SPECIAL REPORT

Cutting out the chemicals

The international treaty drawn up to tackle ozone-destroying substances is gearing up to curb greenhouse gases. **Jeff Tollefson** reports.

Ozone experts are exploring ways to curb powerful greenhouse gases of their own making under the Montreal Protocol, arguing that direct regulation would be faster and cheaper than using carbon markets under a global climate treaty.

The Montreal Protocol set a strong precedent for such an approach, having almost eliminated production of the once-ubiquitous chlorofluorocarbons (CFCs) that eat away at stratospheric ozone. Used in refrigerants, propellants and solvents, CFCs were initially replaced with hydrochlorofluorocarbons (HCFCs); now, chemical manufacturers have moved on to a third-generation replacement, hydrofluorocarbons (HFCs; see graphic). HFCs are cheap and perform well, but are also powerful greenhouse gases. Although in this respect many are less potent than their predecessors, their ability to trap heat can be thousands of times that of carbon dioxide.

Because HFCs do not affect ozone, they are not covered by the Montreal Protocol. As greenhouse gases, they are covered under the Kyoto Protocol, but many believe that they could be eliminated much faster — and at a fraction of the cost — if Montreal were expanded to include them. The Montreal agreement has broad international support, a network of experts worldwide and a 20-year track record of handling these types of chemicals.

"We created these chemicals, and we can get rid of them," says Durwood Zaelke, president of the Institute for Governance & Sustainable

Development, an advocacy group in Washington DC. "We have the technology. We have the chemicals. We have the wherewithal within the treaty. It's just an administrative issue."

The idea has been bouncing around in the environmental community for years, but Argentina, the United States and others garnered support to formally explore the idea during the annual Montreal Protocol conference last November in Doha, Qatar. The treaty's technical advisory team is now working on an assessment of the issue, and government delegates have invited climate negotiators to attend a workshop on the topic in Geneva, Switzerland, in July. A second workshop will focus on ways to collect and destroy ozone-depleting substances from 'banks' of old refrigerators and other such equipment.

Tackling HFCs would represent the most explicit foray yet into the global-warming arena by a body that has to a large extent accomplished its work. The ozone layer, which Montreal was set up to protect, may only now be starting to recover. Emissions of some ozone-depleting chemicals will continue for some time, and even in 2100 long-lived CFCs will remain the dominant ozone destroyers. But schedules are in place to phase out most of the remaining chemicals of concern. "The ozone story is winding to a close," says David Fahey, a physicist at the US National Oceanic and Atmospheric Administration's Earth System Research Laboratory in Boulder, Colorado. But now, he adds, climate change is expanding the

Booming demand for refrigerators is boosting greenhouse-gas production.

Montreal Protocol's horizons.

In fact, the Montreal treaty's links to global warming go all the way back to its preamble, which specifically states that "potential climatic effects" should be considered when analysing chemicals. And Fahey says Montreal's experts have performed well on that account. He co-authored a 2007 paper estimating that, by 2010, the Montreal treaty will have locked in the equivalent of roughly 11 billion tonnes of CO₂ emissions reductions annually — compared with an estimated 2 billion tonnes of reductions per year for the Kyoto Protocol (G. J. M. Velders *et al. Proc. Natl Acad. Sci. USA* **104**, 4814–4819; 2007). The team, led by Guus Velders at the Netherlands Environmental Assessment Agency in Bilthoven, expects to release another analysis of HFCs in advance of the Geneva workshop this summer.

In September 2007, that paper became a focal point in the discussion when Montreal delegates agreed to accelerate the phase-out of HCFCs by a decade, to 2030, explicitly citing the potential to further reduce greenhouse-gas emissions. The US Environmental Protection Agency says that the resulting greenhouse-gas reductions could equate to around 2.6 billion tonnes of CO₂, akin to taking more than 68 million vehicles off the road for 30 years, depending on which chemicals fill the void.

This is largely why the Montreal parties decided to weigh in on HFCs now. Although they represent less than 1% of the greenhouse-gas forcing, HFC emissions are rising by about 15% per year, largely as demand for air conditioning and refrigerators grows in countries

ESTIMATED GLOBAL FLUORO-CHEMICAL CONSUMPTION

The Montreal Protocol has phased out ozone-destroying substances over time, replacing them with other chemical classes.

Radioactive surprise
Old plutonium, vintage 1946, discovered in dump.
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such as China. Left unchecked, that figure will increase rapidly as developing countries begin shifting from HCFCs to HFCs.

"If we don't do it now, the problem will be much bigger later," says Madhava Sarma, former executive secretary for the Montreal Protocol, and now a consultant in Chennai, India. The treaty, ratified by 193 nations at the outset, has already been amended five times. Ratifying the treaty a sixth time to cover HFCs should be doable, he says.

HFCs could also be dealt with in a global carbon market; the problem is that, because many are thousands of times more potent than CO₂, they fetch a price on the market that greatly exceeds the cost of controlling them. In a particularly controversial example, industrialized countries have been offsetting their emissions by paying companies in the developing world to incinerate the chemical HFC-23, which is 11,700 times more potent than CO₂ as a greenhouse gas (M. Wara *Nature* **445**, 595–596; 2007). "In the end, they are going to transfer several billion dollars, but it could have been done for tens of millions," says Washington DC-based David Doniger, a policy director for the Natural Resources Defense Council.

Michael Wara, a researcher at Stanford University in California, is less convinced that HFCs need be addressed under the Montreal Protocol. He says that an alternative pricing structure could be set up within the Kyoto Protocol and the United Nations Framework Convention on Climate Change (UNFCCC) to avoid having to pay the full market value for HFCs. "It makes much more sense in my mind

to deal with this head-on in the UNFCCC," he says.

Even those who support bringing HFCs under the Montreal umbrella realize that the community is not entirely on board yet. This week, the US Department of State is co-hosting a stakeholder meeting with scientists, environmentalists and business representatives to talk about the implications. "There's an education process to go through," says Daniel Reifsnnyder, who handles ozone issues at the State Department. He acknowledges that when he and others floated the idea at the UN climate meeting in Poland last month, they got a cool reception. "In Poznań, there was quite a bit of concern, and I would say even some suspicion, about what people were doing and why," he says.

But the idea does have some powerful backers. The chemical giant DuPont, based in Wilmington, Delaware, is more concerned about industrial HFC refrigerants than incidental HFC by-products, for which the company is already phasing in voluntary controls. Mack McFarland, global environmental manager for DuPont's fluorochemicals business, says policy-makers are beginning to recognize the problems created when HFCs are wrapped into the carbon market.

He illustrates with the following scenario: a US\$25-per-tonne price on carbon equates to \$150 for the cost of the HFCs that go into an average home air conditioner, which translates into a \$450 to \$600 price bump for consumers. By contrast, the Lieberman–Warner climate

legislation introduced in the US Senate last year proposed a stricter phase-down for HFCs than for other greenhouse gases, but under separate regulations. Compliance would cost just \$2 to \$3 per unit, DuPont estimates, meaning only a \$4 to \$6 bump in consumer prices.

Even such a small price signal is sufficient to spur recycling, better industrial processes and, ultimately, the development of new, more climate-friendly chemicals, says McFarland. "We're willing to step forward and do our part." By shifting HFCs into the Montreal Protocol, these same practices can then be exported to the developing world. "It's just a perfect fit," he says.

And many see opportunities to take the Montreal Protocol even further, by applying either the treaty itself or its framework to other powerful greenhouse gases such as perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆), both of which are covered under the Kyoto agreement. Emissions of both gases are limited to relatively small and specialized industrial sectors, which lend themselves to the kinds of rapid technical assessment and technology transfer that Montreal can do.

In Poznań, the Group of 77 developing nations and China proposed a framework for the transfer and financing of climate technologies that is based largely on the Montreal Protocol. The proposal sets up the same kind of governing board, with equal membership representing developed and developing nations, to oversee decisions about which technologies to deploy. They also proposed that developing nations put an eye-popping 0.5–1% of their gross national product into a climate fund to support these and other actions each year.

Wara says that such numbers are well beyond what most governments are going to be willing to fund, which is why markets will be needed to generate the kind of money necessary to realign

the global energy system. Some say such an approach could be deployed alongside a cap-and-trade system to pay for demonstration projects or readily deployable technologies, or even to provide direct support for energy efficiency projects.

Steve Rayner, director of the James Martin Institute for Science and Civilization at the University of Oxford, UK, says the idea has merit. He worries that the carbon market will be too slow to spur the kind of technological transformations that will be necessary to avoid the worst that global warming has to offer. "The more we can simplify and make the direct connections between the investments we are going to make and the installation of technology, the better off we are."

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