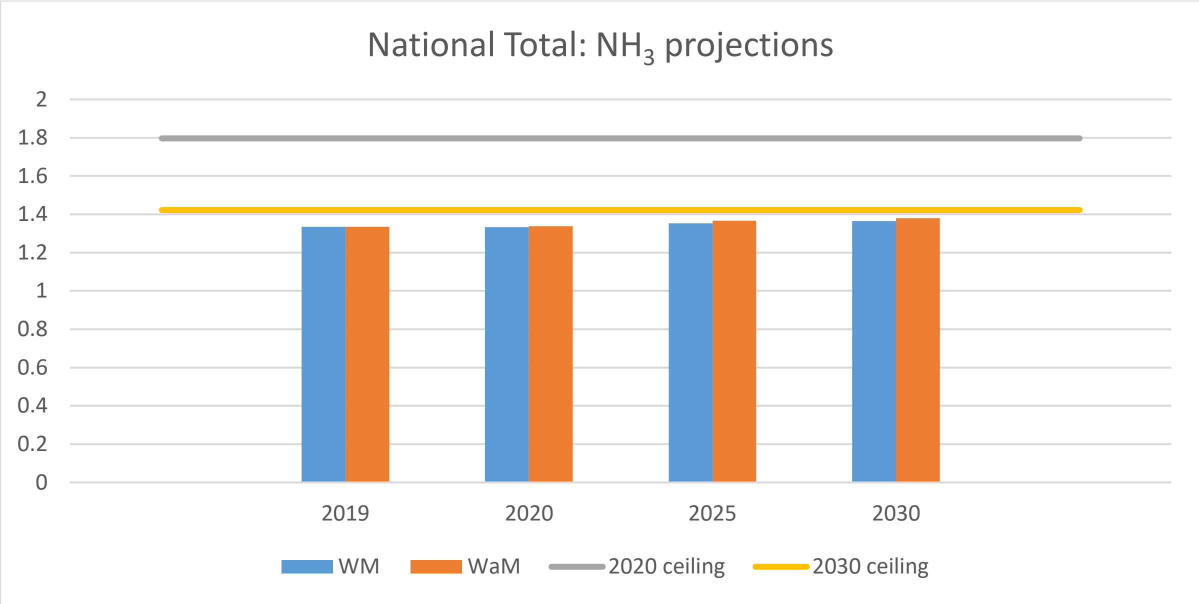

Figure 73: PROJECTIONS FOR NH_3 IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

8.5. Trends for Particulate Matter 2.5 ($PM_{2.5}$)

$PM_{2.5}$ emissions are projected to remain stable from 2019 until 2030. The projections show that $PM_{2.5}$ emissions, will be lower than both the 2020 and 2030 ceilings, for both the WM and WaM scenarios.

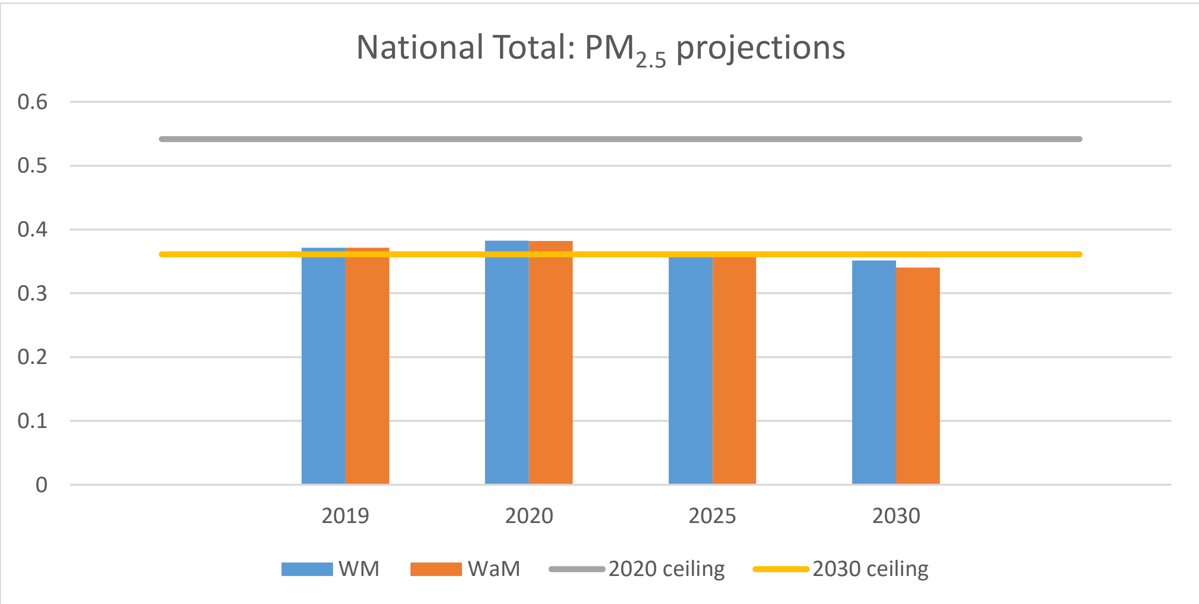

Figure 74: PROJECTIONS FOR $PM_{2.5}$ IN KT FOR 2019, 2020, 2025, 2030 (WM AND WAM SCENARIOS)

9. References

Camilleri, R., & Vella, A. J. (2016). Emission Factors for Aerial Pyrotechnics and Use in Assessing Environmental Impact of Firework Displays: Case Study from Malta. *Propellants, Explosives, Pyrotechnics*, 273-280.

European Environment Agency. (2019). *EMEP/EEA air pollutant emission inventory guidebook: Technical guidance to prepare national emission inventories.* Copenhagen: Luxembourg: Publications Office of the European Union.

Galdies, C. (2011). *The Climate of Malta: statistics, trends and analysis, 1951-2010.* Valletta: National Statistics Office.

National Statistics Office (NSO). (2014). *Census of Population and Housing 2011: Final Report.* Valletta: Government Printing Press.

National Statistics Office. (2020). Transport Statistics 2019 - Reference Year 2018.

Sustech Consulting. (2008). *Agricultural Waste Management Plan for the Maltese Islands.*

Timmers, V. R., & Achten, P. A. (2016). Non-exhaust PM emissions from electric vehicles. *Atmospheric Environment*, 10-17.

UNECE. (2015). *Guidelines for reporting emissions and projections data under the Convention on Long-range Transboundary Air Pollution.* Geneva: United Nations Economic Commission For Europe.

Annex I

The table below presents each pollutant, in Malta's emission inventory, and the sectors which contribute most to its emission.

Table 29: KEY CATEGORY ANALYSIS FOR 2019 DATA

Pollutant	NFR	NAME	% share
NOx (as NO_2)	1A3biii	Road transport: Heavy duty vehicles and buses	24.0%
	1A3bi	Road transport: Passenger cars	18.8%
	1A3ai(i)	International aviation LTO (civil)	10.6%
	1A4ai	Commercial/Institutional: Stationary	9.4%
	1A3bii	Road transport: Light duty vehicles	9.3%
	1A3dii	National navigation (shipping)	8.0%
NMVOC	2D3a	Domestic solvent use including fungicides	22.5%
	1A3bi	Road transport: Passenger cars	18.2%
	1A3bv	Road transport: Gasoline evaporation	10.8%
	3B1a	Manure management - Dairy cattle	6.2%
	1B2av	Distribution of oil products	6.0%
	3B4gii	Manure management - Broilers	4.5%
	1A3dii	National navigation (shipping)	4.1%
	2H2	Food and beverages industry	3.6%
	5A	Biological treatment of waste - Solid waste disposal on land	3.3%
	1A3biii	Road transport: Heavy duty vehicles and buses	3.3%
SOx (as SO_2)	1A3ai(i)	International aviation LTO (civil)	30.2%
	1A4ai	Commercial/Institutional: Stationary	22.7%
	1A3dii	National navigation (shipping)	17.0%
	1A1a	Public electricity and heat production	12.0%
NH_3	3Da2a	Animal manure applied to soils	39.3%
	3B3	Manure management - Swine	14.5%
	3B4h	Manure management - Other animals	11.1%
	3B1a	Manure management - Dairy cattle	8.4%
	3B1b	Manure management - Non-dairy cattle	8.1%
$PM_{2.5}$	2D3b	Road paving with asphalt	18.7%
	1A4bi	Residential: Stationary	13.7%
	1A3bvi	Road transport: Automobile tyre and brake wear	9.9%
	1A3bi	Road transport: Passenger cars	9.2%
	1A3bii	Road transport: Light duty vehicles	8.4%
	1A3biii	Road transport: Heavy duty vehicles and buses	8.2%
	2G	Other product use (please specify in the IIR)	7.5%
	1A3dii	National navigation (shipping)	4.5%
PM_{10}	2D3b	Road paving with asphalt	53.1%
	1A3bvi	Road transport: Automobile tyre and brake wear	7.2%
	1A4bi	Residential: Stationary	5.3%

	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	4.1%
	2G	Other product use	4.0%
	1A3bi	Road transport: Passenger cars	3.5%
	1A3bii	Road transport: Light duty vehicles	3.2%
TSP	2D3b	Road paving with asphalt	79.8%
	1A3bvi	Road transport: Automobile tyre and brake wear	3.0%
BC	1A3bi	Road transport: Passenger cars	24.5%
	1A3bii	Road transport: Light duty vehicles	21.3%
	1A3biii	Road transport: Heavy duty vehicles and buses	19.0%
	1A4ai	Commercial/Institutional: Stationary	11.8%
	2G	Other product use (please specify in the IIR)	7.2%
CO	1A3bi	Road transport: Passenger cars	65.5%
	1A3biii	Road transport: Heavy duty vehicles and buses	5.2%
	1A3biv	Road transport: Mopeds & motorcycles	4.9%
	1A3ai(i)	International aviation LTO (civil)	4.4%
Pb	1A3bvi	Road transport: Automobile tyre and brake wear	52.8%
	2G	Other product use	43.2%
Cd	2G	Other product use	45.9%
	2D3i	Other solvent use	29.4%
	1A4bi	Residential: Stationary	12.6%
Hg	2D3a	Domestic solvent use including fungicides	43.3%
	1A3bi	Road transport: Passenger cars	20.9%
	1A1a	Public electricity and heat production	17.8%
As	1A1a	Public electricity and heat production	53.6%
	1A3dii	National navigation (shipping)	12.2%
	1A4ai	Commercial/Institutional: Stationary	9.9%
	2G	Other product use	6.0%
Cr	1A3bvi	Road transport: Automobile tyre and brake wear	66.6%
	2D3i	Other solvent use	14.5%
Cu	1A3bvi	Road transport: Automobile tyre and brake wear	64.5%
	2D3i	Other solvent use	26.0%
Ni	1A4ai	Commercial/Institutional: Stationary	51.9%
	2D3i	Other solvent use	14.0%
	1A4ciii	Agriculture/Forestry/Fishing: National fishing	11.8%
	1A3dii	National navigation (shipping)	7.4%
Se	2D3i	Other solvent use	36.8%
	5C1bv	Cremation	23.9%
	1A3dii	National navigation (shipping)	13.6%
	1A3bvi	Road transport: Automobile tyre and brake wear	13.2%
Zn	1A3bvi	Road transport: Automobile tyre and brake wear	45.5%
	2D3i	Other solvent use	31.3%
	1A4bi	Residential: Stationary	5.4%

PCDD/ PCDF (dioxins/ furans)	5C1bv	Cremation	95.8%
benzo(a) pyrene	1A4bi	Residential: Stationary	56.2%
	1A4ai	Commercial/Institutional: Stationary	16.0%
	1A3bi	Road transport: Passenger cars	12.3%
benzo(b) fluoranthene	1A4ai	Commercial/Institutional: Stationary	33.1%
	1A4bi	Residential: Stationary	27.7%
	1A2gviii	Stationary combustion in manufacturing industries and construction: Other	19.3%
benzo(k) fluoranthene	1A4ai	Commercial/Institutional: Stationary	49.2%
	1A4bi	Residential: Stationary	19.8%
	1A3bi	Road transport: Passenger cars	8.9%
	5C2	Open burning of waste	8.3%
Indeno (1,2,3-cd) pyrene	1A4bi	Residential: Stationary	54.0%
	1A3bi	Road transport: Passenger cars	17.2%
	1A4ai	Commercial/Institutional: Stationary	14.1%
HCB	5C1bv	Cremation	98.8%
PCBs	5C1bv	Cremation	99.2%