

## Working Paper

# Phasing Down the Use of Hydrofluorocarbons (HFCs)

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## Overview

Developed to replace ozone-depleting substances that are being phased out under the Montreal Protocol, hydrofluorocarbons (HFCs) are used as refrigerants, as solvents, in fire protection and in insulating foams. They are the fastest-growing greenhouse gas (GHG) in much of the world, increasing at a rate of 10–15% per year. Although they only stay in the atmosphere for about 15 years or less, they are so potent that their warming impact measured as 100-year global warming potential (GWP) is up to about 3,000 times that of CO<sub>2</sub> for the most commonly used HFCs.

Replacing HFCs with greener refrigerants has low upfront costs and can result in energy efficiency improvements of 10–50% or greater when the best available technologies are applied when the refrigerant is changed. Cooperative initiatives such as the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC), the Consumer Goods Forum, and Refrigerants, Naturally! are helping countries and companies cut back HFC use. More than 100 nations now support proposals to phase down production and consumption of HFCs under the Montreal Protocol, leaving accounting and reporting of HFC emissions under the United Nations Framework Convention on Climate Change (UNFCCC). The Montreal Protocol's Multilateral Fund (MLF) pays the full, agreed incremental cost for developing country parties to meet their obligations under the treaty.

**The Global Commission on the Economy and Climate recommends that parties to the Montreal Protocol approve an amendment to phase down the production and use of HFCs.**

In addition, countries that are not already working to phase down HFCs should begin developing and implementing domestic regulations to do so, while also increasing their



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## About this working paper

This New Climate Economy Working Paper was written as a supporting document for the 2015 report of the Global Commission on the Economy and Climate, *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. It reflects the research conducted for Section 2.10 of the full report and is part of a series of 10 Working Papers. It reflects the recommendations made by the Global Commission.

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appliance energy efficiency standards. Major companies should commit to phasing out HFCs through cost-effective cooperative action programmes such as those of the Consumer Goods Forum and Refrigerants, Naturally! The Parties to the UNFCCC should also be encouraged to include an HFC phase-down in their “intended nationally determined contributions” (INDCs), and reporting on HFC emissions should be extended to all countries.

Incorporating HFC production and consumption into the Montreal Protocol would provide significant near-term gains to slow climate change, and could lead to avoiding 1.1–1.7 Gt CO<sub>2</sub>e of annual GHG emissions per year by 2030.

## 1. Introduction

Hydrofluorocarbons (HFCs) are the fastest-growing type of GHG in much of the world, with emissions of HFCs increasing at a rate of 10–15% per year.<sup>1</sup> HFCs were developed to replace chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) – ozone-depleting substances that are being phased out under the Montreal Protocol. HFCs are used as refrigerants in air conditioners and other products, to make insulating foams, and as solvents. Unlike the chemicals they replaced, HFCs do not harm the ozone layer, but are potent greenhouse gases, with much greater short-term climate impact than carbon dioxide.<sup>2</sup> Recent scientific estimates suggest that phasing down production and consumption of HFCs with the highest global warming potential (GWP) can cumulatively avoid the equivalent of more than 100 billion tonnes (Gt) of CO<sub>2</sub> emissions by 2050,<sup>3</sup> and avoid up to 0.5°C of warming by 2100,<sup>4</sup> while catalysing significant improvements in appliance energy efficiency that would bring cost savings and further climate benefits potentially more than 100 Gt of CO<sub>2</sub>e by 2050.<sup>5</sup>

One cost-effective and established pathway for reducing HFCs is through the Montreal Protocol, a global treaty that has successfully phased out nearly 100 chemicals similar to HFCs, and has been ratified by 197 countries, making it the only UN treaty with universal ratification. Phasing down production and consumption of HFCs under the Montreal Protocol would complement, not replace, the current practice of developed countries reducing emissions and reporting HFC emissions to the UNFCCC, which includes HFC emissions in its basket of gases. The Montreal Protocol includes a multilateral funding mechanism, the MLF, which would provide funding for the HFC phase-down in developing countries. More and more countries have joined the call for regulating the production and consumption of HFCs under the Montreal Protocol, which is widely considered one of the world’s most effective environmental treaties.

This paper describes how an amendment to the Montreal Protocol, working alongside the UNFCCC regime, can effectively reduce the production and consumption of HFCs. We begin with the global context of HFCs and the public and private benefits achievable through reduced emissions and increased appliance energy efficiency. We then describe technical solutions to support the implementation of a global phase down, and assess the progress made so far through national and regional regulation and voluntary industry agreements. Finally, we make the case for international cooperation through the Montreal Protocol, and offer detailed recommendations.

## 2. The case for phasing down HFCs

Momentum has been building towards more ambitious efforts to reduce HFC emissions. At the international level, well over 100 nations have indicated their support for bringing HFCs under the Montreal Protocol, and 95 Parties have presented formal proposals to amend the Montreal Protocol to phase down HFCs. Since 2013, China, the EU, Japan and the US have all committed to more stringent HFC controls at the national level and to increase the availability of alternatives.<sup>6</sup> India and Brazil have reversed their previous opposition, and the 54-member Africa Group is now also on board.<sup>7</sup> The Consumer Goods Forum, an industry association with over 400 member companies, agreed to begin phasing out HFCs in refrigeration in 2015.<sup>8</sup> This growing consensus reflects the understanding that phasing down HFCs is not only technically feasible with today’s alternatives, but also economically attractive.

Because of their relatively short lifetime in the atmosphere compared with CO<sub>2</sub>, HFCs are part of a group of pollutants known as short-lived climate pollutants (SLCPs), along with methane, tropospheric ozone, and black carbon (see Box 1).<sup>9</sup> HFCs are powerful greenhouse gases: the widely used HFC-134a, for example, has a 100-year GWP of 1,300 – meaning

one tonne of HFC-134a traps as much heat in the atmosphere over 100 years as 1,300 tonnes of CO<sub>2</sub>. Over 20 years, one tonne of HFC-134a traps about 3,700 times as much heat in the atmosphere as one tonne of carbon dioxide.<sup>10</sup>

HFCs are released into the atmosphere in several ways. When used as aerosol spray propellants or as solvents, they are immediately emitted during use, while HFCs used in foams are emitted during the manufacturing process, slowly over the life of the product, and when the foam is damaged or crushed in disposal. HFCs used in refrigeration and air conditioning – such as HFC-134a – leak during use as well as during servicing, when they may be intentionally vented and the equipment recharged with new refrigerant. Atmospheric measurements confirm the fast growth rates of high-GWP HFCs used as substitutes for ozone-depleting substances.<sup>11</sup> Without fast action, the climate impact of HFCs could increase as much as 30-fold by 2050.<sup>12</sup> Such uncontrolled growth of HFCs would cancel out much of the climate benefit from global mitigation efforts.

Unlike other major GHGs such as CO<sub>2</sub> and methane (CH<sub>4</sub>), HFCs are a collection of gases, with different uses, atmospheric lifetimes and GWPs. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report lists 39 common HFCs with atmospheric lifetimes ranging from 7 days to nearly 250 years, and GWPs ranging from less than 1 to over 12,000.<sup>13</sup> The GWP of HFCs currently used as substitutes for the chemicals being phased out under the Montreal Protocol ranges from 100 to 4,000, with an average GWP of 1,600, weighted by usage, and an average atmospheric lifetime of 15 years. Refrigerants with a GWP above 1,000 are considered “high-GWP”.

## Box 1

### **Cutting emissions from short-lived climate pollutants (SLCPs)**

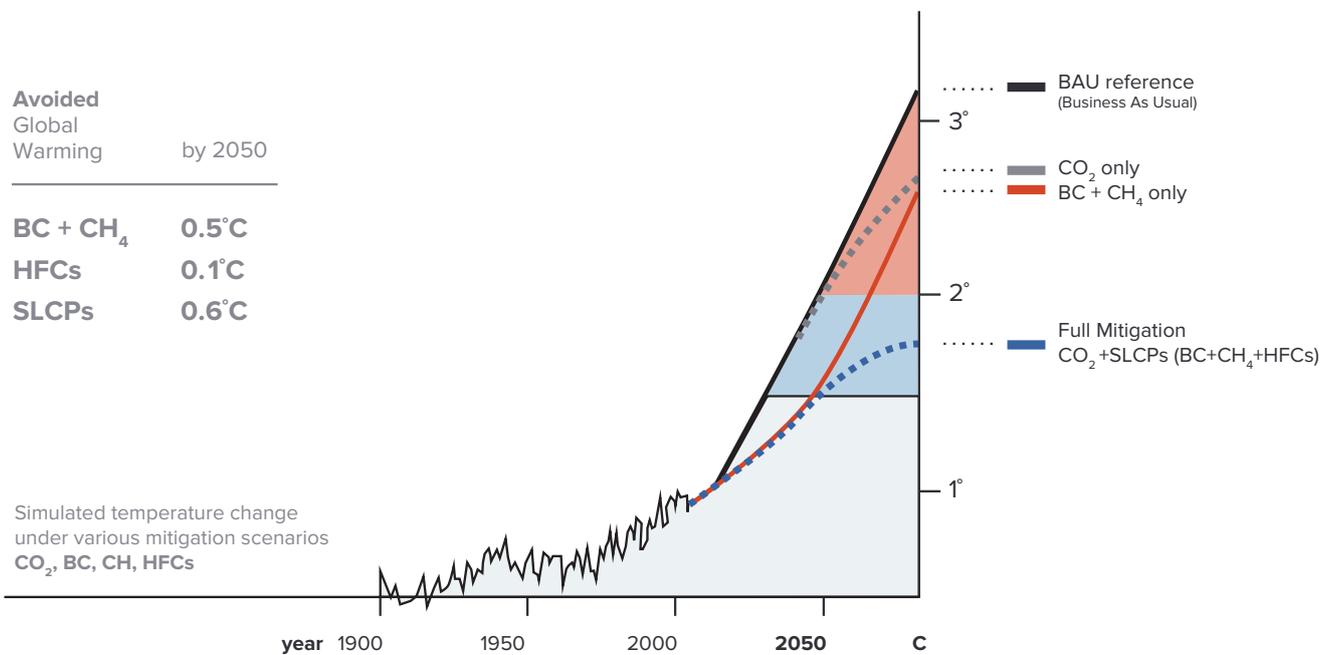
SLCPs are climate and air pollutants that have a relatively short lifetime in the atmosphere – a few days to about 15 years – and have a warming influence on climate, as well as adverse impacts on human health and agricultural crop production. The main SLCPs are black carbon, methane, tropospheric ozone and HFCs.

The short atmospheric lifetime of SLCPs means that their concentrations can be reduced in a matter of weeks to years after emissions are cut, with a fast and noticeable beneficial effect on global temperatures. In many cases, taking action to reduce SLCPs also reduces CO<sub>2</sub> emissions as a consequence of higher energy efficiency; conversely, measures to reduce CO<sub>2</sub> also often reduce SLCPs. While fast action to mitigate SLCPs could help slow the rate of climate change and improve the chances of staying below the 2°C target in the near term through the end of the century, long-term climate protection will only be possible through prompt action to substantially reduce CO<sub>2</sub> emissions along with the SLCPs.<sup>14</sup>

The CCAC is a voluntary partnership uniting more than 100 governments, intergovernmental organisations, civil society and the private sector in the first global effort to address SLCPs as an urgent and collective challenge. Since its launch in 2012, two global resolutions to reduce pollutants and improve air quality have been adopted: the 2014 UN Environment Assembly Resolution “Strengthening the role of the United Nations Environment Programme (UNEP) in promoting air quality” and the World Health Organization’s 2015 “Health and Environment: Addressing the health impacts of air pollution”. The CCAC is supporting the implementation of these resolutions with 11 on-the-ground initiatives to develop and enhance national and regional actions to address SLCPs, promote best practices, and improve scientific understanding and awareness of SLCPs and mitigation strategies.

## SLCP Climate Benefits Avoided global warming

Rapid implementation of SKCP mitigation measures, together with measures to reduce CO<sub>2</sub> emissions, would greatly improve the chances of keeping the Earth's temperature increase to less than 2°C relative to pre-industrial levels.

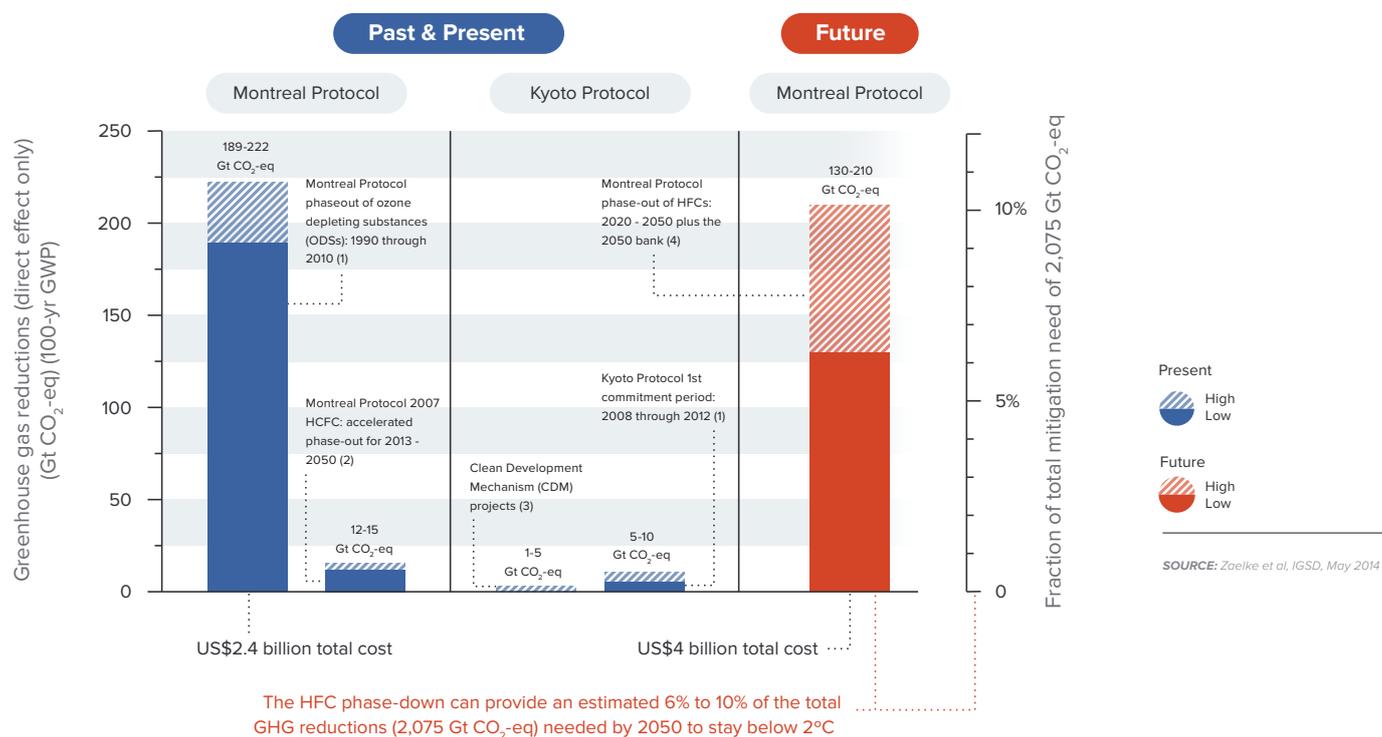


Source: Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, 2014. *Time to Act to Reduce Short-Lived Climate Pollutants: Second Edition.*

The four formal proposals submitted in 2015 to amend the Montreal Protocol (from Island Nations, India, the EU and North America), suggest a staged phase-down undertaken right away in developed countries, with a grace period before developing countries are required to take action. (A fifth proposal from the Africa Group was submitted as a Conference Room Paper.) Under the North American proposal (Canada, Mexico and US), the proposed phase-down would avoid 94–115 Gt CO<sub>2</sub>e of HFC emissions by 2050 (see Figure 2).<sup>15</sup> A key strategy for slowing and reversing the growth in HFCs is to help countries that are currently phasing out HCFCs under the Montreal Protocol, and which would be likely to replace them with HFCs, to “leapfrog” over high-GWP HFCs and move directly to available low-GWP alternatives where feasible, which would provide numerous benefits. A more ambitious “leapfrog” strategy that completely eliminates the production and consumption of high-GWP HFCs by 2020 could avoid the build-up of HFC “banks” contained in millions of refrigerators, air conditioners and fire extinguishers, and trapped in thermal insulating foams, which slowly emit their stored HFCs over a few decades.<sup>16</sup>

Combining efforts to improve the efficiency of the products and equipment using HFCs could double the climate benefits.<sup>17</sup> This would reduce associated GHG emissions, as well as energy costs to consumers and businesses.

Figure 2  
Climate protection from the Montreal Protocol and Kyoto Protocol<sup>18</sup>



Note: The right column represents the avoided emissions, from both new production and from HFC banks, achievable from a rapid phase-out of HFCs. Because ozone-depleting substances currently controlled by the Montreal Protocol are also potent greenhouse gases, between 1990 and 2010 the Montreal Protocol avoided emissions equivalent to as much as 23 times the high-end target of the first commitment period of the Kyoto Protocol (left and middle columns). Note that a rapid phase-out of this kind represents more ambitious action than the more gradual phase-down in the North American proposal to amend the Montreal Protocol.

Sources: 1) Veiders et al., *Proc. Nat. Acad. Sci.*, 104, 4814 (2007); (2) Velders et al., *The Montreal Protocol, Celebrating 20 years of environmental progress* (2007), ed. Kaniaru D. (Cameron May, London, UK); (3) UNEP Riso November 2009; (4) Velders et al., *Proc. Nat. Acad. Sci.*, 106, 10949 (2009); Velders, Solomon, and Daniel, *Atmos. Chem. Phys.*, 14, 4563, 2014.

The Montreal Protocol’s ability to catalyse energy efficiency improvements is shown by the phase-out of CFCs, which helped to drive energy efficiency improvements of up to 60% in some sub-sectors. These efficiency gains were the result of replacing old products and equipment with new, higher-efficiency machines. For example, in the US, CFC-free building chillers are estimated to be up to 50% more energy efficient than the CFC-based machines they replaced.<sup>19</sup> Energy efficiency gains were even higher in developing countries where obsolete air conditioners were often dumped by global suppliers prior to the ozone-depleting substances phase-out that provided funding for modern equipment. In hindsight, it is clear that even greater efficiency gains could have been achieved, especially at the appliance manufacturing level, if the Montreal Protocol had provided more direct incentives and integrated energy efficiency improvements into its targets, objectives and funding.

Recent low-GWP refrigerant demonstration projects documented by the CCAC calculated energy savings of 15–30% and carbon footprint reductions of up to 60–85% for refrigeration in food stores.<sup>20</sup> Coca-Cola, which had installed 1 million HFC-free coolers as of January 2014, reports a 40% improvement in its cooling equipment energy efficiency since 2000.<sup>21</sup> Heineken, which now uses non-HFC refrigeration where technically and legally feasible (about two-thirds of units worldwide), found HFC-free units cost about 15% more at first, but the price difference narrowed as larger numbers were purchased. The new units are also 38% more energy efficient than conventional ones, of which 10–15% is due to the refrigerant (hydrocarbons, CO<sub>2</sub>, and low-GWP HFCs and HFOs), and the rest to technological improvements.<sup>22</sup> Engineering and demonstration projects undertaken by the US Environmental Protection Agency’s Mobile Air Conditioning Climate Protection Partnership achieved reductions of up to 30% in cooling load, 50% in refrigerant emissions, and 30% in fuel emissions for any given level of cooling load, and could be even higher with more advanced designs.<sup>23</sup>

## Box 2

**Combining room air conditioning efficiency improvements with low-GWP refrigerants**

Room air conditioning (AC) is a fast-growing sector for both energy use and high-GWP HFCs globally. Ownership and use of room AC is expected to increase dramatically as global incomes increase and temperatures continue to rise.<sup>24</sup> Roughly 90% of US homes have some form of air conditioning equipment, and in China, urban ownership of room AC grew from near-zero in the early 1990s to near 100% in 15 years.<sup>25</sup> Similar growth is already occurring in major emerging economies such as India (~10–15% per year) and Brazil (~20% per year).<sup>26</sup> Globally, room AC is also the largest contributor to peak load electricity use from household appliances, and can account for 40–60% of peak summer energy load in cities with hot climates, such as New Delhi.<sup>27</sup>

The growth of room AC use, particularly in major emerging economies, is increasing pressure on the capacity of power grids, with far-reaching economic and environmental consequences. A global transition to super-efficient room AC would reduce energy demand, lower operating costs for businesses and households, and reduce GHG emissions and air pollution associated with energy production.<sup>28</sup>

A new study by the Lawrence Berkeley National Laboratory (LBNL) analyses the lifetime CO<sub>2</sub>-equivalent emission reductions achievable from combining technically available improvements in room AC systems with a transition to low-GWP refrigerants. It finds that a combined transition could double the emissions benefit of either policy undertaken in isolation.<sup>29</sup> A combined transition could avoid about 25 Gt CO<sub>2</sub>e by 2030, growing to a cumulative 97.5 Gt CO<sub>2</sub>e by 2050. By 2030, the paired transition could save peak demand equal to 500–1,200 GW of electricity, equivalent to the output of 676–1,576 medium-sized peak-load coal power plants; growing to 1,000–2,500 power plants by 2050.<sup>30</sup>

Improving the energy efficiency of the world's 900 million room air conditioners, by moving to more efficient technologies and low-GWP refrigerants, could avoid another 100 Gt tonnes of CO<sub>2</sub>e emissions by 2050.<sup>31</sup>

### 3. Alternatives to high-GWP HFCs are available for most sectors

About 55% of HFCs used globally in 2010 were in residential, commercial, and industrial refrigeration and air conditioning; another 24% were in mobile (vehicle) air conditioning; 10% in foams; 5% in aerosols; 4% in fire protection systems; and 1% in solvents.<sup>32</sup> Climate-friendly alternatives to high-GWP HFCs are widely and increasingly available for most uses.<sup>33</sup> They fall into two basic categories: non-fluorinated substances with low GWPs, and fluorinated substances with low to mid-range GWPs.

Commercially available non-fluorinated or “natural refrigerants” include: ammonia, with a GWP of near zero; hydrocarbons (e.g., propane and isobutene), with GWPs of less than 4; and CO<sub>2</sub> (with a GWP of 1). Alternative fluorinated substances include the low-GWP HFCs, also known as hydrofluoro-olefins (HFOs), some with GWPs of less than 1, according to the IPCC.<sup>34</sup> Other alternatives include, HFC-32, with a GWP of 677, and HFC-152a, with a GWP of 138, according to the IPCC. There are also “not-in-kind” alternatives that do not involve refrigerants, such as district cooling.

For motor vehicle air conditioning, most automakers supplying EU, Japanese, and North American markets have selected one type (HFO-1234yf) out of the three ozone-safe substitutes available, and commercialisation is well under way.<sup>35</sup> The new refrigerant increases costs by about US\$100 per system initially. Annual fuel savings of US\$37–50 per system offset these costs if systems are upgraded for low leak rates and higher energy efficiency.<sup>36</sup> For room AC, both types of alternative refrigerants considered outperform the status quo HFC-410A appliances in energy efficiency,<sup>37</sup> and one type of AC HFC-32 has earned “Top Runner” energy efficiency status for significantly outperforming all others in Japan.<sup>38</sup> Supermarket air conditioning has demonstrated up to 40% energy savings with natural refrigerants (ammonia, CO<sub>2</sub> and hydrocarbons), and with hybrid systems using a combination of natural refrigerants and low-GWP HFCs and HFOs.<sup>39</sup> For small retail food equipment, Unilever has reported that switching to hydrocarbons such as propane is cost-neutral, with marginal cost savings over time from avoided refrigerant costs.<sup>40</sup>

In some areas, however – such as medical and technical aerosol products, spray foam and fire protection applications – there are still few alternatives, and exemptions from the Montreal Protocol phase-down may be necessary, as was the case for some ozone-depleting substances.<sup>41</sup> In some other applications, economies of scale and competitive prices have not yet been reached.

The energy efficiency of alternatives to high-GWP HFCs is particularly important to all countries, including those with high ambient air temperatures with long and often humid seasons, which are currently choosing replacements for HCFCs.<sup>42</sup> A recent study for the European Commission shows that, in countries with high ambient air temperatures, almost 70% of sectors currently using HCFCs can “leapfrog” past high-GWP HFC refrigerants directly to low-GWP alternatives with equal or better energy efficiency.<sup>43</sup> The same study notes that, for the remaining 30% of uses, low-GWP alternatives with equal or better energy efficiency are in development and are expected to be ready by 2025.<sup>44</sup>

Phasing down high-GWP HFCs would cost relatively little. According to the US Environmental Protection Agency (EPA), HFC emissions could be reduced by more than 40% by 2030 through measures that are cost-effective today.<sup>45</sup> Leapfrogging HFCs in the phase-out of HCFCs would be considerably less expensive than a first conversion from HCFCs to HFCs, and a second conversion from HFCs to low-GWP alternatives. There are also significant cost savings inherent in the avoidance of a build-up of HFC banks, which are widely dispersed across the globe, and both expensive and time-consuming to collect and destroy. Improvements in energy efficiency often have fast payback periods and can save consumers and businesses money on monthly electricity bills.

## 4. National action and international cooperation on HFCs

Early actions by governments and industry have jump-started the technical innovation and commercialisation of alternatives to high-GWP HFCs that can now be globalised by a Montreal Protocol amendment. Countries and regions responsible for more than half of current HFC emissions, by domestic consumption or through exports, are already adopting increasingly stringent regulations, and corporations are implementing voluntary policies to avoid and eliminate these chemicals.

In 2014, China announced that it would strengthen its management of HFC emissions and accelerate the destruction and replacement of HFCs, as part of the action plan to implement the energy conservation and emissions reduction targets of the 12th five-year plan.<sup>46</sup> The EU Fluorinated Greenhouse Gases Regulation, which came into force in January 2015, will phase down fluorinated gases (including HFCs) by 79% by 2030 from 2009–2012 levels.<sup>47</sup> From 2020, very high-GWP HFCs will no longer be allowed in the service and maintenance of certain refrigeration equipment. In addition, as part of its regulatory regime to control HFCs, the European Directive on mobile air conditioning systems requires the use of refrigerants with GWPs lower than 150; new type vehicles sold in the EU are covered as of 1 January 2013, and all vehicles sold in the EU will be covered by 2017.<sup>48</sup>

In the US, President Obama has included action on HFCs in his Climate Action Plan, instructing the EPA Significant New Alternatives Policy Program to prohibit use of the most harmful HFCs and expand the list of acceptable alternatives.<sup>49</sup> State-level action is also progressing: in California, refrigerant regulations for do-it-yourself (DIY) motor vehicle repair require a self-sealing valve on all HFC-134a containers, improved instructions, a recycling programme for used containers, and an education programme that emphasises best practices for DIY vehicle recharging.<sup>50</sup> In addition, California’s Air Resources Board has released an ambitious strategy to reduce HFC emissions by 40% by 2030<sup>51</sup> in accordance with a new law requiring California to develop a comprehensive strategy to reduce SLCP emissions.<sup>52</sup> New rules under the US EPA Significant New Use Policy Program reclassify as unacceptable various HFCs and HFC-containing blends in various end-uses in the aerosols, foam blowing, and refrigeration and air conditioning sectors, where other alternatives that pose lower overall risk to human health and the environment are available or potentially available.<sup>53</sup>

Regulations banning the use of HFCs, prohibiting their venting, taxing HFCs or promoting alternatives are also in place in many other countries, including Austria, Belize, Burkina Faso, Canada, Colombia, Denmark, Egypt, France, Germany, Italy, Macedonia, Montenegro, Netherlands, New Zealand, Norway, Poland, Serbia, Slovenia, Sweden, Switzerland, United Kingdom, Yemen and elsewhere.<sup>54</sup>

Major companies and industry associations are also taking action on HFCs as part of voluntary commitments to sustainability. In 2010, for example, the Consumer Goods Forum agreed to start phasing out HFCs in refrigeration by 2015. Individual

members, including Wal-Mart, Nestlé, Sobeys, SuperValu and Tesco, are already purchasing equipment with alternative low-GWP refrigerants, converting existing equipment to lower-GWP refrigerants, and improving efficiency while reducing leakage.<sup>55</sup> Refrigerants, Naturally! – an initiative organised and operated in cooperation with UNEP and Greenpeace and food and drink companies including Coca-Cola, PepsiCo, Red Bull, and the consumer goods company Unilever – is taking action to eliminate the use of HFCs.<sup>56</sup>

International cooperation to reduce HFCs can accelerate the development and deployment of technologies that use climate-friendly alternatives. The US is engaged in bilateral cooperation on HFCs with India, as part of a broad energy and climate package. And as part of their joint announcement on climate change and clean energy cooperation in November 2014, the US and China agreed “to enhance bilateral cooperation to begin phasing down the use of high-GWP HFCs, including through technical cooperation on domestic measures to promote HFC alternatives and to transition government procurement toward climate-friendly refrigerants.”<sup>57</sup> These countries see amending the Montreal Protocol as an opportunity to take this model of international cooperation a step further, using both technical assistance and financial support to achieve a global reduction in HFC use.

At the same time, the CCAC has launched an initiative that aims to mobilise governments, businesses, international organisations and civil society to work together to slow the growth in the use of high-GWP HFCs.<sup>58</sup> The initiative supports the development of HFC inventories and studies, information-sharing on policy and technical issues, pilot projects to validate and promote climate-friendly alternatives and technologies, and various capacity-building activities. One such pilot project is working to determine the refrigerant containment, energy efficiency, and reliability of secondary-loop motor vehicle air conditioning and to estimate life-cycle climate performance and the fuel and service savings of ownership. The CCAC is also working to build international awareness and support for approaches to curb HFC growth, including a global phase-down under the Montreal Protocol and commitments by CCAC partners.

## 5. The Montreal Protocol as a model for international cooperation on HFCs

Since its adoption in 1987, the Montreal Protocol has phased out almost 100% of nearly 100 chlorinated gases that both destroy the ozone layer and warm the climate. Together with earlier consumer boycotts and national measures, this has put the ozone layer on the path to recovery by mid-century. At the same time, these efforts prevented greenhouse gas emissions that otherwise would have equalled today’s contribution from CO<sub>2</sub>.<sup>59</sup> Similarly, national and private action to reduce high-GWP HFCs is providing critical near-term climate benefits and creating the conditions for fast implementation of the global controls that a Montreal Protocol HFC amendment would provide. The amendment would send a clear signal to countries and markets to move quickly to transition away from high-GWP HFCs.

A hallmark of the Montreal Protocol is its establishment of stringent global, chemical-specific control measures that provide incentives for the research, development, commercialisation, and fast implementation of environmentally superior technology. Global control schedules for production and consumption provide regulatory certainty that profitable markets will be available for next-generation technology, all around the world, while avoiding and overcoming the problem of different national regulations which send mixed market signals and which can be more expensive where manufacturers need to supply products subject to different performance measures.<sup>60</sup>

The Montreal Protocol also has several advantages that will allow Parties to quickly and efficiently implement effective controls for HFCs. These include a well-established infrastructure, with regional technology cooperation network offices, dedicated national ozone offices in every developing country, the expertise of highly independent scientific, environmental effects and technology and economics assessment panels, a fully financed multilateral fund and other cost-effective implementation tools, and the institutional experience of phasing out nearly 100 similar chemicals.<sup>61</sup>

The Montreal Protocol is unique in that every UN Member State is a Party. All Parties are typically in full compliance almost all of the time, with temporary exceptions usually due to unavoidable delay in finance, in equipment delivery or from administrative non-compliance when illegally traded ozone-depleting substances are held as evidence, but technically counted as an import until destroyed.<sup>62</sup> The Montreal Protocol fully implements the equity principle of “common but differentiated responsibilities” by including a requirement for developed countries to undertake their control measures first, followed by a grace period of several

years, before developing countries must undertake their control measures, plus a dedicated funding mechanism that pays the incremental costs of the new technologies that developing countries need for compliance.<sup>63</sup>

The Montreal Protocol's Multilateral Fund (MLF) has played a key role in achieving cost-effective emission reductions. It provides funding to developing-country Parties qualifying under Article 5 of the Montreal Protocol to meet the agreed incremental costs of phasing out consumption and production of ozone-depleting substances.<sup>64</sup> Since its establishment, the MLF has provided more than US\$3 billion in funding.<sup>65</sup> The fund can cover the supply of substitute chemicals, the conversion of existing production facilities and plants where ozone-depleting substances are used in manufacturing in intermediate and end use, as well as patents, royalties, capital costs of equipment, training, premature retirement of equipment, research and development, technical assistance, and recovery and recycling.<sup>66</sup> At the 26th Meeting of the Parties of the Montreal Protocol, in 2014, the Parties agreed to an MLF replenishment of just over US\$500 million for 2015–2017.<sup>67</sup>

If the Montreal Protocol is amended to phase down HFCs, the MLF will provide similar support to developing countries. The Montreal Protocol also provides “essential use”, “critical use” and “emergency” exemptions that allow continued use of a chemical when environmentally acceptable alternatives are not yet available.<sup>68</sup> The orderly and transparent schedule for phasing out chemicals under the Montreal Protocol allows time for markets to innovate and adjust, often resulting in significant cost and technical efficiencies.<sup>69</sup>

Several proposals to bring HFCs under the Montreal Protocol have been submitted since 2009, when the idea was first suggested by low-lying island States fearing the effects of sea-level rise. Four proposals are currently on the table, submitted by the Federated States of Micronesia, the Philippines, and six other Island States; jointly by Mexico, Canada and the United States; by the European Union; and most recently by India, reversing its previous opposition. Well over 100 other Parties have indicated their support, including the 54-member Africa Group, which submitted its own proposal as a Conference Room Paper. The proposals all focus on reducing HFC production and consumption under the Montreal Protocol, and leave accounting and reporting of HFC emissions within the UNFCCC regime.

In April 2015, the Open Ended Working Group (OEWG) of the Montreal Protocol held an extraordinary meeting in Bangkok devoted explicitly to HFCs. The 54 countries of the Africa Group emerged as strong champions of the HFC amendment, with Senegal leading the way. Their effort helped to address some of the remaining concerns from Saudi Arabia and other Gulf states, and resulted in a compromise agreement to continue working in the coming months “to study the feasibility and ways of managing HFCs” and related challenges, with a view to establishing a Contact Group – a formal negotiating group – at the OEWG meeting in July 2015. At the end of the July OEWG, agreement could not be reached, but the Parties took the unusual step of suspending, rather than adjourning, the meeting, to ensure that they would be able to finalise terms for negotiating the final agreement before the Meeting of the Parties in Dubai in November 2015.<sup>70</sup>

Continued high-level political leadership; credible information about HFC alternatives, their costs and performance; and a pledge of adequate resources for fast implementation will be crucial for reaching consensus if the Montreal Protocol is to be amended at the November meeting.

The Montreal Protocol and UNFCCC could further speed the phase-down of high-GWP HFCs by encouraging Parties to include an HFC phase-down in their INDCs to the Paris climate agreement. The CCAC has developed a guidance note to help countries identify specific actions on HFCs and other SLCPs that may be included in their INDCs.<sup>71</sup>

## 6. Conclusion and recommendations

Countries can take a number of actions to help speed agreement on the amendment to phase down HFCs under the Montreal Protocol, ensure its fast implementation while also promoting energy efficiency improvements, and thus help realise an important and low-cost strategy for mitigating climate change.

The Global Commission on the Economy and Climate recommends that Parties to the Montreal Protocol approve an amendment to phase down the production and use of HFCs.

This will require the Parties to:

- Work to address the concerns that prevented the establishment of a Contact Group at the OEWG meeting in July 2015, so they can agree to start formal negotiations on a Montreal Protocol amendment at the OEWG follow-up meeting later this year, with a view to concluding those negotiations by the Meeting of Parties in November 2015 or as soon as possible.
- Increase incentives and regulations for more energy efficient appliances in the phase-out of HCFCs and phase-down of HFCs.
- Implement specific measures under the Montreal Protocol's MLF to support developing countries to leapfrog the use of HFCs where feasible.

Alongside an amendment to the Montreal Protocol, developing countries should join developed countries in accounting for and reporting their HFC emissions under the UNFCCC, and all countries should consider including a phase-down of HFCs in their INDCs.

Finally, at the national level, countries that do not yet have regulations in place for phasing down HFCs should begin developing and implementing such regulations, as well as appliance energy efficiency standards. At the same time, major companies should commit to phasing out HFCs through cost-effective cooperative action programmes such as those of the Consumer Goods Forum and Refrigerants, Naturally!

## ENDNOTES

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<sup>1</sup> Overall, HFC emissions are growing at a rate of 8–9% per year, but the focus of mitigation efforts is on widely used HFCs with high global warming potential, which are growing faster.

See: Velders, G.J.M., Ravishankara, A.R., Miller, M.K., Molina, M.J., Alcamo, J., Daniel, J.S., Fahey, D.W., Montzka, S.A. and Reimann, S., 2012. *Preserving Montreal Protocol Climate Benefits by Limiting HFCs*. *Science*, 335. 922–923. DOI:10.1126/science.1216414.

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Deol et al. (2015) write: “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.”

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## ABOUT THE NEW CLIMATE ECONOMY

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The Global Commission on the Economy and Climate, and its flagship project The New Climate Economy, were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change.

In September 2014, the Commission published *Better Growth, Better Climate: The New Climate Economy Report*. Since then, the project has released a series of country reports on the United States, China, India and Ethiopia, and sector reports on cities, land use, energy and finance. In July 2015, the Commission published *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. It has disseminated its messages by engaging with heads of governments, finance ministers, business leaders and other key economic decision-makers in over 30 countries around the world.

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