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**Report for the Stage 3 *ad-hoc* review of emission
inventories submitted under the UNECE LRTAP
Convention:**

STAGE 3 REVIEW REPORT

DENMARK

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INTRODUCTION

The mandate and overall objectives for the emission inventory review process under the LRTAP Convention is given by the UNECE document '*Updated methods and procedures for the technical reviews of air pollutant emission inventories reported under the Convention*'⁽¹⁾ – hereafter referred to as the 'Review guidelines 2018'.

1. Paragraph 7 (c) of the 'Review guidelines 2018' defines that stage 3 reviews may be annual centralized reviews or ad hoc reviews. Paragraph 18 of the 'Review guidelines 2018' further specifies that such ad hoc reviews could, for instance, focus on specific source sectors, specific pollutants such as heavy metals or persistent organic pollutants, gridded and projections data, or on other areas as requested by the Implementation Committee and that where appropriate, ad hoc reviews could be conducted in line with the present Methods and Procedures for the In-depth (Stage 3) review.

2. At its seventh joint session in September 2021 the Steering Body and the Working Group approved the plan to perform (in 2022) an in-depth review of PM_{2.5} emissions from residential heating and road transport, with a special focus on the topic of '*condensable particulate matter*' and a follow-up review of the implementation of recommendations given as part of the review carried out in 2021. The Parties reviewed in 2021 are Kazakhstan, Liechtenstein, Monaco and Montenegro.

3. Particulate matter can exist as solid or liquid matter (the "filterable" portion) or as gases (the "condensable" portion). Condensable particulate matter is vapour phase at stack conditions, but condenses and/or reacts upon cooling and dilution upon discharge into ambient air to form solid or liquid PM. All condensable PM is assumed to be in the PM_{2.5} size fraction². The inclusion of the condensable component of PM_{2.5} emissions can have a big impact on the emission estimate for certain sources³.

4. This ad-hoc review has assessed PM_{2.5} emission estimates with a special focus on the topic of '*condensables*' for the years 2000 to 2020. Further, for Denmark the implementation of all findings from the in-depth review 2021 have been assessed for all pollutants covered by LRTAP Convention and its protocols (SO₂, NO_x, NMVOC, NH₃, plus PM₁₀ PM_{2.5}, BC, 3 HMs and POP_s) for the time series years 1990 – 2020.]

5. This report covers the results of the stage 3 centralised review (ad hoc review) 2022 of the UNECE LRTAP Convention of Denmark coordinated by the EMEP emission centre CEIP acting as review secretariat. The review took place between April and June 2022 and was performed as desk review with an in person meeting between 30 of May 2022 and 3 June 2022. The following team of nominated experts from the roster of experts performed the review.

¹ Decision 2018/1 adopted by EB: *Updated methods and procedures for the technical review of air pollutant emission inventories reported under the Convention*. ECE/EB.AIR/142/Add.1
https://unece.org/fileadmin/DAM/env/documents/2018/Air/EB/ECE_EB.AIR_142_Add.1-1902937E.pdf

² [Condensable Particulate Matter Definition | Law Insider](#)

³ For more technical details please refer to the EMEP/EEA Guidebook (<https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>) or the report 'How should condensables be included in PM emission inventories reported to EMEP/CLRTAP?' https://emep.int/publ/reports/2020/emep_mscw_technical_report_4_2020.pdf

Ad hoc review - condensables

1A3b Road Transport: Gudrun Stranner, Katrina Young, Magdalena Zimakowska-Laskowska, Martina Toceva and Rebecca Rose

1A4bi Residential: stationary: Aleksandra Nestorovska-Krsteska, André Amaro, Benjamin Cuniasse, Canan Esin Köksal, Damian Zasina, Laureta Dibra, Marion Pinterits, Sam Gorji and Wolfgang Schieder

6. Kristina Saarinen and Jeroen Kuenen were the lead reviewers. The review was coordinated by Sabine Schindlbacher (EMEP Centre on Emission Inventories and Projections - CEIP).

7. The review was performed on the basis of CLRTAP emission data officially reported by Denmark due by 15 February 2022 for emission inventories. The Informative Inventory Reports (IIR), reported due 15 March 2022 under the CLRTAP, informed the review.

8. The emission inventory of Denmark was received on 15 February 2022 and thus by the deadline of 15 February. The Informative Inventory Report was received on 15 March 2022 and thus by the deadline of 15 March.

RECOMMENDATIONS FOR IMPROVEMENTS TO THE PARTY

1.A.4.b.i Residential: stationary

9. Denmark use a Tier 2 and a Tier 3 methodology for calculating PM_{2.5} emissions from the Key Category '1A4bi – Residential: stationary', which is in line with current Reporting Guidelines' paragraph 21⁴.

10. The activity data is based on modelling. The model input is taken from official statistics, various surveys and research studies. The ERT notes that the activity data is described transparently in the Informative Inventory Report. In the 'Future work' Chapter 7, *Updating the emission model for RWC* (p. 73) it is indicated that the total number of appliances is based on data from chimney sweepers for the year 2017. The ERT recommends Denmark to update the information on appliances as soon as possible.

11. The activity data for Denmark do not include collected wood, i.e. wood directly harvested from the forest outside formal market activity. The total wood consumption is estimated using the heat energy demand derived from appliances.

12. The total fuel consumption for each fuel type has been stratified into different appliance types, such as boilers and stoves, in a consistent and complete manner. The basis for this split over appliance types is documented in the IIR and in an external report.

13. Denmark uses the EMEP/EEA Guidebook 2019 emission factors for gaseous fuels, and country specific methodology for biomass for the compilation of emissions from this category.

14. The Party informed the ERT that the country specific methods used in the calculation of emissions are based on external studies, but did not provide detailed information on the measurement/sampling standards or equipment used. This data is provided in an external, non-English report⁵ (see paragraph 16 below). The ERT recommends Denmark to include in the next IIR submission information on the measurement standards and/or equipment used. In case different measurements/equipments are used for different types of equipment it is recommended that these are also documented in the IIR.

15. The measurements include the condensable component of particulate matter (CPM).

16. The rules of determining emission factors from measurements are supplied in another separate report entitled *Dioxin, PAH og partikler fra brændeovne*⁶. The ERT notes that the report, however, does not seem to include results from combustion phases of start-up (ignition) and end (ember). The ERT recommends Denmark to include an English summary of these information into the next IIR submission and also encourages including a discussion of the uncertainty from different variables, mentioned in the Party's response.

17. The ERT found the information included in the IIR to be transparent and sufficient. The Party does not take into account user induced impacts that affect emission levels from those during "normal combustion" (the so-called user impact), which covers e.g. the use of wet/unclean wood or poor management of air circulation in the appliance. While the user

⁴ Reporting Guidelines paragraph 21: "For sources that are determined to be key categories in accordance with the EMEP/EEA Guidebook methodologies, Parties should make every effort to use a Tier 2 or higher (detailed) methodology, including country-specific information."

⁵ https://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR212.pdf

⁶ https://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR212.pdf.

impact is not yet included in the inventory, the ERT encourages the Party to collect data on 'the average national circumstances' e.g. through studies or expert judgement/data collection by chimney sweepers, and to incorporate the information in the inventory for the next submissions.

18. The emission factors partially include the condensable component of PM_{2.5} emissions (Table 1).

Table 1: Inclusion of condensables per fuel type

Fuel Type	Includes the condensable component of PM _{2.5} emissions
Biomass	Yes
Coal	NO ('solid' fuels not occurring in the Annex I)
Liquid	NO ('other' fuels not occurring in the Annex I)
Gaseous	Yes

19. The ERT notes that the potential inconsistencies that can be suggested during the analysis of the emission time series are result of model assumptions and input data about fuel consumption. The methodology is consistent and widely described in a separate report.

20. The PM_{2.5} emissions from small combustion are according to the IIR spatially distributed using various proxy data, e.g. population. Spatial distribution of Denmark's emission is done using the SPREAD model which is characterized in a separate.

21. Denmark lists the following planned improvements for future submissions:

- Constant development of the emission model for residential wood combustion is carried out when new information comes available.

The ERT commends Denmark for their improvement plan and recommends implementing the improvements as scheduled.

22. In addition, the ERT recommends Denmark to implement the following:

- Updating the residential wood combustion model as frequently as possible.

1.A.3.b.i-iv Road transport exhaust emissions

23. Particle emissions from the transport sector are calculated using emission factors from version 5.4 of COPERT. All emission factors in COPERT are based on the Tier 3 methodology of the 2019 EMEP/EEA Guidebook. The IIR provides details of the main features of the model. The IIR describes the calculation of transport emissions transparently.

24. The activity data is taken from official statistics.⁷

25. PM_{2.5} emissions from road transport exhaust include the condensable component of particulate matter. The ERT recommends that Denmark include a statement in the road transport chapter of the IIR confirming whether the condensable component of PM_{2.5} is included in emissions estimates or not.

⁷ Jensen, T.C. 2021: Dokumentation af konvertering af trafiktal til emissionsopgørelser, arbejdsnotat 81834, 38 pp. DTU Transport, 2021

26. The ERT notes that the method is documented transparently in the IIR.

27. The time series is consistent.

28. Denmark lists the following planned improvements for future submissions in their IIR:

- Fuel consumption and emission factors for road transport vehicles will be updated.

The ERT commends Denmark for their improvement plan and recommends implementing the improvements as soon as possible.

29. In addition, the ERT encourages implementing the following:

- To follow the recommended structure of the IIR detailed in Annex II of the 2014 Guidelines for Estimating and Reporting Emission Data, which includes an appendix with a table summarising the use of PM emission factors that include/exclude the condensable component, where available.

REVISED ESTIMATES AND TECHNICAL CORRECTIONS CONSIDERED AND/OR CALCULATED BY ERT

30. In the Appendix of the 'EMEP/UNECE Review Guidelines 2018'⁸ it is stated that if the ERT consider that when emissions are significantly under- or overestimated, then during the review, the Party is invited to submit "Revised Estimates" that address the issue raised. Should the Party decline to do this, or should it not be possible to agree on the quantification of the Revised Estimates, then the ERT may calculate a "Technical Correction" in the absence of an updated emission estimate being provided by the Party itself. The threshold for significance for a technical correction for the in-depth review in 2022 was set at 2% of the national total, i.e. findings identified which result in an over- or under-estimate of emissions of more than 2% of the national total can result in a Technical Correction. The methods for calculating the Technical Corrections are set up in the "Review Guidelines 2018" and use the EMEP/EEA Emission "Inventory Guidebook" as a reference for methods and emission factors.

31. Denmark did not submit any revised estimates and the ERT did not calculate any technical corrections.

⁸ https://www.ceip.at/fileadmin/inhalte/ceip/3_review/advance_version_ece_eb.air_142_add.1.pdf

LIST OF MATERIAL PROVIDED TO ERT

1. Denmark's Stage 2 S&A report
2. Denmark's Stage 1 report 2022
3. Denmark's IIR 2022
4. NFR tables submitted in 2022

LIST OF ADDITIONAL MATERIAL PROVIDED BY THE COUNTRY DURING THE REVIEW

5. Responses to preliminary question raised prior to the review
6. Responses to questions raised during the review