Climate Super Pollutants
A short guide

environmental investigation agency

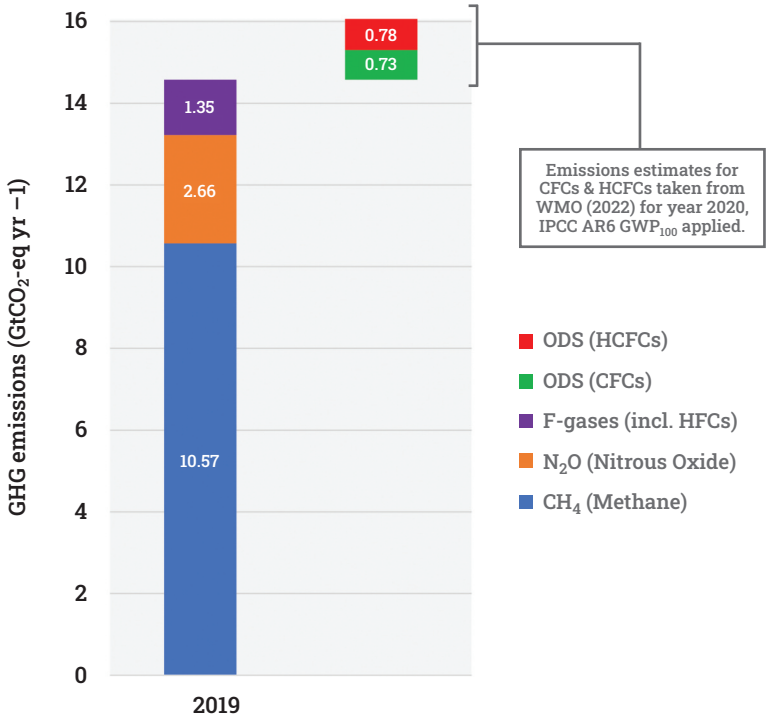
Introduction

The global call to action on climate change is clear – to have any chance of limiting warming to 1.5°C, we must reduce global greenhouse gas emissions to at least 43 per cent below 2019 levels by 2030.[1] For this to happen, immediate action must be taken to ensure that global emissions peak before 2025 and are then rapidly and sustainedly reduced for the rest of the decade.[2]

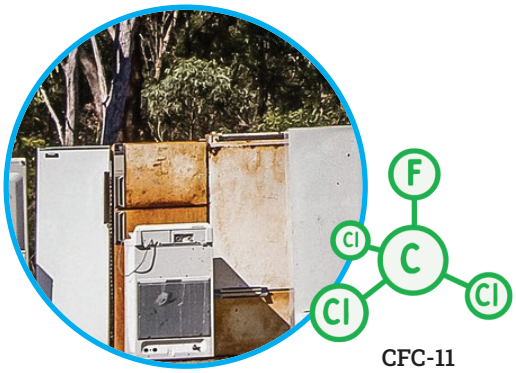
Meeting this target will require substantial reductions in global CO_2 emissions, but there are a number of other greenhouse gases that contribute significantly to climate change and these must also be addressed.

Together, methane, nitrous oxide, F-gases[3] and ozone-depleting substances (ODS)[4] make up more than one-quarter of our annual greenhouse gas emissions globally.[5] To avoid catastrophic climate change, rapid and sustained reductions are also required in emissions of these gases, many of which are short-lived climate pollutants (SLCP) that have a disproportionate impact on warming in the near term.

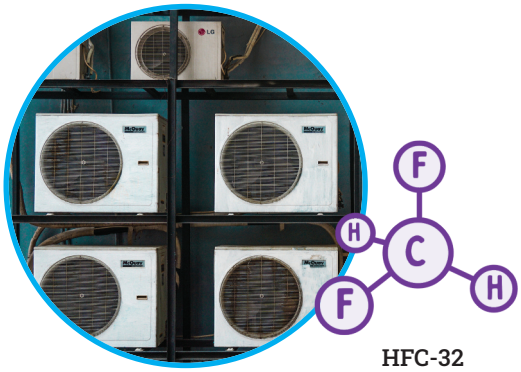
Non-CO_2 anthropogenic greenhouse gas emissions (Gt CO_2-eq yr-1)



Sources: IPCC, AR6 Working Group III Full Report (CO_2, CH_4, N_2O & F-gases);[6] WMO, Scientific Assessment of Ozone Depletion 2022 (ODS).[7]



CFC-11

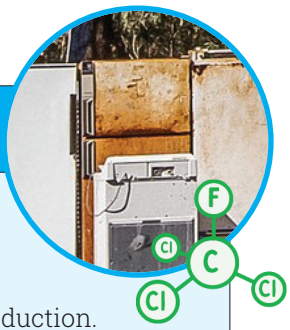


HFC-32

Nitrous Oxide

Methane

Ozone-Depleting Substances (ODS): CFCs & HCFCs



Profile

Global Warming Potentials: GWP100: 46.6-16,200 | GWP20: 168-12,700[8]
Main emission sources: Leaking 'banks' of equipment and products containing these chemicals (e.g., cooling equipment and insulation foams) and emissions from industrial fluorochemical production.
Lifetimes in the atmosphere: 0.9-640 years

Impact of emissions

Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) have contributed almost 10 per cent of global warming to date.[9] The phase-out of ODS under the Montreal Protocol will avoid an estimated 0.5-1°C in additional global warming by 2050,[10] with additional warming avoided through mitigating the impact of increased UV radiation on the amount of carbon held in plants and soils.[11] Nonetheless, annual CFC and HCFC emissions are still comparable to those of HFCs in CO_2-equivalent terms and can be significantly reduced.[12]

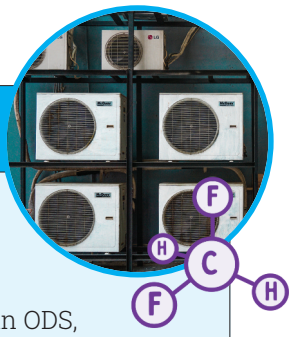
Future action needed

To safeguard the goal of limiting warming to 1.5°C, radiative forcing from CFCs and HCFCs (i.e., the extent to which they contribute to global warming) must be reduced 12 per cent by 2030 and 38 per cent by 2050.[13]

Immediate action to address CFCs and HCFCs

Parties to the Montreal Protocol should strictly limit current exemptions from the ODS phase-outs that relate to fluorochemical production and support the development of a global mechanism to reduce emissions of ODS through improved life-cycle refrigerant management, including collection and destruction of global ODS banks.

F-gases: Hydrofluorocarbons (HFCs)



Profile

Global Warming Potentials: GWP100: 4.8-14,600 | GWP20: 17.4-12,400[14]
Main emission sources: HFCs are synthetic chemicals used primarily as refrigerants in cooling equipment, as foam-blowing agents and in aerosols and fire protection. Production of HCFC-22, an ODS, primarily for its use as a feedstock to produce other chemicals, results in significant by-product emissions of HFC-23.
Lifetimes in the atmosphere: 0.2-228 years

Impact of emissions

Since 2016, the radiative forcing of HFCs in the atmosphere has increased by about one-third.[15] F-gas emissions (primarily HFCs) have increased by 254 per cent since 1990 and are responsible for 0.1°C of the warming we have experienced so far.[16] HFC emissions alone are responsible for two per cent of current global GHG emissions.[17]

Future action needed

To remain consistent with the 1.5°C pathway, annual emissions of HFCs must be reduced by 75-80 per cent by 2050, compared to 2010 levels.[18]

Immediate action to address HFCs

HFCs are controlled by the Kigali Amendment to the Montreal Protocol, which aims to phase down HFC production and consumption by approximately 80 per cent by 2045. Scientific studies clearly show that the current schedule is not sufficiently ambitious to meet the 1.5°C Paris target, therefore Parties to the Montreal Protocol must look to accelerate the HFC phase-down through an adjustment to the Kigali Amendment.[19] National and sub-national governments, and major corporate end-users, should also take leadership to implement policies consistent with an accelerated phase-down and complete phase-out of HFCs by mid-century.

Nitrous Oxide (N_2O)

Profile

Global Warming Potentials: GWP100: 273 | GWP20: 273
Main emission sources: The major anthropogenic sources of N_2O are agriculture (mostly from nitrogen-based fertilisers), nitric and adipic acid production, fossil fuel power generation, wastewater treatment and biomass burning. Natural sources of N_2O are also prevalent, but these are essential to the proper functioning of the Earth's nitrogen cycle.
Lifetimes in the atmosphere: 109 years

Impact of emissions

Human caused N_2O emissions have increased by 33 per cent since 1990 and have already contributed 0.1°C of global warming relative to 1850-1900.[20] N_2O is also the most prevalent ozone-depleting substance in the world today and poses a serious threat to the recovery of the ozone layer.

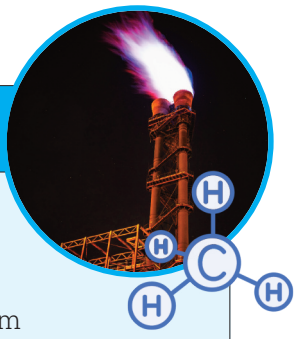
Future action needed

To remain consistent with the 1.5°C pathway, annual emissions of N_2O must be reduced by 22 per cent by 2030 and 25 per cent by 2050, compared to 2015 levels.[21]

Immediate action to address N_2O

The technology to abate almost all industrial emissions of N_2O already exists. In countries and regions where there are no requirements to abate industrial N_2O emissions, regulations must be introduced as a priority. This is a clear, cost-effective and immediate opportunity to prevent a substantial quantity of unnecessary greenhouse gas emissions.[22]

Methane (CH_4)



Profile

Global Warming Potentials: GWP100: 27.9 | GWP20: 81.2
Main emission sources: Agriculture (especially from livestock, manure management and rice cultivation), fossil fuel production and use (including from coal and oil extraction, as well as from fossil gas extraction, processing and use), and from waste processes and facilities such as landfills and sewage treatment.
Lifetimes in the atmosphere: 11.8 years

Impact of emissions

Methane is the second most important greenhouse gas and accounts for almost one-third of warming observed to date.[23] Emissions of methane have increased by 29 per cent since 1990 and have already contributed 0.5°C of warming relative to 1850-1900.[24]

Future action needed

In pathways that limit warming to 1.5°C, with no or limited overshoot, global methane emissions must be reduced by 34 per cent below 2019 levels by 2030, and 44 per cent below 2019 levels by 2040.[25]

Immediate action to address methane

At CoP26 in 2021, the EU and US launched the Global Methane Pledge, setting out a collective goal of reducing methane emissions by 30 per cent by 2030. To ensure its implementation, countries need to develop and implement a robust global governance framework around the Global Methane Pledge that incorporates clear national targets and mitigation measures, comprehensive monitoring, reporting and verification (MRV) and a dedicated financial mechanism to ensure sustained financial support and capacity-building.

References

1. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., https://doi.org/10.59327/IPCC/AR6-9789291691647 (p20).
2. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., https://doi.org/10.59327/IPCC/AR6-9789291691647 (p59).
3. F-gases considered by the IPCC are HFCs, PFCs, SF6 and NF3. This note focuses primarily on HFCs.
4. The ozone-depleting substances referred to here, and addressed in this note, are CFCs and HCFCs.
5. IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p59); World Meteorological Organization (WMO). Scientific Assessment of Ozone Depletion: 2022, GAW Report No. 278, 509 pp.; WMO: Geneva, 2022 (p67). Accessible at: https://csl.noaa.gov/assessments/ozone/2022/downloads/
6. IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p59).
7. World Meteorological Organization (WMO). Scientific Assessment of Ozone Depletion: 2022, GAW Report No. 278, 509 pp.; WMO: Geneva, 2022 (p67). Accessible at: https://csl.noaa.gov/assessments/ozone/2022/downloads/
8. Three of the most prevalent and climate damaging CFCs are CFC-11 (GWP100 6,410), CFC-12 (GWP100 12,500) and CFC-13 (GWP100 16,300). The most prevalent HCFC is HCFC-22 (GWP100 1,910).
9. IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p225).
10. World Meteorological Organization (WMO). Scientific Assessment of Ozone Depletion: 2022, GAW Report No. 278, 509 pp.; WMO: Geneva, 2022 (p310). Accessible at: https://csl.noaa.gov/assessments/ozone/2022/downloads/
11. Young, P.J., Harper, A.B., Huntingford, C. et al. 2021. The Montreal Protocol protects the terrestrial carbon sink. Nature 596, 384–388. https://doi.org/10.1038/s41586-021-03737-3
12. IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p4).
13. IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, https://doi.org/10.1017/9781009157896 (Annex III, p2148).
14. Three of the most prevalent and climate damaging HFCs are HFC-134a (GWP100 1,530), HFC-125 (GWP100 3,740) and HFC-23 (GWP100 14,600).
15. World Meteorological Organization (WMO). Scientific Assessment of Ozone Depletion: 2022, GAW Report No. 278, 509 pp.; WMO: Geneva, 2022 (p121). Accessible at: https://csl.noaa.gov/assessments/ozone/2022/downloads/
16. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., https://doi.org/10.59327/IPCC/AR6-9789291691647 (p4); IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p59).
17. Climate and Clean Air Coalition. Hydrofluorocarbons (HFCs). Accessed 16/11/2023. Available at: https://www.ccacoalition.org/short-lived-climate-pollutants/hydrofluorocarbons-hfcs
18. Rogelj, J., et al, 2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, et al. (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 93-174. https://doi.org/10.1017/9781009157940.004 (Ch.2, p118).
19. Purohit, P., Borgford-Parnell, N., Klimont, Z. et al. Achieving Paris climate goals calls for increasing ambition of the Kigali Amendment. Nat. Clim. Chang. 12, 339–342 (2022). https://doi.org/10.1038/s41558-022-01310-y
20. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., https://doi.org/10.59327/IPCC/AR6-9789291691647 (p4); IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p59).
21. IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, https://doi.org/10.1017/9781009157896 (p13).
22. United States Environmental Protection Agency. Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation Potential: 2015-2050, EPA-430-R-19-010; United States, 2019. Accessible at: https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases
23. IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p159).
24. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., https://doi.org/10.59327/IPCC/AR6-9789291691647 (p4); IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. https://doi.org/10.1017/9781009157926 (p59).
25. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., https://doi.org/10.59327/IPCC/AR6-9789291691647 (p4).

environmental investigation agency

EIA UK
62-63 Upper Street,
London N1 0NY UK
T: +44 (0) 20 7354 7960
E: ukinfo@eia-international.org
eia-international.org

EIA US
PO Box 53343
Washington DC 20009 USA
T: +1 202 483 6621
E: info@eia-global.org
us.eia.org