Draft Discussion Paper

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AMENDING THE MONTREAL PROTOCOL

SUMMARY OF AMENDMENT PROPOSALS AND DISCUSSION OF KEY COMPONENTS TO PHASING DOWN HFCs

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Executive Summary

The Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) is a highly effective treaty that can assist major emerging economies such as India, China, Thailand and Indonesia in transitioning to ozone-safe, low global warming potential (GWP), energy efficient alternatives to hydrofluorocarbons (HFCs). HFCs are manufactured fluorinated chemicals with high-GWP up to 10,800 times higher than carbon dioxide (CO_2).[1] If their rapid growth is not checked, HFCs will offset much of the climate benefits already achieved by phasing out ozone depleting substances (ODS) such as chlorofluorocarbons (CFCs), which are typically also powerful heat-trapping chemicals.[2] Alternatives to HFCs are technically and economically feasible with financial assistance from the Montreal Protocol's Multilateral Fund (MLF).

Amending the Montreal Protocol to include a phase down of HFC emissions will benefit the planet as well as the countries that produce and consume products that use HFCs—this includes the Protocol's Article 5 Parties such as India, China, Thailand, and others. Amending the Protocol now would have the benefit of aligning a phase down of HFCs with the accelerated phase out of hydrochlorofluorocarbons (HCFCs) currently underway. As Article 5 Parties are currently in early phases of their HCFC phase out, alignment of the HFC and HCFC regimes reduces the risk of incurring double transition costs from first switching to high-GWP HFCs and then subsequently switching to lower-GWP alternatives.

There is global support for amending the Montreal Protocol. More than 108 Parties support using the Montreal Protocol to phase down HFCs.[3] Most recently, on March 6, 2015, all 54 African Parties agreed to this objective by

1 United Nations Environmental Programme, *Overview of Issues Related to Hydrofluorocarbons and Their Management*, 6, March 10, 2015, *available at*: UNEP/OzL.Pro.WG.1/35/2. Global warming potential is an index of relative radiative forcing per unit mass for a specified time period (typically 100 years) with CO_2 set equal to 1.

2 *Ibid.*, 4.

3 *United Nations Environmental Programme, Twenty-Second Meeting of the Parties, Annex III: Declaration on the Global Transition Away From Hydrochlorofluorocarbons (HCFCs) and Chlorofluorocarbons (CFCs), November 8-12, 2010,* http://ozone.unep.org/new_site/en/Treaties/treaties_decisions-hb.php?dec_id=726 *(accessed April 7, 2015).* At the Twenty-Second MOP, 90 countries recognized *that hydrofluorocarbons (HFCs) are replacements for ozone depleting substances being phased out under the Montreal Protocol and that the projected increase in their use is a major challenge for the world's climate system that must be addressed through concerted international action to environmentally sound alternatives. These countries declared intent to pursue further action under the Montreal Protocol.* Croatia added its name after the meeting. In Bali, 17 additional parties affiliated themselves with the declaration, raising the total to 108. The following is a list of countries supporting phase down of HFCs through the Montreal Protocol: *Afghanistan, Antigua and Barbuda, Armenia, Austria, Australia, Bahamas, Bangladesh, Belarus, Belgium, Belize, Benin, Bosnia and Herzegovina, Bulgaria, Burkina Faso, Cambodia, Cameroon, Canada, Columbia, Comoros, Congo, Cook Islands, Costa Rica, Cote D'Ivoire, Croatia, Cyprus, Czech Republic, Democratic Republic of the Congo, Denmark, Dominican Republic, Egypt, Equatorial Guinea, Estonia, European Union, Federated States of Micronesia, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guinea, Guinea Bissau, Haiti, Hungary, Indonesia, Iraq, Ireland, Italy, Japan, Kazakhstan, Kenya, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Madagascar, Mali, Mauritius, Macedonia, Malawi, Maldives, Malta, Mexico, Montenegro, Morocco, Mozambique, Myanmar, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Palau, Philippines, Poland, Portugal, Republic of Moldova, Romania, Saint Lucia, Sao Tome and Principe, Senegal, Serbia, Seychelles, Slovakia, Slovenia, Solomon Islands, Spain, Somalia, Sri Lanka, St. Vincent and the Grenadines, Swaziland, Sweden, Switzerland, Timor-Leste, Trinidad and Tobago, Togo, Tuvalu, Uganda, United Kingdom, United States of America, Vietnam, Yemen, and Zambia.*

signing the Cairo Declaration.[4] An increasing number of Parties or groups of parties have put forward proposed HFC amendments to the Montreal Protocol. These include – amendment proposals from the three North American Parties and from The Federated States of Micronesia (FSM), and a conference discussion paper from the European Union. India has indicated that it may put forward its own proposal. An Indian proposal could be informed by consideration of design issues and choices reflected in the proposals already on the table.

An amendment would create a framework to pay the incremental cost of either shifting directly from ODSs to low-GWP alternatives, or the incremental cost of switching from high-GWP HFCs to low-GWP alternatives in cases where HFCs are already in use such as motor vehicle air conditioning. Few other climate protection measures can achieve a similar reduction in greenhouse gas (GHG) emissions so cost-effectively.[5] An HFC phase down under the Montreal Protocol would not interfere with or obstruct any other international agreement. Rather, it would complement efforts under the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol by helping countries meet emissions reduction objectives under those accords.

An increasing number of businesses across the globe are already transitioning to low-GWP alternatives, demonstrating their feasibility and commercial viability. Major companies like Coca Cola Company, 3M, Procter & Gamble, and Unilever support a global agreement to transition to lower GWP refrigerants. Several global companies like Mitsubishi, Fujitsu General, Hitachi, Panasonic, Toshiba, and Sharp are implementing new technologies with these innovative refrigerants, and others, like Daikin are offering their patents to companies manufacturing in developing countries free of charge. Companies from Article 5 Parties too, are bringing innovative, climate friendly products to market. Godrej and Boyce – an Indian appliance manufacturer offers highly efficient room air conditioners based on a low-GWP, hydrocarbon refrigerant.

Several countries have enacted domestic regulations to phase down high-GWP HFCs. This includes some of the largest consumers of HFCs, like the United States, European Union and Japan. However, the full scope of environmental benefits of eliminating HFCs can only be realized through a global agreement for HFC phase down. Absent an agreement, individual countries will continue to enact domestic regulations to deal with HFCs, leading to a patchwork of regulations in the global market place. A global agreement would help realize the full economies of scale of transition supported by the creation of necessary mechanisms to address costs of transition.

This paper discusses key aspects of proposed amendments for phasing down HFCs under the Montreal Protocol, including the North American proposal, Micronesian proposal, and the European Union discussion paper. It also discusses key features that could be included in a proposal to phase down HFCs under the Montreal Protocol, including control measures, grace periods, financial assistance from the Multilateral Fund, intellectual property rights, and safety. Furthermore, this paper explores the reasons why countries should consider their own amendment proposal. This paper is part of ongoing research on phasing down HFCs and is part of a series of papers already published on the benefits of switching to lower-GWP alternatives, including Cooling India with Less Warming: The Business Case for Phasing Down HFCs in Room and Vehicle Air Conditioners[6] and Reducing Stress on India's Energy Grid: The Power Sector Benefits of Transitioning to Lower Global Warming Potential and Energy Efficient Refrigerants in Room Air Conditioners,[7] among others.

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4 Durwood Zaelke, "African Countries Endorse HFC Phase Down Under Montreal Protocol," *Institute for Governance and Sustainable Development*, March 6, 2015, *available at:* http://www.igsd.org/news/documents/3.6.15PRAMCEN.pdf. *See also* United Nations Environmental Programme, "The African Ministerial Conference on the Environment (AMCEN)," http://www.unep.org/roa/InformationMaterial/Events/15thAMCENSession/AboutAMCEN/tabid/794110/Default.aspx (accessed April 7, 2015). The following countries signed the Cairo Declaration: *Angola, Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Republic of Congo, Cote d'Ivoire, Democratic Republic of Congo, Djibouti, Egypt, Eritrea, Ethiopia, Equitorial Guinea, Gabon, Gambia, Ghana, Guinea Bissau, Guinea Conakry, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe.*

5 United Nations Environmental Programme, *Report of the Tenth Meeting of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer and the Twenty-Sixth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, November 2014, *available at:* UNEP/OzL.Conv.10/7-UNEP/OzL.Pro.26/10.

6 Natural Resources Defense Council, et al., "Cooling India With Less Warming: The Business Case for Phasing Down HFCs in Room and Vehicle Air Conditioners," *Issue Paper*, June 2013, *available at:* http://www.nrdc.org/international/india/files/air-conditioner-efficiency-IP.pdf.

7 Natural Resources Defense Council, et al., "Reducing Stress on India's Energy Grid: The Power Sector Benefits of Transitioning to Lower Global Warming Potential and Energy Efficient Refrigerants in Room Air Conditioners," *Interim Draft Issue Brief*, March 2015, *available at:* http://www.nrdc.org/international/india/files/india-energy-grid-alternative-refrigerants-IB.pdf.

Amendment Proposals **for the Montreal Protocol**

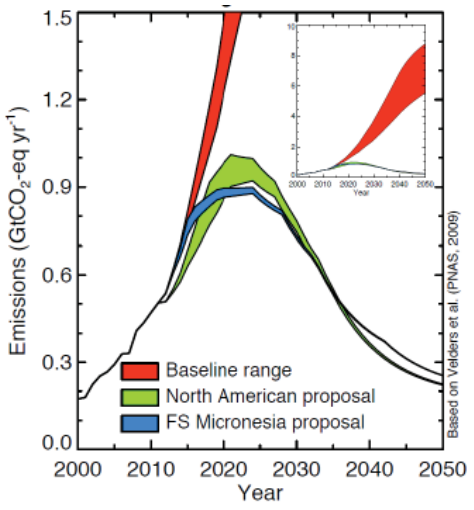
The three main proposals to amend the Montreal Protocol have been put forward by North American countries, Micronesian countries, and the European Union. There is significant global support for amendment proposals to phase down HFCs under the Montreal Protocol. Both the North American and Micronesian amendment proposals would reduce HFC production and consumption by 85% and 95% over the next decade, avoiding the equivalent of 84 to 100 billion metric tons of CO_2 by 2050.[8]

North American Proposal

Proponents of the North American proposal include Canada, Mexico, and the United States. It would avoid an estimated 90 gigatonnes (Gt) CO_2 equivalent GHG by 2050.[10] The un-negotiated proposed amendment would reduce GHG consumption and emissions by 93,800 – 115,000 million tonnes of CO_2 equivalent through 2050. Of this, 80,900 – 102,100 million tonnes of CO_2 equivalent is attributable to HFCs.[11] The North American proposal lists 19 specific HFCs in Annex F as controlled substances.[12] It gives Article 5 Parties access to the MLF to pay the agreed incremental costs of transition.

The Amendment proposal calls for a gradual phase down rather than a complete phase out. It provides time and flexibility for government and industry to manage the transition to alternative chemicals and technologies with the lowest carbon foot-

GWP-WEIGHTED EMISSIONS



Source: Andersen, Brack and Depledge (2014). [9]

8 United Nations Environmental Programme, *Proposed Amendment to the Montreal Protocol Submitted by Canada, Mexico, and the United States of America*, 3, September 1, 2014, *available at:* UNEP/OzL.Pro.25/5. This is known as the North American Proposal. *See also*, United Nations Environmental Programme, *Proposed Amendment to the Montreal Protocol Submitted by the Federated States of Micronesia*, 9, May 16, 2014, *available at:* UNEP/OzL.Pro.WG.1/34/5. This is known as the Micronesian Proposal.

9 Andersen, Stephen O., Duncan Brack and Joanna Depledge, *A Global Response to HFCs Through Fair and Effective Ozone and Climate Policies*, Chatham House (Presentation at Open-Ended Working Group to the Montreal Protocol, July 15, 2014). Data developed by Velders et al. (2009).

10 UNEP, "Report of the Tenth Meeting of the Conference of the Parties" (2014) at 16.

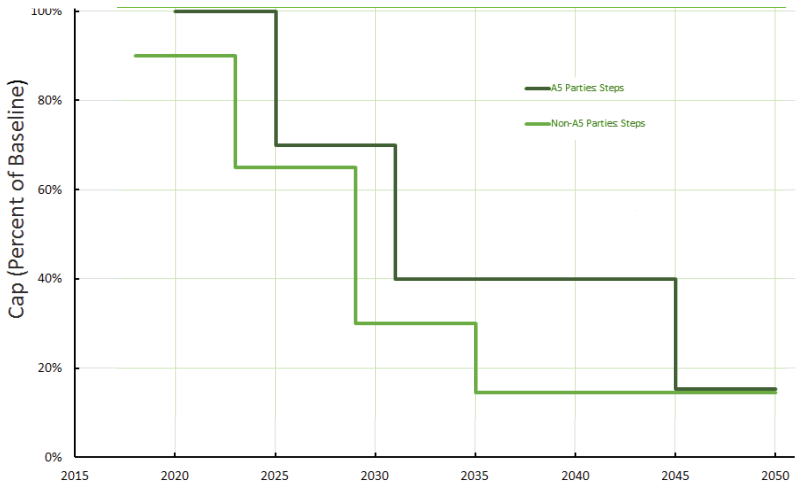
11 U.S. Environmental Protection Agency, *Benefits of Addressing HFCs Under the Montreal Protocol*, July 2014, 3, *available at:* http://www.epa.gov/ozone/downloads/Benefits_of_Addressing_HFCs_under_the_Montreal_Protocol-July2014MASTER_REV4.pdf.

12 UNEP, "North American Proposal" (2014) at 8.

print and also allows continued use in previously manufactured equipment that may not be suitable for retrofit to new refrigerants. It proposes that Non-Article 5 Parties phase down HFCs first; and Article 5 Parties follow with a grace period. It replaces HFCs where alternatives are already available, or are coming to the market soon and allows time to develop alternatives for uses where alternatives are not available yet. Because it is not a total phase out, there is assurance that high-GWP HFCs can continue to be used indefinitely for applications that prove essential and cannot be replaced.

Proposed phase down of listed HFCs in Non-Article 5 Parties follows a schedule of compliance. Production and consumption of HFCs is averaged on a GWP weighted basis. The baseline is averaged using 100% of HFC consumption and production and 85% of HCFC consumption and production from 2008 to 2010. Consumption and production is capped at 90% in 2018, 65% in 2023, 30% in 2029, and 15% in 2035. This means Non-Article 5 Parties reduce GWP-weighted HFC consumption by 10% in 2018, 45% by 2023, 70% by 2029, and 85% by 2035. Article 5 Parties follow a different schedule and get a grace period.[13] These Parties may not exceed 75% of the baseline, which is a combination of 100% HFC plus 40% of HCFC consumption and production from 2011 to 2012. Article 5 Parties may not exceed 70% in 2025, 40% in 2031, and 15% in 2045.[14] This means, Article 5 Parties must reduce HFC levels by 30% by 2025, 60% by 2031, and 85% by 2045.

HFC REDUCTION STEPS FOR ARTICLE 5 AND NON-ARTICLE 5 COUNTRIES (% OF BASELINE)



Source: U.S. Environmental Protection Agency (EPA)[15]

Micronesia Proposal

The Micronesia proposal was submitted by the FSM, a 607-island nation made up of four island groups: Yap, Chuuk, Pohnpei, and Kosrae. This proposal would result in the benefit of a reduction of 100 billion tonnes of CO_2 equivalent by 2050.[16] The Micronesia proposal lists 19 specific HFCs in Annex F along with two hydrofluoroolefins (HFO)/HFC blends as controlled substances.[17] HFOs differ from HFCs because they are alkenes, not alkane and therefore have a very low GWP, often lower than hydrocarbon and CO_2 "natural refrigerants." Similarly, the proposal allows access to the MLF to pay for the transition.

13 *Ibid.*, 5.

14 *Ibid.*

15 *Ibid.*, 2.

16 UNEP, "Micronesia Proposal" (2014), at 9.

17 *Ibid.*, 7-8.

KEY ELEMENTS	NORTH AMERICAN PROPOSAL	MICRONESIA PROPOSAL	EUROPEAN UNION DISCUSSION PAPER
Listing of HFCs	19 HFC substances	21 HFC substances, including some HFOs	HFCs generally
Grace Period for Article 5 Parties	10 years	To be determined by the Parties	Up to 15 years
Non-Article 5 Parties Control Measures for Consumption and Production of HFCs	***Reduction Schedule*** • 2018 – 90% • 2023 – 65% • 2029 – 30% • 2035 – 15%	***Reduction Schedule*** • 2017 – 85% • 2020 – 70% • 2023 – 55% • 2026 – 45% • 2029 – 30% • 2032 – 15% • 2035 – 10%	***Reduction Schedule*** • 2017 – 85% • 2018 – 65% • 2021 – 45% • 2024 – 30% • 2027 – 25% • 2030 – 15%
Non-Article 5 Parties Baseline	2008—2010 100% average HFC and 85% HCFC consumption and production	2014–2016 average HFC and HCFC production and consumption	2009–2012 HFC production and consumption + 15% 1989 HCFC baseline
Article 5 Parties Control Measures for Consumption and Production of HFCs	***A5 Reduction Schedule*** • 2020 – 100% • 2025 – 70% • 2031 – 40% • 2045 – 15%	To be determined by the Parties	***A5 Reduction Schedule*** • 2019 – freeze in consumption and production of HCFC/HFC combined • 2045 – 85% reduction in production
Article 5 Parties Baseline	2011—2012 100% average HFC and 40% HCFC consumption and production	To be determined by the Parties	2015—2016 (2019); 2009—2012 + 70% of 2009—2010 HCFC (2045)
Multilateral Fund Financing	Yes	Yes	Yes
HFC Emissions Reduction by 2050	84 billion tonnes CO_2 eq.	100 billion tonnes CO_2 eq.	Unspecified
Impact on UNFCCC/KP	No impact: Complimentary	No impact: Complimentary	No impact: Complimentary
Emissions Reporting	Yes	Yes	Data collection
Import/Export Licensing	Yes	Yes	Unspecified
Relationship to HCFC Phase Out	Recognizes HCFC is ongoing but does alter phase out schedule	Recognizes HCFC is ongoing	Factors HCFC into calculation and does not alter HCFC phase out schedule
Limits HFC-23 By-product Emissions	Yes	Yes	Unspecified
Bans on Trade in HFCs with Non-Parties	Yes	Yes	Unspecified

Non-Article 5 Parties begin a phase down of listed HFC/HFO blends. Similar to the North American proposal, the schedule calls for a gradual phase down. Baseline consumption for Non-Article 5 Parties may not exceed the average of HFC and HCFC consumption and production from 2014 to 2016.[18] They may not exceed 85% in 2018, 70% in 2020, 55% in 2023, 45% in 2026, 30% in 2029, 15% in 2032, and 10% in 2035. This means Non-Article 5 Parties must reduce consumption by 15% in 2018, 30% by 2020, 45% by 2023, 65% by 2026, 70% by 2029, 85% by 2032, and 90% by 2035. Article 5 Parties phase down would begin a number of years later

18 UNEP, "Overview of Issues Related to HFC Management," (2015) at 18

on an equitable schedule determined by the parties.[19] Most important, the proposal offers MLF funding for agreed incremental costs of compliance, which also includes destruction of HFC-23 not already financed by the Clean Development Mechanism.[20]

European Union Discussion Paper

The European Union submitted a discussion paper at the Twenty-Sixth Meeting of the Parties (MOP) to the Montreal Protocol to further evolve discussions. The paper advocates phasing down HFCs for Non-Article 5 Parties with unambiguous regulatory and market signals.[21] It proposes a baseline of the average production and consumption for the years 2009 to 2012 in CO_2 equivalents plus 15% of the 1989 baseline for HCFC phase out.[22] The reduction schedule calls for gradual phase down for Non-Article 5 Parties with production and consumption to reach 85% in 2017, 65% in 2018, 45% in 2021, 30% in 2024, 25% in 2027, and 15% in 2030.[23] This means, a 15% reduction by 2017, 35% reduction by 2018, 55% reduction by 2021, 70% reduction by 2024, 75% reduction by 2027, and 85% reduction by 2030.

The EU approach does not suggest a reduction schedule for HFC consumption in Article 5 Parties, rather a freeze in combined HCFC/HFC consumption from 2019 onwards. The baseline for Article 5 Parties would be the average consumption of HFCs and HCFCs in 2015 and 2016.[24] For HFC production, Article 5 Parties would freeze production by 2019, with a baseline average of HFC production for the years 2009 to 2012, plus 70% of the 2009 and 2010 HCFC baseline, and a scheduled reduction to 15% in 2045.[25] This means an 85% reduction by 2045. The paper includes a grace period provision, taking into account the more recent conversion of production facilities to phase down HCFCs, giving Parties a flexible transition schedule over a longer period. This approach supports the principle of *Common But Differentiated Responsibilities* (CBDR). It does not affect the schedule for phasing out HCFCs and allows greater flexibility and technology choices for Article 5 Parties.[26] It also supports use of the MLF to finance phase down.

19 UNEP, "North American Proposal" (2014) at 6.

20 *Ibid.*, 9.

21 United Nations Environmental Programme, *Enabling a Global Phase down of Hydrofluorocarbons: Discussion Paper Submitted by the European Union*, November 6, 2014, 3, *available at:* UNEP/OzL.Pro/26/INF/7. This is referred to as the European discussion paper.

22 *Ibid.*, 5.

23 *Ibid.*

24 *Ibid.*, 6.

25 *Ibid.*

26 *Ibid.*, 3-5.

Key Features for an HFC **Amendment Proposal**

Grace Period

The Montreal Protocol is built on the principle of CBDR. Non-Article 5 Parties are always obligated to act first. Article 5 Parties follow after a grace period and with the benefit of financial assistance, provided through the Montreal Protocol's MLF. A grace period is valuable in that it allows Parties, like India to see how phase down works in other countries and to prepare, choosing the best option for their particular circumstances.

A grace period also allows manufacturers and suppliers of chemicals and equipment to reach economies of scale and competitive prices by supplying to Non-Article 5 markets first, bringing down the cost to Article 5 Parties. The grace period also serves as a mechanism to ensure intellectual property rights will be less of an issue and expense. Many patents are already in place and will expire after 20 years depending on the patent type and country. Some will expire by the time the Article 5 Parties control measures come into force. For example, if an amendment were accepted on the 27th MOP in November 2015, the grace period would be in place until 2025 under the North American proposal.

All the proposed amendments provide for a grace period and establish different timelines for phase down for Article 5 and Non-Article 5 Parties. The North American proposal calls for a 10-year grace period and the Micronesian proposal calls for an equitable grace period to be set by the parties.[27] The European Union discussion goes a step further, allowing for different phase down schedules to be established in countries that are only consumers of HFCs and those that are producers. Countries with emerging economies could choose a grace period that is equitable and factors in the individual circumstances of the country with enough flexibility to account for market price and patents.

Financial Assistance from the Multilateral Fund

Over the Montreal Protocol's thirty plus year history, the MLF has successfully raised and delivered funding to assist Article 5 Parties in phasing out CFCs, HCFCs, and many other ozone-depleting GHGs. As of November

27 UNEP, "North American Proposal" (2014) at 7. *See also*, UNEP, "Micronesian Proposal" (2014) at 6.

8, 2014, contributions to the MLF totaled over U.S.$3.26 billion.[28] So far, it has funded expenditures of approximately U.S.$3.14 billion for implementation of projects anticipated to result in phasing out 463,814 ozone-depletion potential (ODP) weighted tonnes of controlled substances. Approximately 453,771 ODP tonnes have already been phased out. The MLF spent U.S.$2.9 billion from 1990-2010 to phase out CFCs and HCFCs.[29] Of the projects, 144 approved programmes were in Article 5 countries. It is one of the reasons why the Montreal Protocol is the world's most effective multilateral environmental agreement.

All three proposals on the table currently propose funding an HFC phase down through the MLF. Using the proven MLF financing mechanism of Montreal Protocol to phase down HFCs offers a distinct advantage over climate treaties, under which a functioning financing mechanism has yet to be created. The Montreal Protocol has a track record of delivering specific funding to go with new control commitments. It is a proven way to support developing country transitions to environmentally superior technologies.

An amendment to the Montreal Protocol for controlling HFCs can include provisions for financing of agreed incremental costs.[30] Action started through the accelerated phase out of HCFCs provides a 25% funding increase for climate-friendly alternatives.[31] Current proposals for HFC phase down include commitments for additional funding from the MLF to be used to transition to lower-GWP alternatives. Parties can negotiate the terms of the amendment to include money that not only helps fund the currently ongoing phase out of HCFCs, but also saves costs in the future by avoiding a double transition, as HFCs will most certainly be obsolete very soon.

Intellectual Property Rights: Access to Technology Under Favorable Conditions

Intellectual property rights are a concern for many Parties making the transition to lower-GWP refrigerants as patents factor into overall cost. However, several factors, including history, indicate patent issues can be resolved if the Montreal Protocol is amended to include phase down of HFCs. Generally, patent protections last 14 to 20 years depending on the type of patent and the country. Many patents for low-GWP alternative refrigerants are already in place. Furthermore, the HFC amendment can be negotiated to include provisions for the MLF to pay the full cost of patent licensing fees where unpatented alternatives are not available, or patented alternatives are cost-prohibitive.

Under the North American and Micronesian proposals, significant grace periods allow time for patents to expire and for technology to reach economy of scale and competitive prices. This means that by the time Article 5 Parties have to implement a phase down, intellectual property rights will not be a consideration. Moreover, many refrigerants are not subject to patents. Refrigerants like propane (HC-290 or R-290), propene (HC-1270 or R-1270), isobutane (HC-600 or R-600), ammonia (R-717), CO_2 (R-744), and HFC-152A are not subject to significant patents because most manufacturing, application, and component patents have already expired. HFC-32's (R-32) basic production patents have already expired, leaving only the application patents in place. For motor vehicle air conditioners (MAC), HFC-152A's production patent has already expired and many companies now produce it.

28 Multilateral Fund for the Implementation of the Montreal Protocol, "Welcome to the Multilateral Fund," http://multilateralfund.org/default.aspx (accessed April 7, 2015).

29 Technology and Economic Assessment Panel, *Task Force Decision XX/7 Interim Report: Environmentally Sound Management Of Banks Of Ozone Depleting Substances*, (June 2009), 25-27, 42-47, *available at:* http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-october-2009-decisionXX-7-task-force-phase2-report.pdf.

30 Andersen, Stephen, O. and K. Madhava Sarma, "Making Climate Change and Ozone Treaties Work Together to Curb HFC-23 and Other "Super Greenhouse Gases,"" 2 (November 2010). The Technical and Economic Assessment Panel (TEAP) of the Montreal Protocol concluded that the revenue per year for the HFC-23 destruction exceeded the revenue from HCFC-22 sales by a factor of four or five due to perverse incentives for overpayment. To prevent this from happening, the Multilateral Fund only pays for incremental costs and only if the project is not already covered under Clean Development Mechanisms under the Kyoto Protocol.

31 UNEP, *Workshop on Hydrofluorocarbon Management Issues*, UNEP/OzL.Pro/Workshop.7/3, 9 (August 5, 2014).

Some companies that do have patents on refrigerants like R-32 are willing to allow developing country companies to use the refrigerant at no cost. For example, Daikin offers "free-of-charge access" to its basic application patent for the manufacture of R-32 room air conditioners (RAC) for sale in developing countries. It allows these companies using their patents at no charge to sell in both Indian and export markets.[32] Fujitsu General, Hitachi, and Toshiba joined with Daikin in partnership to bring air conditioner technologies to developing country markets. Fujitsu General is already taking advantage of this free access to technology and selling R-32 based air conditioners in the Indian market.

However, even where a patent does exist and the company is not offering free access to the technology, companies wanting to do business within the country are required to gain government approval to do business within the country. As part of the negotiation and approval process, governments can place specific restrictions or favorable patent arrangements on companies as a requirement of doing business within that country that can reduce the patent effect. For example, HFO-1234yf is produced by Asahi Glass Chemicals and a joint venture of DuPont, Honeywell and Shanghai 3F New Material, under separate chemical process patents and marketed by DuPont and Honeywell under an application patent. Countries with emerging economies could place restrictions or negotiate favorable terms, such as those offered by Daikin, on these companies. There are limited patents on component designs for natural refrigerants and other low-GWP alternatives, but none are expected to be an impediment to HFC phase down.

In the event patents are an expense, the HFC amendment can make clear that the MLF will consider patent licensing as part of agreed incremental costs. The ODS phase out was accomplished despite being subject to intellectual property rights. ODS alternatives protected by patents were sold at fair and reasonable prices and any excess cost for patents was paid for by the MLF.[33]

HFC Control Measures and Baselines

The control schedule and base level years will be an important aspect of amendment proposals. All three different proposals currently on the table have very different control schedules and baseline years. However, all three recognize the principle of CBDR in that they subject Article 5 Parties to a different schedule and base the average consumption and production cut off amounts on different years—essentially allowing different amounts for different Parties with different circumstances. Article 5 Parties' proposals could also factor in the feasibility of compliance and offer a control schedule that is realistic.

Base levels under all three proposals are different. The North American proposal calls for a baseline that is averaged using 100% of HFC consumption and production and 85% of HCFC consumption and production from 2008—2010 on a GWP weighted basis for Non-Article 5 Parties and 100% of average HFC consumption and production and 40% of average HCFC consumption and production from 2011-2012 for Article 5 Parties. The Micronesian baseline is the average of HFC and HCFC consumption and production from 2014—2016. However, it leaves the base level open for Article 5 Parties.[34] The European Union discussion paper's baseline year for Non-Article 5 Parties is the average of 2009—2012 in CO_2 equivalents plus 15% of the 1989 baseline for HCFC phase out.[35] For Article 5 Parties, the baseline years are 2015—2016 short term. Countries with emerging economies could set the baseline at something that is realistic and make the calculation based on either a GWP-weighted basis or CO_2 equivalent.

32 Daikin Global, "Free-of Charge Access to Basic Patent for Emerging Countries in Order to Reduce Refrigerant Environmental Impact," September 2011, http://www.daikin.com/csr/management/management_07.html (accessed March 30, 2015).

33 Andersen, Brack and Depledge, "A Global Response to HFCs" (2014) at 19.

34 UNEP, "Overview of Issues Related to HFC Management," (2015) at 18

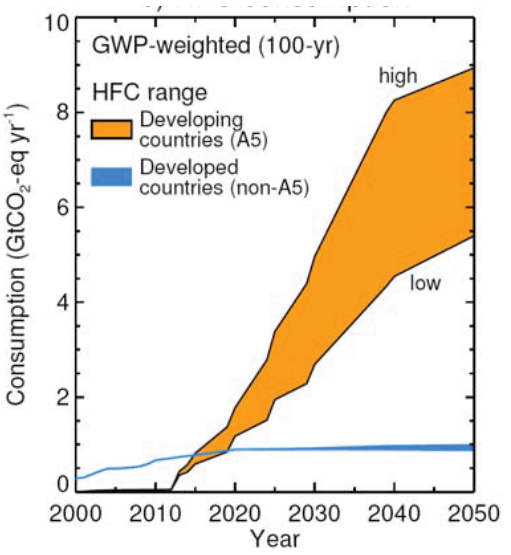
35 *Ibid.*, 5.

The control schedules are equally different under current proposals. Each reduction schedule factors in a percentage of consumption and production reduction that is based on incremental decreases on certain years. The North American proposal allows for a different reduction schedule for Article 5 Parties, however, it is more stringent than Micronesia's Article 5 reduction schedule that merely states it will be determined by the Parties. The European Union offers a different approach that does not subject Article 5 Parties to the same reduction schedule either, offering a freeze in consumption with a long-term reduction goal. All proposals include various stringent reduction schedules for Non-Article 5 Parties—making those countries take the lead. As seen by these varying reduction schedules and baselines, countries in emerging economies can vary their proposals in a flexible manner depending on the particular circumstances of the country.

Why Countries Should Move Forward with an **Amendment Proposal**

HFCs contribute to direct climate forcing at approximately 0.012 W m^{-2}.[37] Estimates show that HFC-23, a byproduct of HCFC-22, could also contribute to annual emissions up to 0.35 Gt of CO_2 equivalent by 2035, which could lead to 0.91 Wm^{-2} of radiative forcing.[38] Different scenarios conducted by experts in the field showed the potential of HFC radiative forcing to grow anywhere from 0.10-0.40 Wm^{-2} by 2050 with emissions growing anywhere from 3.5-8.8 Gt CO_2 equivalent per year in 2050.[39] There was an increase in consumption from almost zero in 1990 to 1100 million tonnes CO_2 equivalent in 2010.[40] If HFC consumption continues unchanged, by 2050 they could represent as much as 25% of CO_2 equivalent emissions, offsetting efforts to stabilize CO_2 emissions at 450 ppm.[41] However, due to their short lifecycles, atmospheric abundance and climate effects of HFCs decrease quickly if emissions are curtailed.

HFC CONSUMPTION



Source: Velders et al. (2009).[36]

There Is Global Support for an Amendment

There has been significant diplomatic progress towards phasing down HFCs under the Montreal Protocol. In 2013, the world's largest economies agreed at the G-20 summit to use the institutions and expertise of the Montreal Protocol to phase down HFC production and consumption, while continuing to account for HFC emissions

36 Velders, Guus, J. et al, "Factsheet: The Large Contribution of Projected HFC Emissions to Future Climate Forcing," 1, June 2009, *available at*: http://www.epa.gov/greenchill/downloads/Factsheet_Velders_HFC.pdf

37 UNEP, "HFCs: A Critical Link," (2011) at 20.

38 *Ibid.*, 17.

39 *Ibid.*, 22-23.

40 Environmental Investigation Agency, *The Montreal Protocol in 2012: Celebrating Past Achievements: Facing up to Future Challenges*, 2, November 2012, *available at:* http://eia-international.org/wp-content/uploads/EIA_Montreal_Protocol_report_1112_FINAL_HIRES.pdf.

41 UNEP, "Workshop on HFC Management Issues" (2014) at 3.

under the climate treaties.[42] The G-20 agreement built on earlier multilateral agreements at Rio+20, as well as the Bali and Bangkok declarations signed in 2011 and 2012 by a majority of the world's nations, both developed and developing, at the MOP to the Montreal Protocol. In addition, the United Nations Environmental Programme (UNEP) partnered with over 60 Parties and organizations to work to phase down some HFCs.[43]

Over 108 Parties support the phase down of HFCs through the Montreal Protocol.[44] On March 6, 2015, at the 15th session of the African Ministerial Conference on the Environment in Cairo, Egypt, all 54 African Parties meeting in Cairo Egypt urged member states to use the Montreal Protocol to phase down production and use of HFCs.[45] The Cairo Declaration "*urge[s] member States to use the experience, expertise and institutions of the Montreal Protocol … to phase down the production and consumption of [HFCs] while continuing to use other existing mechanisms for accounting and reporting of emissions…; and request[s] the parties… to work towards establishing an open-ended contact group during its meetings in 2015 ….*"[46]

Domestic Actions Support Global HFC Phase Down

To strengthen global support for phasing down HFCs, multiple countries have already put this goal into action through domestic legislation. Flourishing regional and sub-regional HFC policies have created a patchwork of market conditions.[47] Current and emerging market trends and regulations in Australia, China, the European Union, Japan, the United States and elsewhere are moving toward refrigerants with a lower impact on climate and using different standards to reach these goals. These inconsistent regulatory measures are already affecting major export markets and providing an early commercial driver for change among export-oriented companies. Many companies design products that satisfy the most stringent energy efficiency, safety, and environmental standards so they can be freely marketed worldwide.

- **CHINA** is the largest manufacturer of room air conditioners in the world. It manufactures over half of the world's mini-split air conditioner systems. However, China is transitioning away from HFC-410A to R-290 and R-32.[48] In June 2014, China announced a target of reducing HFC emissions by 0.28 billion tons of CO_2 equivalent by 2015, building on U.S.-China agreements on HFCs.[49] In 2013, when China agreed to eliminate its production and surplus production capacity for HCFCs, the MLF supported China's efforts with an amount up to U.S.$385 million.[50] China elected not only to move away from HCFCs, but also to move to more climate-friendly alternatives. With assistance from the Montreal Protocol's MLF as part of China's HCFC phase out management plan (HPMP), Chinese appliance manufacturers such as Midea and Meizhi converted production lines to safely manufacture R-290 room air conditioners.[51]

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42 G20, *G20 Leaders' Declaration*, September 2013, *available at:* https://www.g20.org/sites/default/files/g20_resources/library/Saint_Petersburg_Declaration_ENG_0.pdf.

43 United Nations Environmental Programme, "UN Environment Head Welcomes Signal to Combat Climate Change by World's Two Largest Economies," *UNEP News Centre*, June 9, 2013, http://www.unep.org/newscentre/Default.aspx?DocumentID=2718&ArticleID=9538&l=en (accessed April 1, 2015).

44 United Nations Environmental Programme, *Report of the Twenty-Fourth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, November 2012, 24, *available at:* UNEP/OzL.Pro.24/10.

45 Zaelke (2015).

46 African Ministers of the Environment, *Cairo Declaration on Managing Africa's Natural Capital for Sustainable Development and Poverty Eradication*, March 6, 2015, *available at:* http://www.unep.org/roa/Portals/137/AMCEN15Docs/Cairo%20declaration.pdf

47 *Ibid*.

48 U.S. EPA, "The Benefits of Addressing HFCs" (2014) at 17.

49 Institute for Governance & Sustainable Development, "China Announces Aggressive Action to Cut HFCs," May 28, 2014, *available at:* http://www.igsd.org/news/documents/5.28.14PRChinaStrongonHFCs_000.pdf.

50 Multilateral Fund for the Implementation of the Montreal Protocol, "Multilateral Fund Approves Landmark Project for China with Ozone and Climate Benefits - Up To US $385 Million of Funding Over the Next 17 Years," April 22, 2014, http://www.multilateralfund.org/InformationandMedia/default.aspx?PageView=Shared (accessed March 25, 2015).

51 United Nations Industrial Development Organization, "Montreal Protocol: Demonstration Sub-Project for Conversion From HCFC-22 to Propane at Midea Room Air-Conditioner Manufacturing Company and Demonstration Sub-Project for Conversion Of Room Air-Conditioner Compressor Manufacturing From HCFC-22 to Propane at Guangdong Meizhi Company," *available at:* http://www.unido.org/fileadmin/user_media_upgrade/Worldwide/Projects/MPB_China.pdf.

The Chinese Ministry of Environmental Protection is also preparing a subsidy program that will use MLF funding for the HPMP to support Chinese companies manufacturing R-290 room air conditioners for the domestic market and for export. Fourteen manufacturers with HCFC-22 production lines have applied for funding to support the manufacture of these more climate-friendly air conditioners.[52] In addition, Shanghai 3F New Materials Company and DuPont partnered to build a plant in China to supply HFO-1234yf for vehicle air conditioners and other applications. DuPont and Honeywell have also agreed to supply HFO-1234yf from the facility in China.

- **THE EUROPEAN UNION** finalized a stronger regulation known as the F-gas Regulation that went into effect January 1, 2015. It seeks to reduce fluorinated gas (F-gas) emissions by two-thirds compared to 2014 levels—a 72-73% reduction by 2030. [53] The regulation bans F-gases with a GWP of greater than 2,500 and includes a phase down and quota system for the supply of HFCs, along with bans on certain HFC-containing equipment, and a requirement to destroy or recycle the HCFC-22 production byproduct HFC-23. It also expands existing regulations on labeling, refrigerant management and reporting requirements, and training programs to cover HFCs. The F-gas Directive is expected to reduce CO_2 equivalent emissions by 1.5 Gt by 2030 and 5 Gt by 2050.[54] In addition, the 2006 E.U. Mobile Air Conditioning Directive (E.U. MAC Directive) will establish a schedule for transitioning air conditioners in all new cars sold in Europe after 2017 from HFC-134A to refrigerants with a GWP no higher than 150.[55]

- **JAPAN** enacted a new law in April 2013 to reduce HFC emissions through "measures that cover the total life cycle of fluorocarbons from manufacture through disposal, as well as equipment using these gases."[56] The law requires that air conditioner and refrigeration unit manufacturers and importers transition to non-fluorinated gases or low-GWP fluorocarbons by certain deadlines.

- **UNITED STATES** President Obama announced both international and domestic measures to address HFCs in the President's Climate Action Plan released June 2013.[57] As a result, the U.S. implemented the U.S. EPA Significant New Alternatives Policy program (U.S. EPA SNAP) to ensure a safe, smooth transition away from ozone depleting compounds while encourage private sector investments in technology with lower GWP emissions. The program approves climate-friendly chemicals and prohibits harmful high-GWP alternatives.[58] By February 2015, the EPA approved 5 new lower-GWP or low-GWP hydrocarbon refrigerant alternatives under the U.S. EPA SNAP program: R-290, R-32, R-600a, ethane (HC-170 or R-170), and a blend of hydrocarbons propane, propylene and isobutane (HCR-188c or R-441A).[59]

  Automobile manufacturers in the United States have been rapidly phasing down HFC-134A in vehicle air conditioning in order to continue sales in the European Union and in response to incentives from the U.S.

52 Hydrocarbons21.com, "Chinese Ministry of Environmental Protection Offers Subsidy for R290 Air Conditioner Production," July 30, 2014, http://www.hydrocarbons21.com/articles/chinese_ministry_of_environmental_protection_offers_subsidy_for_r290_air_conditioner_production (accessed March 25, 2015); *See also*, U.S. EPA, Benefits of Addressing HFCs under the Montreal Protocol (2014), at 16.

53 European Council, *Regulation (EU) No. 517/2014 of the European Parliament and of the Council of 16 April 2014 on Fluorinated Greenhouse Gases and Repealing Regulation (EC) No 842/2006, 2014*, *available at*: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN.

54 U.S. EPA, "The Benefits of Addressing HFCs" (2014).

55 European Council, *Directive 2006/40/EC Relating to Emissions from Air-conditioning Systems in Motor Vehicles and Amending Council Directive 70/156/EEC*, May 17, 2006, *available at*: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0040&from=EN.

56 U.S. EPA, "The Benefits of Addressing HFCs" (2014) at 10.

57 Executive Office of the President, *President's Climate Action Plan*, June 2013, 10, *available at:* https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf.

58 U.S. EPA, "The Benefits of Addressing HFCs" (2014) at 10.

59 U.S. Environmental Protection Agency, *Protection of Stratospheric Ozone: Listing of Substitutes for Refrigeration and Air Conditioning and Revision of the Venting Prohibition for Certain Refrigerant Substitutes*, 40 CFR 82, February 27, 2015, *available at*: http://www.epa.gov/ozone/snap/download/SAN_5745-SNAP_Low_GWP_Refrigerants_FRM_Signature_Version-signed-2-27-2015.pdf.

EPA that offer credit toward mandatory fuel efficiency standards for low-GWP refrigerants.[60] The U.S. EPA is also in the process of removing HFC-134A from the list of refrigerants under the U.S. EPA SNAP program and removing other high-GWP refrigerants from the list of acceptable refrigerants for a half-dozen other products, including domestic refrigerators and freezers, stand-alone refrigerated display cases and vending machines, and other appliances.[61]

- **AUSTRALIA** requires a license for import, export, and manufacturing of synthetic greenhouse gases, including HFCs. This requires quarterly reporting and a cost recovery levy of $165 per tonne of CO2 equivalent. The license fee is U.S.$15,000.[62]

POLICY MEASURES AND INITIATIVES	PARTIES
Legislation, Regulations or Other Mandatory Measures	
Control of HFC production and consumption	Australia, Canada, Denmark, European Union,** Japan, Switzerland, United States *Austria, Belize, Colombia, Croatia, Montenegro, Serbia, Sweden, the Former Yugoslav Republic of Macedonia, Turkey*
Control of HFC emissions	Australia, Canada, European Union, Japan, Netherlands, Norway, Switzerland, Togo, United States *Colombia, Germany, Montenegro, New Zealand, Sweden, Yemen*
Training and certification	Australia, Canada, European Union, Japan, Netherlands, Norway, Republic of Moldova, United States *Italy, Montenegro, United Kingdom*
Record keeping and reporting	Australia, Canada, European Union, Japan, Netherlands, Norway, Switzerland, Togo, United States *Belize, Egypt, Montenegro, New Zealand*
Labelling	European Union, Norway, United States *Belize, Montenegro, Yemen*
Economic Incentives	
Tax and import incentives	Denmark, Norway, Poland, Slovenia, Spain *Burkina Faso, China, New Zealand, the Former Yugoslav Republic of Macedonia*
Refunds and other incentives	Belgium, Canada, Denmark, European Union, Germany, Japan, Mozambique, Norway, Spain, United States *Colombia, New Zealand*
Emission trading and compliance credits	European Union, United States *China, New Zealand*
HCFC Phase Out Management Plans	
Introduction of alternatives to HFCs through projects funded by the Multilateral Fund	Bangladesh, El Salvador, Mexico, Paraguay, Republic of Moldova, Swaziland, Zimbabwe *Bosnia and Herzegovina, Maldives, Thailand*
Other Initiatives	
Energy efficiency	Bangladesh, Canada, European Union, Japan, Mexico, Netherlands, Norway, United States *Sweden*

60 Executive Office of the President, President's Climate Action Plan, (2013) at 10. *See* U.S. EPA, "The Benefits of Addressing HFCs" (2014) at 16. *See also* Zaelke, Durwood and Nathan Borgford-Parnell, "Primer on Short-Lived Climate Pollutants," Institute for Governance & Sustainable Development, 44-45 (November 2013), *available at:* http://www.igsd.org/documents/PrimeronShort-LivedClimatePollutantsNovemberElectronicversion.pdf.

61 U.S. EPA, "The Benefits of Addressing HFCs" (2014) at 10.

62 Australia Department of Environment, *Controlled Substances License to Import Synthetic Greenhouse Gases (SGGs) – HFCs, PFC, and/or SF6*, http://www.environment.gov.au/protection/ozone/licences-and-reporting/hfcs-pfcs-and-sf6 (accessed April 14, 2015).

POLICY MEASURES AND INITIATIVES	PARTIES
Voluntary agreements	Canada, European Union, Netherlands, United States
Industry initiatives	United States
Alternative technologies	Canada, Denmark, Germany *Brazil, India, Mauritius*
Awareness raising	Denmark, European Union**, Ireland, Netherlands, Norway, United States

Source: UNEP (2015)[63]

Global Markets Are Already Phasing Down HFCs

Multinational companies support phasing down HFCs under the Montreal Protocol. Room and vehicle air conditioners are global markets in which international companies compete for market share—these markets are linked. Over 400 private sector companies from 70 different countries, known as the Consumer Goods Forum (CGF) have pledged to phase down HFC refrigerants starting in 2015.[64] This includes large companies who do business in large developing economies like India and China—companies like Coca Cola Company, 3M, Procter & Gamble, and Unilever.[65] In addition, the Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants (CCAC) has also undertaken several initiatives to reduce HFCs. It consists of 99 partners, 45 being country partners and 54 being non-state partners.[66] On September 16, 2014, more than a dozen companies from manufacture to retail of HFCs pledged rapid phase out of obsolete HFC products and phase in of replacement technology.[67] This includes Red Bull, Coca Cola Company, PepsiCo, Target, SEVO Systems, True Manufacturing, Thermo King, Mission Pharmacal, Kroger, Johnson Controls, Honeywell, Emerson Climate Technologies, Du-Pont, Danfoss, Carrier, Arkema, and Air Conditioning Heating & Refrigeration Institute.[68] This shows industry is working aggressively in all sectors to switch to lower-GWP refrigerants.[69]

However, global market transformation is complex, requiring consistent and decisive global policy direction.[70] A patchwork of national and regional regulations does not send a strong signal to industry to develop new technologies and fails to guarantee financial support to developing countries. While domestic regulations and business commitments would help achieve GHG reductions in the immediate term, these cannot substitute the global effort needed for containing growth of HFCs at a manageable cost, with support to companies who do business within the countries.

63 UNEP, "Overview of Issues Related to HFC Management," (2015) at 23.* Parties in italics have not submitted information to the Secretariat themselves; information presented in the table has been taken from the USEPA report submitted by the United States. ** The European Union submitted regulations applicable to its 28 member States and additional information on behalf of five member States (Denmark, Ireland, Poland, Slovenia and Spain). All European Union member States that have submitted information either through the European Union or individually are listed in the table.

64 U.S. EPA, "The Benefits of Addressing HFCs" (2014) at 10.

65 *Ibid.*

66 UNEP, "Overview of Issues Related to HFC and their Management" (2015), at 12.

67 Press Release, The Whitehouse, *Obama Administration Partners with Private Sector on New Commitments to Slash Emissions of Potent Greenhouse Gases and Catalyze Global HFC Phase Down*, September 16, 2014, https://www.whitehouse.gov/the-press-office/2014/09/16/fact-sheet-obama-administration-partners-private-sector-new-commitments- (accessed March 25, 2015).

68 *Ibid.*

69 The Alliance for Responsible Atmospheric Policy, "Industry Progress and Needs" (2014).

70 *Ibid.*

Phasing Down HFCs Is Economically Feasible

Cost is a major factor in considering feasibility of an HFC phase down and one that each Party must realistically consider. Estimates indicate that costs of transitioning to low-GWP alternatives are feasible. Moreover, transitioning to chemicals that would soon be obsolete is an expensive way forward for Article 5 Parties that have not yet substantially transitioned to HFCs.

The October 2014 Technology and Economic Assessment Panel (TEAP) report contains overall estimates of cost for Article 5 Parties under two scenarios for HFC phase down, with costs ranging between U.S.$ 459-972 million for the first scenario and ranging between U.S.$ 1080-3240 million for the second.[71] TEAP describes the first scenario, as a "relatively achievable scenario based on current technology options and potential trends."[72] It describes the second scenario as "a more progressive 'what if' assessment... believed to be at the limit of what could be achievable in the period to 2030."[73] TEAP also concludes that both R-32 and R-290 based small self-contained air conditioners and mini-split air conditioners are economically viable and have little to no additional costs anticipated.[74]

While it is difficult to estimate the actual cost for some developing economies to phase down HFCs, such as India, comparisons with prior phase downs or other country HFC phase downs is a good place to start. For example, Indian industry so far has received Rs.547 million (U.S. $87.47 million) to phase out ODSs.[75] In addition, Thailand recently determined that the cost to transition from HCFC-22 to R-32 in room air conditioners, thereby leapfrogging over high-GWP HFC-410A would be a total estimated cost of Rs.367 million (U.S. $5.84 million), which is paid by the Montreal Protocol MLF.[76] That is close to what India plans to pay to build an international cricket stadium in Lucknow (Rs.300 crore). It is also much less than other countries spend on stadiums for the World Cup. For example, Germany spent $1.87 billion to build 12 stadiums for the 2006 World Cup and South Africa spent $1.48 billion on 10 arenas in 2004 in preparation for the World Cup.[77]

Costs will trend downward as scale and experience improve and with the announced entry to the market of new producers. Several global leading air conditioning component suppliers such as Guangdong Meizhi Compressor (GMCC), Copeland, Dalian Sanyo (Panasonic), Danfoss, Sanhua, and Saginomiya are developing or have already announced compressors and components for use with R-32. Given the expansion of R-32-oriented production, the cost of appliances using this refrigerant are expected to decline in the future, making them more viable compared to existing alternatives.

By leapfrogging over HFC-410A in room air conditioners, countries with emerging economies will get the benefit of not paying double transition costs—one for the transition from HCFC to HFC-410A and then a second transition to low-GWP refrigerants later. Moreover, the costs are also offset by savings in other areas. For example, improved energy efficiency leads to a decrease in oil imports. It is estimated that switching to more energy efficient room air conditioners alternatives would decrease India's oil imports by 101 million barrels in 2020 and 266 million barrels in 2035.[78] Moreover, improved energy efficiency will lead to a decrease in investment requirements

71 United Nations Environment Programme, *Report of The Technology and Economic Assessment Panel: Decision XXV/5 Task Force Report,* October 2014, 6, *available at*: http://conf.montreal-protocol.org/meeting/mop/cop10mop26/presession/Background%20Documents%20are%20available%20in%20English%20o1/TEAP_Task%20Force%20XXV5-October2014.pdf.

72 *Ibid.*, 3.

73 *Ibid.*

74 *Ibid.*, 14-16.

75 The World Bank, *Implementation Completion and Results Report on a Grant in the Amount of US$83.02 Million to the Republic of India for a Chlorofluorocarbon Production Sector Gradual Phase out Project (ODS III),* June 22, 2012, 6.

76 World Bank, *Thailand HFCF Phase out Management Plan (Stage I): Environmental Management Plan*, January 2014, 26, *available at:* http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/02/05/000333037_20140205113143/Rendered/PDF/E44400V30SF0EA00Box382142B00PUBLIC0.pdf.

77 Reuters, "Soccer-Brazil World Cup Stadiums on Track, But Costs Soar" April 3, 2012, http://www.reuters.com/article/2012/04/03/soccer-world-brazil-idUSL2E8F2GG820120403 (accessed March 25, 2015).

78 Chaturvedi, Vaibhav and Priyadarshi R. Shukla, "Role of Energy Efficiency in Climate Change Mitigation Policy for India: Assessment of Co-benefits and Opportunities Within an Integrated Assessment Modeling Framework," *Climate Change* 123 (3-4) (September 7, 2013) 597-609.

for electricity generation – up to U.S.$1.3 trillion without an HFC phase down policy and U.S.$3 trillion with an HFC phase down policy.[79] Last, the funds not wasted on fuel imports and power plant investment can provide jobs and profits in other sectors.

As a result of highly globalized markets, automobile manufacturers generally prefer to design for the most stringent safety requirements of any of their markets. This simplifies manufacturing, requiring fewer parts and fewer types of refrigerant-charging equipment. Inventory costs are reduced since vehicles can be shipped to any market. The service sector's tool and training costs are also minimized once the fleet turns over and requires only one refrigerant. However, this path has the disadvantage of raising the cost of vehicles sold in export markets that do not yet require a low-GWP refrigerant.

Indian automobile manufacturers that market cars in Europe are ready and able to comply with the E.U.'s MAC F-Gas Directive. In fact, two companies with a significant presence in India—TATA Motors and Maruti Suzuki have designed prototype HFO-1234yf systems for the vehicles they intend to export to Europe and TATA is a partner in a demonstration of secondary-loop MACs that use reduced refrigerant charge of either HFC-152A (GWP=138; about $5/kg) or HFO-1234yf (GWP<1; about $120/kg), which will have very low refrigerant leak rates and higher energy efficiency that offsets added costs of components.

Most Indian suppliers of mobile air-conditioning systems and components have business affiliations with international companies that are already supplying European and North American markets with HFO-1234yf systems. By the end of 2014, there were 2 million vehicles with HFO-1234yf.[80] Some Indian suppliers provide components for these systems. For example, Behr, Denso, Delphi, and Visteon already manufacture MAC components and systems for Indian and global markets and can quickly supply HFO-1234yf systems for cars made in India using designs and parts already commercialized for cars sold in the European Union and North America. Delphi and Subros have sophisticated and capable research facilities in India that could develop components and systems suitable for the hot and humid Indian climate. However, field personnel will need training and specialized tools to leak check and recover and recharge refrigerants.

Safety and Flammability Risks of Alternatives Can Be Mitigated

Safety of alternative refrigerants is a valid global concern. Flammability in lower-GWP alternative refrigerants can be higher than the default replacement refrigerants. For example, for room air conditioners, R-290 and R-32 are more flammable than the status quo HFC-410A and HFC-152A and HFO-1234yf are more flammable than the status quo HFC-134A for motor vehicle air conditioners. However, proper safety standards, training, enforcement, and insurance can reduce many of these concerns. Safety Standards ensure that products and services are safe, reliable and of good quality.

Every product that reaches the market requires an adequate risk assessment. A risk assessment is based on various factors such as ignition, consequence, leak probability, and pooling probability.[81] With proper design, construction, testing, markings, manufacture, storage, maintenance, repair, and recovery, along with proper leakage detection sensors and handling by trained technicians, flammability concerns are minimal. For example, SAE International (formerly known as the Society of Automotive Engineers) has developed a full set of safety standards for HFO-1234yf and is working on safety standards for HFC-152A and CO_2.

79 *Ibid.*

80 The Alliance for Responsible Atmospheric Policy, "Industry Progress and Needs for Replacing High GWP HFCs" (Montreal Protocol HFC Management Workshop, Paris, July 11, 2014).

81 Osami Kataoka, et al., "Flammability Evaluation of HFC-32 and HFC-32/134a Under Practical Operating Conditions" (International Refrigeration and Air Conditioning Conference, 1996), *available at:* http://docs.lib.purdue.edu/iracc/297.

BOX: FLAMMABILITY AND SAFETY STANDARDS

Flammability and toxicity requirements are covered by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) safety standard. Safety Standard 15 addresses refrigerants. Safety Standard 34 deals with designation and safety classification. Also, safety is covered by ASHRAE's international equivalents, international safety standards (ISO) 5149 and ISO 817.[82] This is similar to Europe's safety standard 378.

Under ASHRAE refrigerant standards, flammability classifications fall under 4 classes depending on the flame speed. Class 1 has no flame propagation; class 2L has mild flammability; class 2 has moderate flammability; and class 3 is highly flammable. ISO 817 contains few variances from Standard 34, except that it does not include safety classifications and has more conservative refrigerant concentration limits.[83] ISO 817 provides a system for assigning designations to refrigerants, establishes a system for assigning a safety classification to refrigerants based on toxicity and flammability data, and provides a means of determining the refrigerant concentration limit. ASHRAE's standard 15 deals with design, construction, installation, operation, and inspection of the equipment. ISO 5149 is standard 15's counterpart. It consists of four parts which addresses definitions, classification, selection criteria, design, construction, testing, marking, documentation, installation, operation, maintenance, repair and recovery.[84]

Safety and Flammability in Room Air Conditioners (RAC)

R-290 is a highly flammable substance. However, application in residential and commercial refrigeration is safe if it meets European and ISO standards for 1 to 1.5 ton capacity for use in rooms large enough to keep refrigerant concentration below the lower flammability limit (LFL). Designed with relatively small charge sizes, flammable hydrocarbon room air conditioners have been found effective and safe, as evidenced by Godrej and Boyce's energy efficient R-290 air conditioning units already on the Indian market. Flammability was addressed by implementing four important standards: (1) designing the appliance and manufacturing facility to minimize risks; (2) limiting the quantity of refrigerant charge in the air conditioner according to ISOs; (3) selling the appliance only for installation in rooms large enough to prevent refrigerant concentration from reaching the LFL; (4) having trained technicians in the air conditioner using factory; and (5) implementing safety procedures and training service personnel.[85] The German Society for International Cooperation, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) published detailed handbooks for R-290 room air conditioner manufacturing, installation, and service safety.[86]

Manufacturers already safely handle other flammable refrigerants in other applications. System designs can be used to reduce potential fire hazards for room air conditioners by reducing leaks as well as, for smaller units, ensuring that leaks pose no flammability threats. Hydrocarbons like R-600 are already used extensively in other appliances such as refrigerators, reaching 55% penetration rate in industrialized countries.[87] Many Chinese manufacturers are also moving production lines to R-290 air conditioners. This shows that designs can be used to reduce potential fire hazards for room air conditioners by reducing leaks as well as, for smaller units, ensuring that leaks pose no flammability threats.

82 Tom Watson, "International Refrigerant Standards and Their Influence on the Global HVAC Industry and Refrigerant Replacement," ASHRAE, 2013, *available at*: http://www.unep.org/ozonaction/Portals/105/documents/virtualexpo/crh2013-WatsonTom%20(ASHRAE).pdf.

83 *Ibid.*

84 *Ibid.*

85 *See* Dilip Rajadhyaksha, *"Development and Handling of Hydrocarbon Air- Conditioners – The Godrej Experience,"* (Presentation at Bangkok Technology Conference, June 29, 2013), http://www.unep.fr/bangkoktechconference/docs/IIIA1%20Dilip%20Rajadhyaksha%20Godrej%20Presentation.pdf. Held in conjunction with the Montreal Protocol Open-Ended Working Group (OEWG).

86 GIZ Proklima International, *Guidelines for the Safe Use of Hydrocarbon Refrigerants: A Handbook for Engineers, Technicians, Trainers, and Policy-makers: For a Climate-friendly Cooling* (2012), *available at:* http://www.giz.de/expertise/downloads/giz2010-en-guidelines-safe-use-of-hydrocarbon.pdf.

87 GIZ Proklima International, *Production Conversion of Domestic Refrigerators from Halogenated to Hydrocarbon Refrigerants: A Guideline* (2011), *available at*: http://www.thai-german-cooperation.info/download/2011_production_conversion.pdf

R-32 is mildly flammable. Tests conducted on R-32 showed that while R-32 is mildly flammable, the risk associated with use of R-32 is far lower than R-290 and the safe cooling capacity is up to about 4.5 tonnes, which makes them the preferred choice for larger rooms in hot climates.[88] In fact, R-32 is widely used already. Japan, Thailand and China were the first Parties with companies introducing R-32 room air conditioners. Now, R-32 is sold in 30 countries[89] and Fujitsu General launched two new models in India following Daikin's successful introduction several years ago.[90]

R-290 and R-32 are flammable refrigerants, but they can be safely used with appropriate design and safety standards. Europe established safety standards for room air conditioners using these refrigerants, and such standards are in the final stages of approval in Japan, the United States, and other countries. Adoption of similar safety standards in countries with emerging economies would ensure that inadequately designed products using these refrigerants are excluded from the market. It is also important that installation and service technicians receive proper training and tools. Industry, however, recognizes safety as a top priority. For example, Godrej and Daikin technicians are specifically trained in safe installation and maintenance of the new models, and both companies include installation by certified technicians in the price of the products. In 2013, Daikin held service technician training in India to expand the servicing network for R-32. This project trained 3,600 local installers.[91]

REFRIGERANT	GWP	ENERGY EFFICIENCY	ASHRAE & ISO FLAMMABILITY	MARKET STATUS	REGULATORY STATUS
Current High-GWP Refrigerant Used in Room Air Conditioner					
HCFC-22	High (1810)	High	Class 1: Not flammable	Scheduled for phase-out under the Montreal Protocol, with a reduction scheduled over time in India.	No longer allowed in new appliances sold in the E.U., the U.S., or other developed countries
Replacements for HCFC-22 in Room Air Conditioner					
HFC-410a	High (2088)	Low	Class 1: Not flammable	Has been licensed to a number of global chemical producers and its patents are expiring.	
HFC-32	Medium (675)	High	Class 2L: Mildly flammable	There will be multiple suppliers of HFC-32, since the chemical is already manufactured as a component of HFC-410a; patents for manufacturing HFC-32 have long expired, guaranteeing competitive pricing; and construction of new production is under way in India by Daikin. Daikin has announced that it will allow companies in developing countries to use basic HFC-32 air-conditioning patents at no charge through "non-assertion contracts."	
HC-290 (Propane)	Low (<5)	High	Class 3: Highly flammable, but is approved by respected national and international safety authorities for refrigeration and air-conditioning applications with relatively small charges and explosion-proof electrical connections and components such as switches.	Godrej in India produces room air conditioners using HC-290; Gree in China and more than half of the manufacturers in China have chosen HC-290. Two air-conditioner production lines and a compressor production line have already been converted. China adopted IEC 60335-2-40, which will enter into effect in July 2013, allowing air conditioners to be charged with up to 350 grams of HC-290.	Companies have yet to apply to the U.S. EPA for SNAP approval
HFO/HFC blends (DR7, L41, L20)	Medium (~350 to ~700)	Neutral to Positive	Class 1: (not flammable) or Class 2L: (mildly flammable)	DuPont, Honeywell, Arkema, and other companies announced plans to commercialize low-GWP blends suitable for room air conditioners; they are not yet available in commercial room air-conditioner products.	

88 Kataoka, et al., (1996).

89 Daikin Group, *Corporate Social Responsibility Report 2014*, 13 (2014), *available at:* http://www.daikin.com/csr/report/2014/daikin_csr2014e_all.pdf.

90 Cooling Post, "Fujitsu R32 units launched in India," April 13, 2014, http://www.coolingpost.com/world-news/fujitsu-r32-units-launched-in-india/ (accessed April 1, 2015).

91 Mark Stanga, "Update on R32 Air-conditioning and Heat Pump Manufacturing and Sales-Progress Since Last OEWG in Bangkok 2012," (Daikin Presentation, June 29, 2013), *available at*: http://www.unep.fr/bangkoktechconference/docs/IIIB-3%20Mark%20Stanga%20Daikin.pdf.

Safety and Flammability in Mobile Air Conditioners (MAC)

HFC-152A is a mildly flammable refrigerant that is safe to use in secondary loop designs. It is allowed under the EU MAC F-gas Directive and listed as acceptable by the U.S. EPA SNAP program. It has been engineered and tested and system suppliers have announced commercial availability.[92] The U.S. EPA determined that the flammability risks are manageable and reducible by modest design.[93] Testing has also shown it is difficult to ignite when released into engine compartments.

HFO-1234yf is also listed as mildly flammable but safe to use in vehicles. HFO-1234yf flammability is managed through engineering design and service procedures. SAE International, the global professional society of automobile engineers, and several other fire safety organizations have investigated and confirmed the safety of HFO-1234yf. MAC Members of the SAE cooperative research project carried out the analysis, which included members of most major car manufacturers from various regions of the world. The SAE's analysis found that the refrigerant poses an "extremely low-level risk" that is a million times lower than the risk of vehicle fires due to all causes. SAE also found that flammability claims by advocates of competing technology were based on highly unrealistic crash test conditions—conditions that would be extraordinarily unlikely to occur in real life.[94]

Many of the other chemicals and materials in automobiles such as fuels, lubricants, plastics, and fabrics are far more flammable. Passengers and service workers are kept safe by effective systems designs—the same is true for HFO-1234yf in vehicle air conditioners. However, it is not safe to retrofit vehicle air conditioners to use hydrocarbons due to high leak rates, casual service, and the many sources of ignition in the engine compartment and in service facilities.

REFRIGERANT	GWP	MARKET STATUS	ALLOWED IN U.S. OR EUROPE	ASHRAE & ISO FLAMMABILITY
Current High-GWP Refrigerant Used in Automobile Air Conditioners				
HFC-134a	1430[a]	Replaced CFC-12 in new Japanese, North American, and European cars in 1994 and worldwide by 2010	Currently allowed under EPA SNAP, but under review to be removed; does not meet the E.U.'s F-Gas directive	Class 1: Not Flammable
Replacements for HFC-134a in Automobile Air Conditioners				
HFO-1234yf	~4[b]	Choice of automobile manufacturers in North America, Japan, and Europe; world-scale production plant now operating in China; first cars entering the market	Allowed under EPA SNAP; meets the E.U.'s MAC F-Gas directive	Class 2L: Mildly flammable
HFC-152a	124[c]	Prototyped, but not commercialized; no intellectual property barriers to manufacture or use	Allowed under EPA SNAP; meets the E.U.'s MAC F-Gas directive	Class 2L: Mildly flammable
Hydrocarbons	<5[d]	Not considered safe by any major vehicle manufacturer; no intellectual property barriers to manufacture or use	Not allowed under EPA SNAP; meets the E.U.'s MAC F-Gas directive	Class 3: Highly flammable
Carbon Dioxide (CO_2)	1[e]	Prototyped, but not commercialized	Allowed under EPA SNAP; meets the E.U.'s MAC F-Gas directive	Class 1: Not flammable

Exponential Growth Demands Action

Nearly 50% of HFC production is located in Article 5 Parties.[95] Countries with predicted growth would benefit from taking the driver's seat. For example, India is the second fastest growing major economy worldwide. Room air

92 U.S. Environmental Protection Agency, *HFC-152a as an Alternative to HFC-134a in Mobile Air Conditioners*, October 30, 2007, *available at:* http://www.epa.gov/cpd/mac/152a/FINAL%20HFC%20152a%20REPORT.pdf.

93 U.S. Environmental Protection Agency, *Report of the 14-15 August 2007 U.S. EPA Workshop on HFC-152a Secondary Loop Vehicle A/C Systems*, October 30, 2007, *available at:* http://www.epa.gov/cpd/mac/152a/FINAL%20HFC%20152a%20REPORT.pdf.

94 Press Release, SAE International, "SAE International Cooperative Research Project CRP1234-4 on R-1234yf Safety, Finishes Work and Presents Conclusions," June 21, 2013, http://www.prweb.com/releases/2013/6/prweb10860540.htm (accessed March 25, 2015).

95 *Ibid.*, 4.

conditioners and energy consumption more than doubled from 2006 to 2011.[96] An analysis by PwC – a consulting firm – reports that annual sales of room ACs reached 3.44 million in 2010.[97] The U.S. Department of Energy (DoE), Lawrence Berkeley National Laboratory (LBNL) estimates that the average urban households owning an air conditioner is likely to grow to 30% by 2020 and 73% by 2030.[98] Based on these forecasts, air conditioning units will increase at least 20 times the current number with an expected growth from 4.6 million to approximately 116 million air conditioning units by 2030.[99] Emerging and growing economies like India's could reap the financial benefits of leading this transition.

At the 2014 Twenty-Sixth MOP to the Montreal Protocol, leaders of China and India made high-level statements recognizing the importance of phasing down HFCs and the potential for using the Montreal Protocol.[100] Similar to China and the U.S., India and the U.S. made joint statements and pledged cooperation on the phase down of HFCs in addition to recognizing the need to use the institutions and expertise of the Montreal Protocol to reduce consumption and production of HFCs, while continuing to report and account for the quantities reduced under the UNFCCC.[101]

The Framework Is Already in Place

The Montreal Protocol is a highly effective treaty that achieved universal ratification with 197 Parties. It was "designed to reduce the production and consumption of [ODS]," [102] and is an example of how countries can cooperate to combat a serious global problem. Under the Montreal Protocol, developing countries that once consumed less than a specified quantity of CFC per capita are known as "Article 5" Parties. There are currently 147 Article 5 Parties, including India.[103]

The Montreal Protocol is different from the UNFCCC and its Kyoto Protocol. The aim of the climate treaties is to reduce GHG emissions. Unlike the Montreal Protocol, the UNFCCC includes a list of what it defines as developed country parties – known as the "Annex I Parties."[104] These parties are expected to 'take the lead' in addressing climate change. All other non-listed parties are known as non-Annex I Parties.[105] The Kyoto Protocol sets legally binding emission targets for UNFCCC Annex I Parties.[106] Currently, there are 192 member Parties including Annex I and Non-annex I Parties.[107] Almost all of the Annex I parties took on quantified emission targets for the first commitment period, but only some agreed to emission targets for the second period. Non-Annex I Parties have a general obligation to mitigate and adapt to climate change, but no specific targets.[108]

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96 The World Bank, *Residential Consumption of Electricity in India,* July 2008, *available at:* http://moef.nic.in/downloads/public-information/Residentialpowerconsumption.pdf.

97 Analysis of impact of super efficiency on AC manufacturers suppliers in India. Price Waterhouse Coopers, June 2012

98 Phadke, Amol, Nikit Abhyankar, and Nihar Shah, "Avoiding 100 New Power Plants by Increasing Efficiency of Room Air Conditioners in India: Opportunities and Challenges," Lawrence Berkeley National Laboratory, 17 (2013), *available at:* http://www. superefficient.org/Resources/~/media/Files/eeDAl%20Papers%20%202013/031_Shah_finalpaper_eeDAl13.pdf.

99 *Ibid.*

100 UNEP, "Report of the Tenth Meeting of the Conference of the Parties" (2014) at 30.

101 *Ibid.,* 16.

102 United Nations Environmental Programme, "The Montreal Protocol on Substances that Deplete the Ozone Layer," http://ozone.unep.org/new_site/en/montreal_protocol.php (accessed March 25, 2015).

103 United Nations Environmental Programme, "List of Parties Categorized as Operating Under Article 5 Paragraph 1 of the Montreal Protocol," http://ozone.unep.org/new_site/en/parties_under_article5_para1.php (accessed April 1, 2015).

104 United Nations, *United Nations Framework Convention on Climate Change* (1992), *available at:* http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf.

105 *See,* Andersen, Stephen O., Duncan Brack, and Joanna Depledge, "Summary: A Global Response to HFCs Through Fair and Effective Ozone and Climate Policies," Chatham House (Research Paper, July 2014), *available at:* http://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/201407HFCSummary.pdf.

106 United Nations Framework Convention on Climate Change, "Status of Ratification of the Kyoto Protocol," http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php (accessed April 1, 2015).

107 Andersen, Stephen O., Duncan Brack, and Joanna Depledge, *A Global Response to HFCs Through Fair and Effective Ozone and Climate Policies*, Chatham House (Presentation at Open-Ended Working Group to the Montreal Protocol, July 15, 2014).

108 Ibid.

Proposals to include HFCs under the Montreal Protocol do not usurp the climate treaties; rather they are intended to support the overall global efforts to protect the climate system and are therefore, complimentary.[109] In fact, they can complement one another without any conflict. The Montreal Protocol controls the production and consumption of manufactured chemicals, whereas the climate treaties control and account for emissions. The Montreal Protocol removes HFCs from the market and as a result, would once-and-for-all mitigate emissions that would be counted toward UNFCCC/Kyoto targets.[110] HFCs are different from the majority of gases that fall under the climate treaties because they are intentionally produced.[111] They were invented as a direct result of phasing out ODSs such as CFCs and HCFC, and their rapid growth is directly attributable to compliance with the Montreal Protocol.[112] Hence, HFCs fall within the jurisdiction of the Montreal Protocol and its framework agreement (the 1985 Vienna Convention) because the ambit of those treaties includes assuring the safety of replacement chemicals.[113]

The Montreal Protocol is a well-established functioning agreement with expertise, experience, and already established supporting institutions and mechanisms necessary to effectively control HFCs. So far, no action has been taken under the climate treaties to phase down HFCs.[114] In fact, climate benefits are greater under the Montreal Protocol than under the climate treaties. The combined amount of emissions reduced or avoided from 1990 levels by 2012 under the Kyoto Protocol were approximately 10 Gt CO_2 equivalent.[115] However, it is estimated that the Montreal Protocol avoided between 8-10 Gt of CO_2 *per year* of emissions.[116] With significant global support, now is the time to act to benefit from what the Montreal Protocol has to offer.

SUBSTANCE LIST UNDER PROPOSED AMENDMENTS	IPCC AR5 GWP
Group I	
HFC-32	677
HFC-41	116
HFC-125	3170
HFC-134	1120
HFC-134a	1300
HFC-143	328
HFC-143a	4800
HFC-152	16
HFC-152a	138
HFC-161	4
HFC-227ea	3350
HFC-236cb	1210
HFC-236ea	1330
HFC-236fa	8060
HFC-245ca	716
HFC-245fa	858
HFC-365mfc	804
HFC-43-10mee	1650
HFC-1234yf (HFO)	<1
HFC-1234ze (HFO)	<1
Group II	
HFC-23	12400

109 U.S. Environmental Protection Agency, *Summary: North American 2013 HFC Submission to the Montreal Protocol*, 2013, *available at*: http://www.epa.gov/ozone/downloads/HFC_Amendment_2013-Summary.pdf.

110 EIA, "The Montreal Protocol in 2012," (2012) at 2.

111 Mack McFarland, "Challenges for India in Meeting HCFC Phase out Commitments and Addressing Global Climate Change," DuPont (Presentation, Meeting of the Technology and Finance Standing Committee, November 7, 2013).

112 United Nations Environmental Programme, *HFCs: A Critical Link in Protecting Climate and the Ozone Layer: A UNEP Synthesis Report*, 16, 2011, *available at*: http://www.unep.org/dewa/Portals/67/pdf/HFC_report.pdf.

113 United Nations Environmental Programme, *Decision XIX/6 of the 19th Meeting of the Parties to the Montreal Protocol*, September 2007, http://ozone.unep.org/new_site/en/Treaties/decisions_text.php?m_id=11&show_all (accessed March 25, 2015).

114 *Ibid.*, 18.

115 *See* Guus J.M. Velders, et al., "The importance of the Montreal Protocol in Protecting Climate," *Proceedings of the National Academy of Sciences*, 104 (2007): 4814-4818.

116 UNEP, "HFCs: A Critical Link," (2011) at 19.

About the Project Team

Council on Energy, Environment and Water (CEEW) is an independent, not-for-profit policy research institution. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It does so through high-quality research, partnerships with public and private institutions, and engagement with and outreach to the wider public.

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Recent Research on Phasing Down HFCs

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