

Technology and Economic Assessment Panel

Response to Decision XXXV/7: Emissions of HFC-23

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on behalf of the TEAP

Decision XXXV/7: Emissions of HFC-23

2. To request the Technology and Economic Assessment Panel to prepare a report to the Thirty-Sixth Meeting of the Parties containing information regarding:
 - a) The quantity of HFC-23 being consumed, by country and by sector;
 - b) Updated estimates on the amounts of HFC-23 generated at and emissions from HCFC-22 production facilities including methodology with respect to such emissions. In preparing this information, the Technology and Economic Assessment Panel should take into account information reported under paragraph 3 ter of Article 7 by all parties that manufacture Annex C, Group I and/or Annex F substances, as well as information from other sources;

Decision XXXV/7: Emissions of HFC-23

- Paragraph 1 – Request to Science Assessment Panel, as presented.
- Paragraph 5 – Invitation to parties to provide information to the Panels that may help inform the reports. No information provided.
- This TEAP report updates information in the 2022 MCTOC Assessment Report and the 2023 TEAP Response to Decision XXXIV/7: Strengthening institutional processes with respect to information on HFC-23 by-product emissions.

TEAP's Response to Decision XXXV/7

- MCTOC led preparation of the report on behalf of TEAP.
- MCTOC and SAP collaborated closely in preparation of their comprehensive reports and conclusions that support further consideration by parties.
- For paragraph 2(a), MCTOC consulted TEAP experts to address HFC-23 consumption from other relevant sectors.
- For paragraph 2(b), MCTOC estimated or documented amounts of HFC-23 generated at and emitted from HCFC-22 production facilities.
- For additional context, consistent with previous reports, updated information is provided on other HFC-23 emissions from consumptive and emissive uses of HFC-23, including as by-product from the production of other Annex C, Group I, and Annex F substances.

Background (1)

- There are several chemical mechanisms that can generate HFC-23 as a by-product in chemical production processes, including:
 - ***Over- or under-reaction of chemicals*** present in the reaction vessel enroute to the intended product, e.g., HFC-23 is an over-fluorination of HCFC-22.
 - ***Presence of impurities in the feedstocks that are being reacted***, e.g., chloroform impurity in dichloromethane feedstock, used to produce HFC-32, is hydro-fluorinated to HFC-23.
 - ***Unintended side reactions***, where the feedstock follows a different reaction path than the one that is desired to make the product, e.g., cleavage of carbon-carbon bond in the production of HFC-125 from perchloroethylene, with subsequent hydro-fluorination of the resulting mono-carbon molecule to form HFC-23.

Background (2)

- The generation of HFC-23 as a by-product during HCFC-22 production is far greater than the amount of HFC-23 required for use as feedstock or for consumption.
- Parties to the Kigali Amendment in which HCFC-22 is produced are required to destroy HFC-23 using a destruction technology, e.g., incineration, approved by the Montreal Protocol.
- Operation and maintenance of incineration facilities to destroy HFC-23 by-product is a cost to the companies responsible for its generation, particularly as HCFC-22 is a low profit margin product.

Quantity of HFC-23 being consumed, by country and by sector (1)

- Information on consumption is not always readily available to the level of detail requested in the decision, i.e., by country and by sector.
- HFC-23 consumption and feedstock use data are not available for all parties due to the timing of reporting obligations associated with ratification of the Kigali Amendment.
- Some data are available from other sources relating to the quantities used for each of the applications.

Quantity of HFC-23 being consumed, by country and by sector (2)

- HFC-23 is consumed as a feedstock and in very small quantities in emissive uses for fire suppression, very low temperature refrigeration, and semiconductor and electronics manufacturing.
- Several parties that manufacture Annex C, Group I and/or Annex F substances capture the HFC-23 that is generated for feedstock and/or emissive uses, or divert it for destruction; alternatively, parties produce HFC-23 separately for feedstock and/or emissive uses.

Quantity of HFC-23 being consumed, by country and by sector (3)

- Reported HFC-23 consumption was 3,684.3 tonnes (2022):
 - 2,614.3 tonnes for non-feedstock uses (A7 and published by US EPA 2022).
 - 1,070 tonnes for feedstock use (A7 for 2022).
 - Fire protection: Small consumption compared to HFC-227ea.
 - RACHP: Very small consumption in ultra-low temperature refrigeration.
 - Etchant and chamber cleaning in semiconductor and electronics manufacturing: Average annual growth rate has been approximately 15%, with global consumption of 277 tonnes in 2013 increasing to 720 tonnes in 2020.

Updated estimates on quantities of HFC-23 generated at, and emissions* from, HCFC-22 production facilities

- To update estimates, the methodology and information used by MCTOC was:
 - Article 7 data on quantities of **HCFC-22 production** and **HFC-23 emissions** are reported by parties under mandatory obligations.
 - Timing of obligations impacts completeness for HFC-23 emissions data, which was supplemented with reported UNFCCC data for the USA.
 - Data on quantities of **HFC-23 generated** from HCFC-22 production are reported by parties on a voluntary basis and are not published by party in this report. HFC-23 generation data are not reported by all parties known to produce HCFC-22.
 - MCTOC applied estimated HFC-23 by-product generation rates to A7 reported HCFC-22 production quantities to estimate HFC-23 by-product generation quantities.

*Emissions are defined as the total HFC-23 emitted from a facility that generates HFC-23 as a by-product after any abatement

Updated estimates on quantities of HFC-23 generated at, and emissions from, HCFC-22 production facilities (2022)

- Total HCFC-22 production reported under A7 was about 1,197,000 tonnes (A5, 989,638 tonnes; non-A5, 207,362 tonnes).
- Estimated HFC-23 by-product generation from HCFC-22 production is in the range of about 18,000 to 36,000 tonnes. This is consistent with the HFC-23 generation data reported by parties on a voluntary basis.
- Total HFC-23 emissions from HCFC-22 production reported under A7 and UNFCCC (for USA) was about 836 tonnes.

TEAP estimates of HFC-23 emissions from known emissions sources (1)

- Updated estimates of global HFC-23 emissions are provided, including from facilities that manufacture Annex C, Group I, or Annex F substances and emissive uses, as previously presented in the September 2023 TEAP Report in response to decision XXXIV/7.
- Current best estimates of HFC-23 emissions are based on known sources and updated available information included in the report and from the September 2023 TEAP Report.
- Some of these are broad estimates where further information to improve their accuracy is currently not available.

TEAP estimates of HFC-23 emissions from known emissions sources (2)

- TEAP estimates HFC-23 emissions from known emissions sources at about **1,470–3,540 tonnes per year** in recent years.
- Excludes SAP estimate of the potential additional source of HFC-23 from atmospheric oxidation (**less than 430 tonnes per year** in recent years).
- Under UNFCCC's Category 2 Industrial Processes and Product Use for net HFC-23 emissions and removals, total reported HFC-23 emissions for Annex I parties only were **1,431 tonnes** for 2021.
- In comparison, based on atmospheric observations, SAP reports estimated global HFC-23 emissions of **13,900 ± 700 tonnes** for 2022.

Summary, uncertainties, and inferences from differences in HFC-23 emissions estimates (1)

- There are large differences between TEAP and SAP estimates of global HFC-23 emissions (1,470–3,540 tonnes cf. $13,900 \pm 700$ tonnes).
- Uncertainties in atmospheric-derived estimates cannot explain the difference between SAP and TEAP estimates.
- Differences between TEAP and SAP estimates cannot currently be explained with the data reported under A7 and other sources.
- TEAP has identified all the major sources likely to contribute most of the HFC-23 emissions and these are outlined in the report.

Summary, uncertainties, and inferences from differences in HFC-23 emissions estimates (2)

- Around 95% of estimated total global **HFC-23 by-product generation** is from HCFC-22 production.
- A major portion of TEAP's estimate of total **HFC-23 emissions** comes from data reported under A7 and UNFCCC for HFC-23 emissions, predominantly from HCFC-22 production.
- For known sources other than HCFC-22 production, uncertainties in TEAP estimates of HFC-23 emissions from these relatively smaller emission sources are unlikely to bridge the difference between TEAP and SAP estimates.
- Any unknown smaller sources are unlikely to bridge the large difference between TEAP and SAP estimates.

Summary, uncertainties, and inferences from differences in HFC-23 emissions estimates (3)

- There are unknowns and uncertainties surrounding A7 data reporting for HFC-23 emissions, including how facilities are measuring and reporting HFC-23 emissions.
- Given the large difference between TEAP and SAP estimates, the question arises whether data is accurate and/or combined from all the sources required under Article 7.
- Consideration of approaches used by parties when measuring and reporting HFC-23 emissions might address some of the current unknowns and uncertainties.
 - E.g., Guidance for facilities in measuring, estimating, and reporting emissions is available under the UNFCCC Guidelines and from national governments.
- Refinements to Data Form 6 might help address some of these issues.
- Parties may wish to consider refinements to the reporting of HFC-23 emissions.