environmental investigation agency

A Bridge to the Future: 40 Years of Success and Unprecedented Challenges Ahead

EIA Briefing to the 37th Meeting of Parties to the Montreal Protocol
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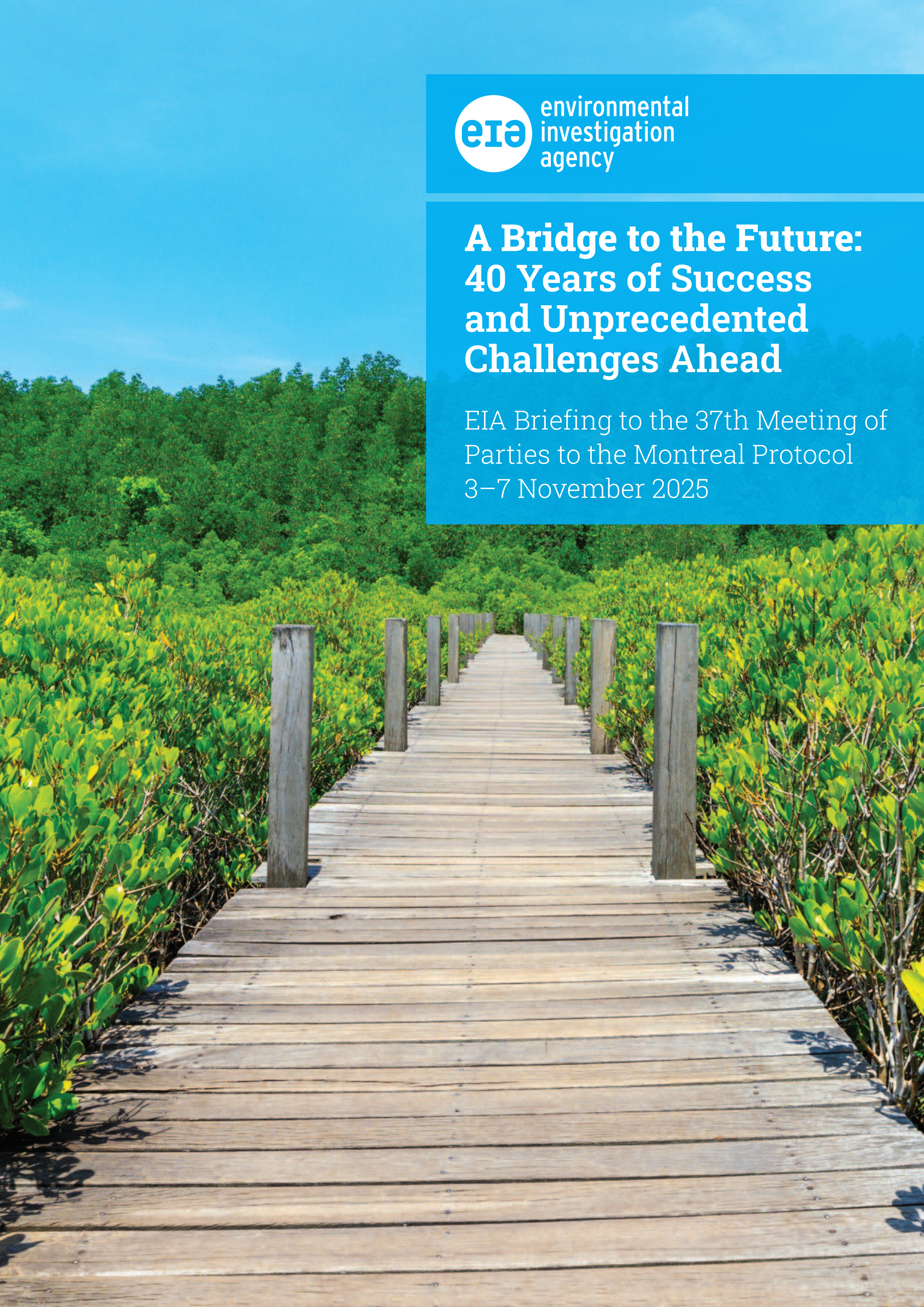


Introduction

As the international community marks four decades of the Vienna Convention, the achievements made under the treaty and its Montreal Protocol stand as proof that, by following the science and prioritising the protection of human health and the environment, collective action can successfully respond to global environmental crises.

Today we face an unprecedented need for urgent action as global warming is projected to overshoot 1.5°C within a few years. The planet is passing its first climate tipping point as ocean temperatures rise more rapidly than previously expected and warm-water coral reefs collapse, threatening livelihoods and food sources for millions of people.[1] Meanwhile emissions of ozone-depleting nitrous oxide (N_2O) are ballooning, and the feedstock use of otherwise controlled ozone-depleting substances (ODS) is further intensifying - even the full recovery of the ozone layer can no longer be guaranteed. The science is clear: current action is insufficient. Yet, every tonne of super-pollutant emissions avoided this decade remains a decisive opportunity to steer the planet toward recovery.

At this meeting, Parties will be presented with numerous opportunities to rise and meet these challenges. The draft terms of reference for the 2027-29 Multilateral Fund (MLF) replenishment are pivotal in ensuring sustained investment in the future of the Montreal Protocol. Meanwhile, the informal meeting on facilitating implementation of the Montreal Protocol underscores a recognised need to strengthen and modernise the treaty's institutions. Robust reporting, licensing and quota systems, capacity building, effective monitoring and enforcement, and the active role of the Implementation Committee, must remain central to these deliberations. A separate briefing on this informal meeting is available.[2]

Now more than ever, the Montreal Protocol must demonstrate multilateralism at its best and uphold the principles of fairness and equity. With this in mind, and conscious of item 14 of the provisional agenda on Classification of the State of Palestine as a Party operating under paragraph 1 of Article 5, EIA stresses the importance of ensuring that all Parties are able to participate fully under the treaty, recognising that climate change and ozone depletion are global issues that affect us all.

Terms of reference for the study on the 2027-2029 replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol

The 2027-2029 triennium will be a critical juncture in the implementation of the Montreal Protocol and its Kigali Amendment. As we approach the total phase-out of the production and consumption of hydrochlorofluorocarbons (HCFCs) in 2030, important milestones will also be reached in the concurrent phase-down of hydrofluorocarbons (HFCs). In 2028, Group 2 Article 5 (A5) countries will implement their HFC freeze, and in 2029, Group 1 A5s will meet their first HFC phase-down step (10% reduction from baseline). With these dual HCFC and HFC targets to meet, the 2027-2029 period represents both a challenge, and an opportunity to strengthen the Montreal Protocol.

EIA emphasises that **the terms of reference (TOR) for the study must include analysis relevant to maintaining all existing work being carried out by the MLF, and to the work that will be necessary to meet the growing needs of A5 Parties now pursuing dual phase-out and phase-down obligations**. It is crucial to acknowledge, and not to underestimate, the difficulties inherent in implementing the concomitant HCFC and HFC phase-out and phase-down.

To tackle the climate crisis, the 2027-2029 replenishment must maintain, and expand on, the additional funding offered to countries submitting Kigali Implementation Plans (KIPs) with phase-down targets that go beyond bare compliance. Due to the HCFC component,[3] and in some cases instances of stockpiling, many A5 HFC baselines provide for a level of consumption that far exceeds their actual need (as reflected during baseline years, and the years immediately following). Without more ambitious KIP targets, we will not see real-term reductions in HFC consumption this decade. Rather, the use and subsequent emission of HFCs will continue to rise.

To make financial resources go further, KIPs must be integrated with the final stages of HCFC Phase-Out Management Plans (HPMPs) to optimize implementation and encourage leapfrogging of HFC-based technologies where possible. For example, demonstration projects that pilot natural refrigerants or not-in-kind (NIK) technologies should align with long-term conversion strategies. The foundations laid in the HPMPs, such as the institutional frameworks for licensing, technician certification and customs enforcement, should also be expanded under KIPs for maximised effectiveness.

It is crucial that Parties are given the funding and support needed to develop the infrastructure, policies, safety standards and building codes required to scale up ultra-low GWP natural refrigerants, especially in those sectors where they are already available. Such support is even more vital given the growing scientific evidence that many fluorinated chemicals are a source of persistent pervasive per- and polyfluoroalkyl (PFAS) pollution, contributing to environmental contamination and posing potentially significant human health risks.[4]

Finally, with over 100 countries having made use of a soon-closing MLF funding window to draw up inventories of their unwanted ODS banks and plans for their disposal, it is now incumbent on Parties to ensure that funding is available to see these plans swiftly and fully implemented.

EIA appreciates the progress made by Parties at the 47th Open Ended Working Group (OEWG), including the submission of a joint conference room paper (CRP) by Australia, Canada, Japan and the United Kingdom.[5] EIA recommends the following items be included in the TOR for the Technology and Economic Assessment Panel (TEAP) replenishment report.

Elements for inclusion in the TOR for the TEAP replenishment report:

- Financial incentives for A5 Parties proposing early and/or more ambitious action under KIPs, when backstopped by phase-down targets that go beyond compliance with the Kigali Amendment;
- Additional funding to support the unique needs and challenges faced by low-volume-consuming (LVC) and very-low-volume-consuming (VLVC) countries in achieving their long-term phase-down goals;
- Resource allocation to support training and capacity building, and for activities to maintain and/or enhance energy efficiency, including demonstration and pilot projects, especially for the safe adoption of climate-friendly natural refrigerants;
- Resource allocation for activities to support best practices for end-of-life management, including the implementation of plans for the collection and disposal of controlled substances identified in national inventories of banks;
- Additional sustainable funding modalities for pilot projects to strengthen and enhance regional atmospheric monitoring, especially given the unexpected and unexplained data discrepancies in emissions of controlled substances like HFC-23;
- Increased funding for institutional strengthening and further capacity building and modernization of the Protocol's core compliance mechanisms for monitoring and reporting, including the compliance assistance programme (CAP), especially given the rising threat of illegal trade.

Emissions of HFC-23

The latest Scientific Assessment Panel (SAP) update suggests that the Montreal Protocol's Kigali Amendment is beginning to curb global HFC-23 emissions, but progress is inadequate and not achieving anticipated emission reductions. Despite reductions since the 2018-19 estimated peak emissions of 16.9 ± 0.7 kt/yr, measured emissions remain far higher than reported figures, exposing major data and potential compliance gaps.

Global emissions have declined even as HCFC-22 production rose by 15%, potentially suggesting some level of increased abatement efforts. Atmospheric measurements show HFC-23 emissions in 2023 were 14.2 ± 0.7 kt, slightly below 2022 levels. However, a substantial gap of 9.6-13.3 kt remains between measured (top-down) and reported or estimated (bottom-up) emissions.[6]

According to the TEAP, HCFC-22 production is still believed to be the dominant source of HFC-23 by-product formation, accounting for an estimated 95%. The ratio of HFC-23 emissions relative to HCFC-22 production (E_{23} /P_{22}) fell to roughly 1.1% in both 2022 and 2023. This value is approximately half of what would occur without abatement, indicating that some abatement is taking place. Still, this rate is significantly higher than the 0.1-0.3% derived from reported emissions and the value defined by the Multilateral Fund as destruction "to the extent practicable".

TEAP's 2025 HFC-23 report provides an updated assessment of estimated sources of HFC-23 emissions, in total estimating between 1.6-3.7 kt/yr.[7] However, the only updated data are estimated emissions from HCFC-22 production, which are updated from 2022 values to 2023. All other estimates of known emission sources (e.g., TFE/HFP manufacture, other fluorochemical manufacturing, fire protection, feedstock use, low-temperature refrigeration) remain the same as previously reported in 2024, and many of these estimates have wide ranges of uncertainty.

EIA stresses the urgent need for more data to better understand polytetrafluoroethylene (PTFE, "Teflon") production processes, which account for approximately 70% of the global fluoropolymer market. A 2024 study in Eastern China found significant correlations, including similar seasonal patterns, between emissions of HFC-23 and perfluorocyclobutane (PFC-318, c-C_4F_8), a co-product of PTFE production using HCFC-22.[8] A 2019 study found that while Eastern China is a major source of PFC-318 emissions associated with PTFE production, notable emissions also occur in India and Russia.[9] The increased HFC-23 levels in these regions further suggest that TFE–HFP–PTFE chemistry is a key contributor. The 2019 study also noted that at least one PTFE production facility in Zhejiang province, operated by Juhua Group Corporation, has produced hydrofluoroolefins (HFO-1234yf) since 2016 using a process based on the pyrolysis of HCFC-22 to TFE and HFP - the same chemistry used for PTFE production, which can generate PFC-318 and HFC-23 as by-products.[10]

Fundamentally, the HFC-23 emissions gap still cannot be explained with the data currently available to the Montreal Protocol's expert panels. Either abatement is not occurring at the levels reported, or there are additional, unknown sources of substantial HFC-23 emissions, or both. Regional atmospheric data suggest that under-reporting is occurring. Emissions from eastern China have declined but they still account for around 40 ± 5% of global emissions in 2023 and are significantly larger than expected based on reports to the MLF on by-product abatement. In the two regions where total HFC-23 emission reports and regional measurements are available – Western Europe and Japan – the atmospheric data also suggests under-reporting (see Table 1). Indeed, every monitored region shows higher estimated emissions than expected, often to a significant extent. Given that regional monitoring is able to attribute less than half of global emissions, with important gaps in Argentina, India, Mexico, the Russian Federation, the United States and the rest of China, comparable under-reporting in other regions could account for some of the missing emissions. This underscores the urgent need for stronger regional monitoring, reporting and verification.

The TEAP points out that a key uncertainty is how facilities are measuring HFC-23 emissions (including amounts from equipment leaks, process vents and destruction devices) and that consideration of approaches to measuring and reporting HFC-23 emissions might address some of the unknowns and uncertainties. While UNFCCC provides guidance for estimating and reporting HFC-23 by-product emissions, no standardised methodology or best practice guidance exists under Article 7. Decision XXXVI/3 invited Parties to share their methodologies for estimating and reporting HFC-23 emissions, but only four of the ten Parties with HCFC-22 production responded to this request. The submissions revealed major differences in the methods used and assumptions made to estimate HFC-23 emissions, as well as measures that are in place for verification. The need for consistency is further demonstrated by the striking discrepancy in Russia's reported data to the UNFCCC of 760 and 818 tonnes of by-product-related HFC-23 emissions in 2021 and 2022, compared to zero under Article 7.

The continued large gap between reported and observed emissions of HFC-23 is a priority compliance challenge for the Parties which demands a strong response. At a very basic level, reporting on this critical issue is highly inadequate. Inconsistencies between UNFCCC and Montreal Protocol data highlighted in EIA's 2024 report remain.[11]
EIA has the following recommendations on emissions of HFC-23:

- **Additional information sharing and transparency:** Parties with HCFC-22 and fluoropolymer production provide transparent comprehensive information, including on HFC-23 generation. There is also a strong need for more information around the geographic locations and scales of PTFE production as well as up-to-date information on abatement technologies in place in PTFE facilities and reported emissions.

- **Establish a technical task force:** Set up a task force to develop an accounting methodology and guidelines for measuring, controlling and reporting HFC-23 emissions, taking into account current practices by Parties, MLF experience and UNFCCC guidelines.

- **Strengthen monitoring networks:** Expand atmospheric monitoring and sharing of atmospheric data in those regions responsible for remaining HCFC-22 production (including US, Russian Federation, India and the rest of China).

- **Investigate unaccounted sources:** Undertake research into other potential sources including other fluorochemical production.

- **Re-examine feedstock exemption:** The use of HCFC-22, HFC-23 and other controlled substances as feedstock must be re-examined, given the clear evidence that emissions are not 'negligible'.

Figure 1: Annual global HFC-23 emissions derived from atmospheric monitoring. HFC-23 emissions are from Stanley *et al.*, (2020), SAP (2024), SAP (2025) and WMO (2022).

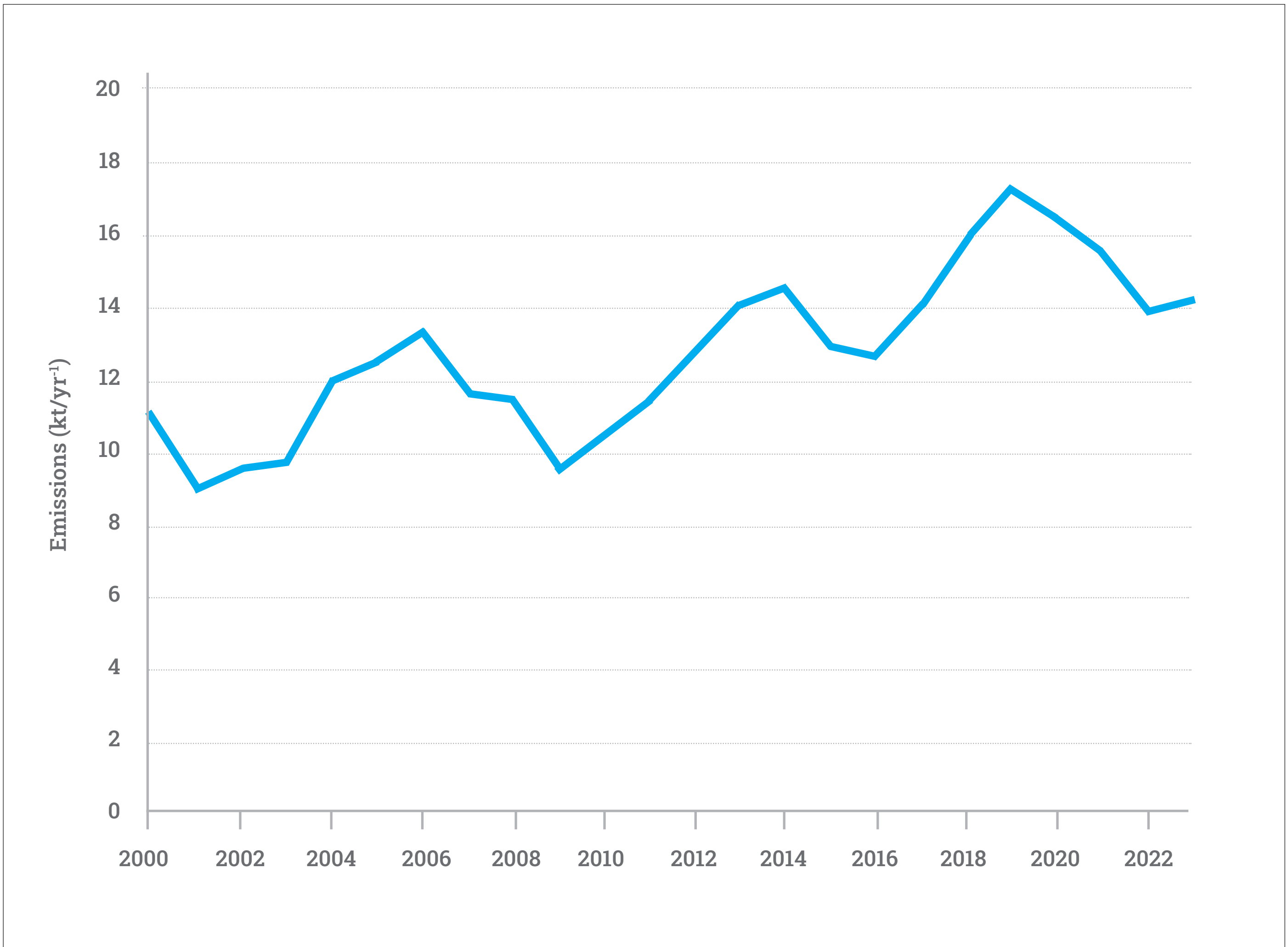


Table 1: Reported and observed data on HFC-23 emissions.

Region [a]	2023 emissions inferred from atmospheric monitoring (kt)	2023 by-product emissions reported under Article 7 (kt)	2022 total and by-product emissions reported to UNFCCC (kt)	Proportion of global emissions based on atmospheric monitoring 2023 [b]
Global	14.2 ± 0.7	0.959		
North-west Europe	0.15 ± 0.04	0.0051	0.022 total (0.01 by-product)*	~1%
China	E China: 5.6 ± 0.7	0.9	**N/A**	E China: 40 ± 5%
Japan	W Japan: 0.10 ± 0.07	0.00004	0.009 total (0.0003 by-product)**	W Japan ~0.7%
Democratic People's Republic of Korea (DPRK)	0.01 ± 0.01	0.008	**N/A**	~0.1%
Republic of Korea (ROK)	0.23 ± 0.02	0	**N/A**	~1.6%
Argentina	**Unavailable**	0	**N/A**	**Unavailable**
India	**Unavailable**	0	**N/A**	**Unavailable**
Mexico	**Unavailable**	0.000004	**N/A**	**Unavailable**
Russian Federation	**Unavailable**	0	0.845 total (0.818 by-product)***	**Unavailable**
United States of America	**Unavailable**	0.044	0.253 total (0.224 by-product)	**Unavailable**

The terms *Unavailable* and *N/A* represent distinct data limitations. *Unavailable* indicates that no atmospheric monitoring data exist (or are public) for the region, preventing independent estimation of emissions. As a result, associated values derived from these data are also unavailable. *N/A* denotes the absence of reporting to the UNFCCC, meaning no officially submitted data are available for those countries.

Proportion of emissions gap filled by disparity between reporting and regional emissions (SAP, 2025)	Number of HCFC-22 production facilities (2023)	Estimated percentage of global HCFC-22 production [(c)]	Notes
	48		Global emissions have decreased by 16 ± 6% since 2019
0.7-1.5%	3	~5.5%	NW Europe includes Ireland, UK, France, Netherlands, Belgium, Luxembourg and Germany. This includes most but not all HCFC-22 producing countries in the EU with Italy being the notable exception.
E China: 40 ± 10%	23	~68%	Most of China's HCFC-22 production is concentrated in Eastern China. Emissions observed from Eastern China have decreased from 2019 peak.
W Japan, ROK, DPRK: 1.5-3%	4	<2.5%	Western Japan only includes a portion of the country's HCFC-22 production facilities. The sum of emissions detected across this region is notably smaller than the period 2018-2022.
	1		
	1		
Unavailable	1	15%	
Unavailable	5		
Unavailable	1		
Unavailable	2		
Unavailable	10		

Footnotes:

a Australia is not included in this table despite the availability of regional monitoring data, since emissions are minor and lower than UNFCCC reported data.

b Based on SAP (2025). Where SAP did not give figures, this was calculated based on the measured emissions and the global total emissions in 2023 of 14.2 kt.

c Based on SAP (2025) and estimates made for China's share of global production in 2017 according to UNEP/OzL.Pro/ExCom/82/68 Corr1.

* Note that in 2022, the Netherlands reported zero emissions under Article 7 but 10.4 tonnes by-product to the UNFCCC.

** Note that in 2022, Japan reported only 0.000034 kt under Article 7.

*** Note that Russian Federation reported zero emissions in 2022 under Article 7.

Gosan Regional Station, (Jeju Island, Republic of Korea), operates as part of the Advanced Global Atmospheric Gases Experiment (AGAGE) network to take high-precision, high-frequency measurements for a wide range of CFCs, HCFCs, HFCs, PFCs, Halons and other halocarbons.

Enhancing regional atmospheric monitoring of substances controlled by the Montreal Protocol

Parties should continue to work with urgency to close gaps in the regional monitoring of emissions of controlled substances and to ensure sufficient resources are available to sustain and strengthen the existing global network of monitoring stations, including through the establishment of a funding window this year for pilot projects under the MLF.

At OEWG47, the Advisory Committee announced it had expanded to include six new experts and shared key outcomes of the EU-funded pilot project, noting Observation System Simulation Experiments (OSSEs) are a key preliminary step in positioning measurement sites to capture upwind emissions.[12] The informal session resulted in delegates calling on the Secretariat and the General Trust Fund (GTF) to present a suggested allocation of funds for future atmospheric monitoring activities to the 37th Meeting of the Parties (MOP37).

Clearer guidance on the complementarity of funding under the MLF and GTF will aid planning for regional monitoring projects. EIA notes that the 2025 budget allocates USD $400,000 from the cash balance of the Trust Fund for the Montreal Protocol to assess potential sites for regional emissions monitoring.[13] Further, while the EU pilot project concludes at the end of 2025, there is funding through a short-term grant of EUR 4.5 million to UNEP from the EU to support the establishment of three monitoring stations. In addition, the 98th Meeting of the Executive Committee (ExCom) of the MLF is requested to consider a funding modality to support a limited number of pilot projects to enhance regional atmospheric monitoring.[14] **EIA recommends that Parties ensure this specific monitoring MLF funding window is established at the next ExCom**.

The global HFC-23 emission gap, which emerged in 2015, persists a decade later.[15] This problem is not unique to HFC-23; the 2022 Scientific Assessment of Ozone Depletion reported unexplained emissions of chlorofluorocarbons (CFCs)-13, 112a, 113a, 114a, 115, and carbon tetrachloride (CCl_4, CTC), attributing emissions to feedstocks, by-products and unknown sources.[16] Atmospheric monitoring also revealed unexpectedly high emissions of CFC-11 in 2018, which then subsequently rapidly declined.[17] This highlights both the benefit and the need for additional regional-scale monitoring to close major gaps in the global monitoring network.

Given the difficulty explaining the large discrepancy between atmospheric monitoring and reported emissions over the last decade and the urgency to locate the sources, Parties should consider significant investment in regional atmospheric monitoring stations and seek collaborative funding options.

Strategies to address accumulated refrigerant banks nearing end of life in A5 Parties

EIA has long advocated for a response under the Montreal Protocol to the issue of refrigerant banks. With more than 100 A5 Parties having now drawn up inventories of their unwanted ODS banks (per ExCom Decision 91/66),[18] it is timely to consider both how the collection and disposal of existing banks should be funded, and how the accumulation of future banks can be prevented; particularly in countries with limited recovery, recycling, reclamation and destruction capabilities.

EIA welcomes the draft decision submitted by Chile, Cuba and the Dominican Republic, which asks the TEAP to prepare a comprehensive report for MOP39 analysing global quantities of used refrigerant, existing destruction and reclamation sites, and scenarios addressing the benefits of avoided ozone depletion and emissions associated with end-of-life refrigerant management.

While supportive of the requests put forward in the jointly submitted draft decision, **EIA recommends that the analysis in the requested TEAP report is expanded to consider potential consequences of increased international transport of used refrigerants and the estimated costs involved, particularly as they relate to stockpile management and the potential risk for illegal trade in controlled substances**.

Past cases of illegal trade have exploited weaker controls on used materials, including the mislabeling of virgin refrigerants as recycled, or diverting waste shipments to black markets.[19] EIA encourages the TEAP to evaluate these risks and identify measures to prevent similar exploitation under expanded transboundary movement. EIA also recommends inviting Parties developing new reclamation or destruction facilities within the next two years to share this information with the TEAP, ensuring that the report to MOP39 reflects the most up-to-date global capacity.

As cross-border transport for reclamation and destruction increases, importing countries may record inflated consumption levels, requiring adjustment under Decisions XVIII/17 and XXII/20.[20] EIA suggests requiring Parties to declare specific destruction timelines and reviewing reporting procedures to ensure follow-through. Additionally, higher volumes of imported used refrigerants heighten the need for strong safeguards against leaks and illegal diversion. While current decisions require measures to prevent such losses, EIA recommends that the adequacy of these provisions be reviewed to strengthen lifecycle management and environmental protection.

EIA outlines the above concerns for consideration, however, we note that proactively financing capacity-building for reclamation and destruction in-country would mitigate some of the risks associated with increased transboundary shipments of used refrigerant.

Importantly, on the point of financing, EIA notes that the initial proposal included text to consider the role of carbon markets in funding activities related to refrigerant banks, which was removed from the proposal during discussions at OEWG47. **EIA strongly supports the removal of this text, being firmly of the view that carbon offset credits do not represent a sustainable solution to managing end-of-life ODS and HFCs, serving only to delay real climate action**. The myriad and systemic issues with carbon crediting, and with a carbon market-based approach to refrigerant management specifically, are discussed in our 2024 briefing ‘Polluting the Protocol’.[21]

Feedstock uses of controlled substances

The Montreal Protocol has a feedstock problem - one rooted in two early decisions that shaped how feedstock uses are treated under the treaty.

The first was Decision II/1 (the London Amendment), in which the Parties established that “production” refers to “controlled substances produced […] minus the amount entirely used as feedstock in the manufacture of other chemicals.”[22] This effectively excluded feedstock use from calculations of both production and consumption under the treaty, as well as from associated control measures. Around the same time, however, the London Amendment did require Parties to report on the quantities of controlled substances used as feedstocks (specifically their production, imports and exports) under paragraph 3 of Article 7.[23]

The second was Decision IV/12, in which the Parties agreed that trace amounts of controlled substances resulting from inadvertent or coincidental production, unreacted feedstock or their use as process agents would not be considered controlled substances under paragraph 4 of Article 1.[24]

Together, these foundational decisions established the basis for how feedstocks are treated under the Protocol’s control and reporting framework: the ODS and HFCs used as feedstocks are controlled substances (albeit with the caveat about insignificant quantities), but are not subject to production or consumption controls.

Now, however, a growing body of evidence refutes the assumption underpinning the feedstock exemption, indicating that feedstock use does lead to significant emissions.

While other applications of ODS have been, or are being, phased out, the feedstock exemption has allowed production to grow significantly, reaching 1.96 million tonnes of ODS and 183,527 tonnes of HFCs in 2023.[25] As a result, some controlled substances are now being produced in greater volumes than ever before. For example, the 2022 Scientific Assessment reported that, by 2019, global HCFC-22 production reached almost 1,000 Gg, the highest of any fluorocarbon in history.[26] Over 70% of this production was for feedstock use.[27] By 2023, output of HCFC-22 had risen to 1,175 Gg (1.175 million tonnes),[28] with 969,354 tonnes for feedstock.[29] Meanwhile, Annex I CFC production has also increased to 222,304 tonnes,[30] a volume around 50% greater than in 1998.[31]

These figures actually underestimate true production and emissions. Many industrial processes make intermediate chemicals used immediately in further on-site reactions, without separating or selling them as individual products.[32] These chemicals are not reported as production for feedstock use, however they are still likely to have implications for total emissions, both from leakage of the intermediates themselves and through potential by-products such as HFC-23.

EIA investigator setting up infrared detection equipment outside Honeywell International's fluorochemical facility at Baton Rouge, Louisiana, USA. EIA investigators detected an array of fluorinated gas emissions from the fenceline of the facility, including several CFCs and HFCs not reported by the facility in recent years of mandatory greenhouse gas and toxic substances reporting.[33]

The 2022 Scientific Assessment of Ozone Depletion assessed emissions for a range of regulated ODS feedstocks, estimating 2019 total emissions to be 37.2-58.9 Gg, equivalent to 88.1-145.8 million tonnes of CO_2 equivalent ($MtCO_2e$).[34] More recent science further underscores the urgency, and significance, of this large-scale industrial production with a drumbeat of studies sounding the alarm bell.[35]

At MOP36, in Decision XXXVI/5, Parties were invited to provide information on their practices and technologies to manage emissions of controlled substances during their production and use as feedstock.[36] The submitted information highlighted that emissions occur across the lifecycle and that various measures are needed to prevent these emissions.[37]

The emissions factors identified by the TEAP and SAP further support this conclusion.[38] Nevertheless, transparency on fluorochemical production and feedstocks is almost entirely absent, hampering the ability of the TEAP and SAP to understand the emissions and limiting the information available for policymakers. EIA notes with concern that despite a total of seventeen Parties reporting use and/or production of ODS feedstocks in 2023, only four provided information in response to Decision XXXVI/5.[39]

In light of the mounting evidence around feedstock emissions, which already serves to undermine the rationale for the feedstock exemption, Parties should take further steps at MOP37 to address the feedstock problem. In particular, EIA recommends:

- **Information sharing and transparency:** Parties provide comprehensive data on the production and use of controlled substances as feedstock, differentiated by chemical and end product, with information on the processes used, their potential emissions and potential alternatives and;

- **TEAP analysis:** TEAP analyse the information submitted and recent scientific publications, providing regular updates in its annual progress reports.

GIZ / Anton Sahler

Refrigeration and Air Conditioning (RAC) technicians from 11 countries participated in 'Cool Training 2025: Advancing Know-How On Natural Refrigerants Worldwide', held by the Bundesfachschule Kälte-Klima-Technik (BFS), and organized by GIZ Proklima on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ).[40]

National and regional initiatives to support the implementation of the Kigali Amendment to the Montreal Protocol

Achieving sustainable cooling and cold chains demands a holistic approach that considers entire systems and value chains and addresses critical factors including refrigerants and energy efficiency. Several recent initiatives have sought to promote such innovative approaches. Of particular interest are centres of excellence, state-of-the-art programmes for applied research, technical assistance, learning, teaching and knowledge transfer, among other activities.

Foremost among these centres is the Africa Centre of Excellence for Sustainable Cooling and Cold-Chain (ACES) in Rwanda, which deploys a coordinated suite of solutions. ACES has also pioneered a hub-and-spoke model, which allows ACES (the hub) to scale up and roll out its services to other countries via specialised outreach and knowledge establishments (spokes).[41]

At present, an ACES-linked spoke in Kenya is operational with two others under development in Senegal and Lesotho. Another example includes the Haryana-UK Centre of Excellence on Sustainable Crop Post-Harvest Management and Cold Chain in India, scheduled to open in 2027, with several spokes planned.[42]

Other centres, many focusing on energy efficiency, have also proliferated. These include the ASEAN Centre of Energy,[43] East African Centre of Excellence for Renewable Energy and Efficiency (EACREEE),[44] Southern African Centre for Renewable Energy and Energy Efficiency (SACREEE)[45] and Energy Evaluation Asia Pacific (EEAP).[46] These energy efficiency-specific centres could further support Kigali implementation.

Taken together, centres of excellence offer exciting opportunities for enhanced cooperation and alignment of energy efficiency-focused efforts with the Montreal Protocol. Centres for excellence could also be highly complementary in building capacity to support adoption of HFC alternative technologies and workforce development, as well as energy efficiency activities.

Against this backdrop, Rwanda and the United Kingdom have submitted a draft decision to bring information to the Parties, and to explore what enhanced role, if any, regional centres of excellence can play to support Kigali implementation.

EIA strongly supports the Rwanda-UK draft decision, believing that Parties should welcome the opportunity to explore how centres of excellence can assist with on-the-ground implementation of KIPs, learning more about their modalities, costs, outputs, scope and institutional arrangements, and considering how they can cooperate with existing Montreal Protocol institutions and activities, such as the CAP and funding under the MLF. EIA further supports the draft decision's call for a funding window, which would allow ExCom to gain experience with centres of excellence, helping to develop best practices and establish interlinkages with the delivery of sustainable cooling and cold chains.

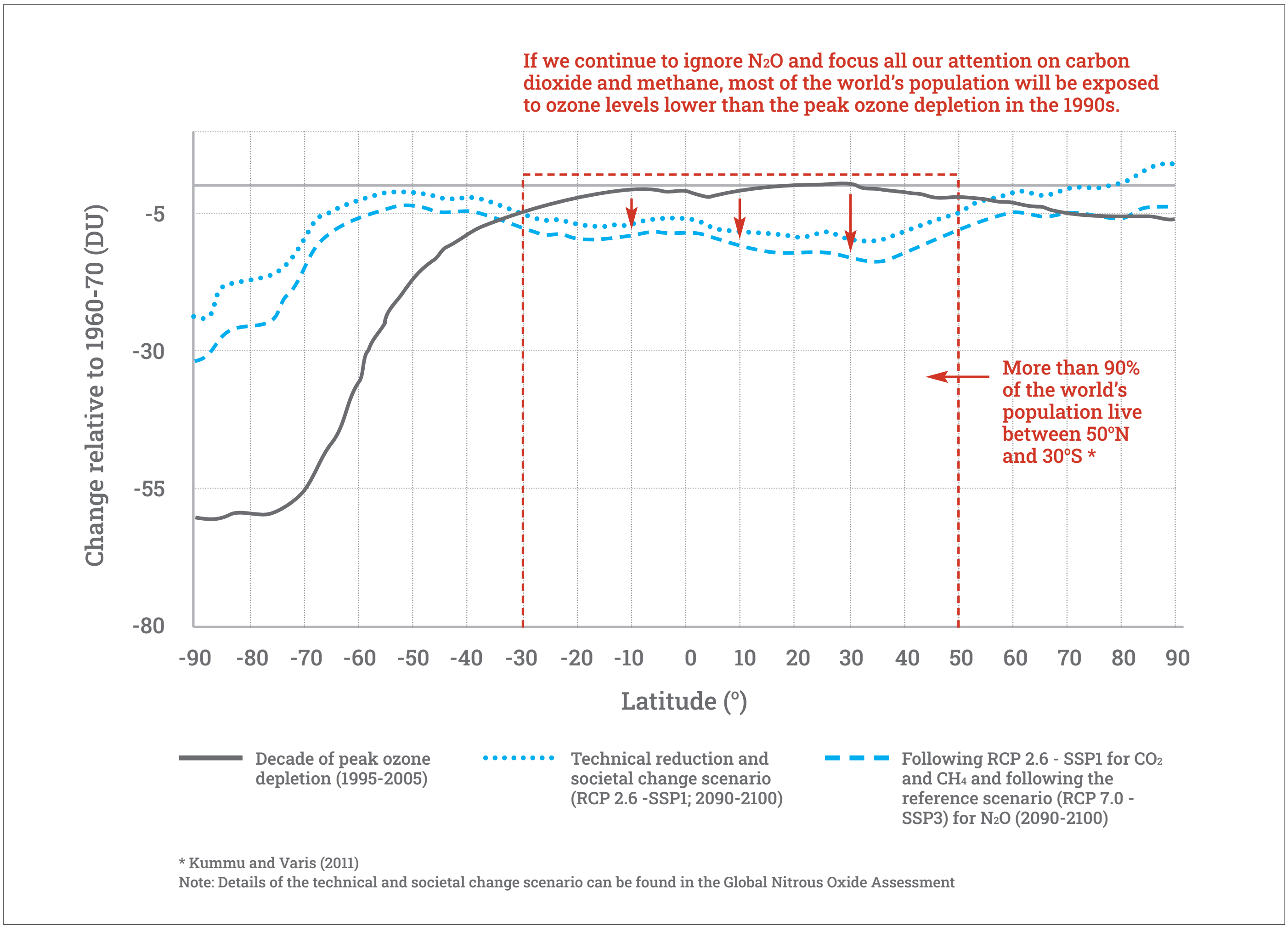
Emissions of nitrous oxide and the role of the Montreal Protocol

Nitrous oxide (N_2O) is the world's most significant ODS, with annual emissions now equivalent to those of all Montreal Protocol-controlled ODS combined (weighted by ozone depletion potential; ODP).[47] It is also the third most important greenhouse gas, after carbon dioxide (CO_2) and methane, and is responsible for around 10% of warming to date (~0.1°C).[48] With emissions up 40% since 1980, and still accelerating, the threat posed by N_2O is becoming increasingly profound.[49]

There is no credible pathway to 1.5°C without decisive action on N_2O,[50] and the threat to stratospheric ozone is similarly stark. In a scenario where CO_2 and methane are reduced, but emissions of N_2O are left unchecked (in line with the latest Nationally Determined Contributions submitted under the Paris Agreement), stratospheric ozone would be driven to even lower levels than the previous period of peak of ozone depletion (1995-2005) (see Figure 2).[51] This would result in greater UV exposure globally, raising skin cancer rates by up to 10% and increasing instances of cataracts.[52]

Agriculture accounts for around three-quarters (~75%) of anthropogenic N_2O emissions, mostly due to fertiliser over-use and poor manure management.[53] Around 5% of emissions come from industrial sources, mainly the production of nitric and adipic acid, and the remaining ~20% arise from fossil fuel combustion, wastewater treatment, aquaculture and biomass burning.[54] Importantly, proven and cost-effective solutions to mitigate emissions across many of these sectors already exist.

Figure 2: Global N_2O Assessment (2024): total column global ozone in Dobson units for the decade of peak ozone depletion (1995–2005), compared with the end of the 21st century following the technical reduction and societal change scenario (RCP 2.6 -SSP1-2.6; 2090–2100) and the end of the 21st century following RCP 2.6 - SSP 1-2.6 for carbon dioxide and methane but following the reference scenario (RCP 7.0 - SSP3-7.0) for nitrous oxide, relative to the pre-ozone-depletion period. Credit: CCAC



Abatement of N_2O emissions from adipic and nitric acid production globally is achievable at prices below USD $20. Improved fertiliser management and the adoption of best practices and technologies, meanwhile, could reduce agricultural emissions by 40% by 2050, without threatening food security.[55]

The case for action on N_2O is overwhelming. Ambitious abatement could avoid up to 235 billion tonnes of CO_2e emissions by the end of the century, equivalent to more than six years of current fossil fuel emissions.[56] Such a reduction would also safeguard the recovery of the ozone layer and prevent up to 20 million premature deaths worldwide by 2050 due to a reduction in harmful co-emitted air pollutants (notably ammonia and nitrogen oxides, or NO_x).[57] These are benefits on a scale that few other environmental interventions can match.

The threat posed to stratospheric ozone recovery, a direct challenge to the legacy of the Montreal Protocol, now demands that Parties contend with N_2O. **As a first step, EIA recommends Parties should request that the SAP and the TEAP prepare reports on N_2O emissions, their implications for ozone recovery, and the technical options for their control and abatement**.

From there, Parties should consider introducing requirements for the abatement of industrial by-product emissions. This is a clear "low-hanging fruit" opportunity, which could avoid 2.5 billion tonnes of CO_2e emissions by 2050.[58] Industrial emissions are well-suited for controls under the Montreal Protocol and indeed, a precedent for controlling by-product emissions was introduced under the Kigali Amendment in relation to HFC-23.[59]

Aligning with efforts under the UNEP Nitrogen Working Group, and other international frameworks, will be critical to avoid duplication and ensure coherence. But only the Montreal Protocol has the track record, framework and enforcement mechanisms to deliver the kind of robust, coordinated action required. Bringing this overlooked ODS under the purview of the Montreal Protocol would protect the ozone layer, help to stabilise the climate and safeguard the health of millions. With proven solutions at hand, the time to act is now.

Coral bleaching in Ningaloo, Western Australia, February 2025. The world has passed its first climate tipping point, with the widespread mortality of warm-water coral reefs. We are dangerously close to further catastrophic tipping points with global warming set to breach 1.5°C.

As the planet approaches the moment of overshooting 1.5ºC of warming and passes its first climate tipping point, we urge Parties to come together and continue to show multilateralism at its best by following the science, upholding principles of fairness and equity, and taking action.

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