preparedness that have been recommended, planned, or implemented to date are based on current information. Changes in viral characteristics or epidemiological/geographical trends may call for modification of recommendations. Authorities in home countries of pilgrims and the global public health community should monitor the situation and advise potential pilgrims and all stakeholders accordingly. Pilgrims can receive updated information from the Web sites of the MoH (www.moh.gov.sa) and the Ministry of Hajj (www.hajinformation.com).

For a summary of recommendations in this paper and information about H1N1, see Flu Prevention Advice in the supporting online material and freely available on *Science* Express.

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Flu Prevention Advice

www.sciencemag.org/cgi/content/full/1183210/DC1

Published online 29 October 2009

10.1126/science.1183210

CLIMATE CHANGE

Bridging the Montreal-Kyoto Gap

Using carbon markets to eliminate substances that deplete stratospheric ozone could pay huge dividends in combating global warming.

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Because of the growing need for near-term, feasible, greenhouse gas (GHG) abatement options (*1*), there is increasing interest in the scale and cost-effectiveness of potential emission reductions from destruction of ozone-depleting substances (ODSs) (*2*). Chlorofluorocarbons (CFCs) and other ODSs not only damage stratospheric ozone, but also are powerful GHGs, with global warming potentials (GWPs) up to 11,000 times that of carbon dioxide (CO_2) (*3*). The Montreal Protocol eliminates production of these chemicals but does not control their emissions or require destruction of ODSs produced before phase-out deadlines. The Kyoto Protocol targets emissions of CO_2 and other non-ODS GHGs. Because of these regulatory gaps, large quantities of ODSs remain in legal use or storage in older refrigeration and air-conditioning equipment, building and appliance insulation, fire suppression systems, and government and industrial stockpiles (*4*). Without requirements or incentives for destruction, these ODSs will ultimately be released to the atmosphere and contribute to anthropogenic climate change.

Current global ODS banks (not yet emitted into the atmosphere) are estimated to represent (in terms of GWP) the equivalent of 16 to 18 billion tons of CO_2 (CO_2 eq) (*4*) (see the graph, page 941 and table S1). Of this total, refrigerants and other "reachable banks" are ~8.8 billion tons of CO_2 eq (*5*); most of which (6 billion tons of CO_2 eq) is expected to be lost to the atmosphere by 2015 (*4*).

Reachable banks can be collected and destroyed in accordance with industry standards (*6*) by using technologies and infrastructure available in industrialized countries and feasible for developing countries. Highly regulated destruction technologies, such as rotary and cement kilns, plasma arc, and waste-to-energy conversion, provide sufficient capacity, with removal efficiencies above 99%. Remaining ODS banks are in less accessible, but more stable, sources, such as building insulation, that are less prone to rapid leaking.

Governments may be tempted simply to mandate destruction of ODS banks. However, given their dispersed nature and continued demand for recycled ODSs to service older equipment, direct financial incentives are essential. This could be accomplished by issuing GHG emission reduction credits (offsets) for permanent, certified removal of ODS banks. These credits could then be traded in carbon markets as a mitigation alternative alongside other targeted GHGs.

ODS destruction can be precisely monitored and is verifiable (*7*), "additional" (*8*), and permanent, representing the highest-quality GHG reduction. Projects can be implemented quickly, on the order of months. Voluntary carbon markets that commercialize GHG emission reductions outside government-mandated programs have spurred the development of protocols, verification systems, infrastructure, and financing (*9*, *10*). However, the size of global ODS banks far exceeds the capacity of voluntary carbon markets alone to create enough incentive for collection and destruction of ODSs. Instead, ODS destruction credits should be included in national and global mandatory compliance carbon markets.

Parties to the Montreal Protocol are considering a systematic, international approach to management of ODS banks, with incentives leveraging private capital from carbon markets to promote destruction of ODS banks (*11*). The Kyoto Protocol's Clean Development Mechanism may serve as a guide for such a system (*12*). Parties will also receive recommendations from the Technology and Economic Assessment Panel (TEAP) of the United Nations Environment Programme

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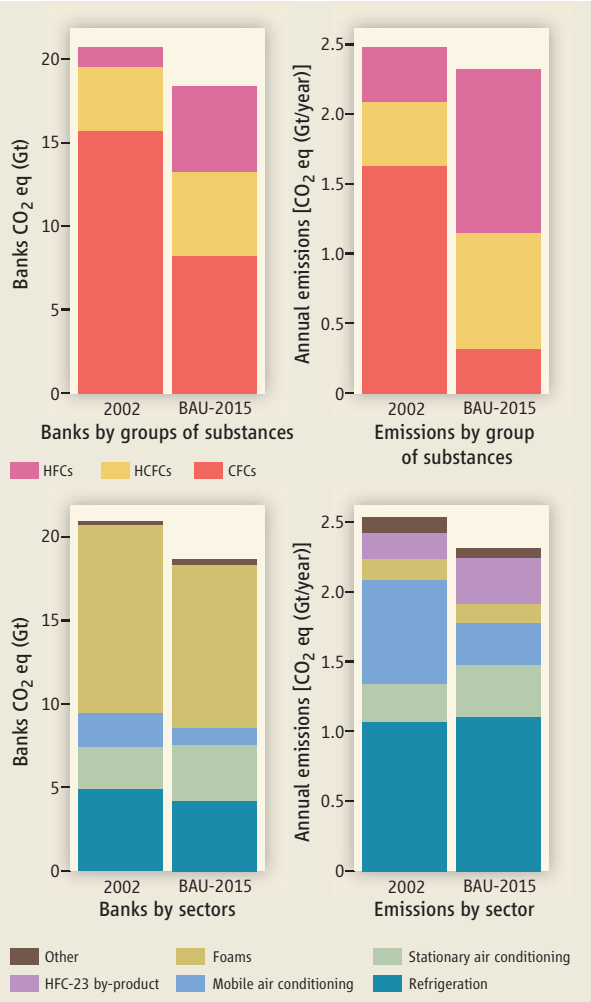
Published by AAAS



Historic data for 2002 and business-as-usual (BAU) projections for 2015 of GHG CO_2 eq banks (left) and direct annual emissions (right) related to the use of CFCs, HCFCs, and HFCs. "Other" includes medical aerosols, fire protection, nonmedical aerosols and solvents. [Source: figure SPM-4 from (*4*)]

(UNEP) and World Bank on funding mechanisms, including carbon finance (*13*).

Average costs to separate, collect, and destroy ODSS from "low-" and "medium-effort" sources, such as refrigeration and air-conditioning equipment, are estimated to range between U.S. $15 and $35 per ton of CO_2 eq; between now and 2013 to 2014, costs could fall below $10 per ton of CO_2 eq (*5*). These costs are comparable to and, for the low-effort sources, well below the cost of abatement for the majority of GHG reduction measures (*14*), as well as projected prices of emissions permits in the European Union Emissions Trading Scheme (*15*) and a likely U.S. cap-and-trade system (*16*).

Pending U.S. cap-and-trade legislation (*17*, *18*) recognizes the climate benefits of destroying ODSs by allowing the U.S. Environmental Protection Agency (EPA) to allocate additional allowances for production and import of hydrofluorocarbons (HFCs; non–ozone-depleting substitutes for CFCs) in exchange for destruction of CFCs. Unfortunately, demand for HFCs will represent only a small fraction of the total U.S. ODS bank (*19*). Thus, these bills, in their current forms, would not substantively slow ongoing, preventable ODS release. Instead, making ODS destruction eligible under cap-and-trade provisions as a general GHG offset available to all regulated businesses would expand financing needed to prevent these emissions, and provide a much-needed source of near-term carbon abatement. In the United States, ODS destruction could rapidly scale to generate several hundred million tons per year of verifiable reductions by 2015 to 2020, helping to contain overall costs to the economy.

As domestic and international climate negotiations go into high gear, policy-makers worldwide have an immediate, cost-effective opportunity to prevent release of hundreds of millions of tons of CO_2 eq, by incorporating the following measures:

1. Count banked ODSs that have been phased out of production as controlled GHGs and allow creation of GHG offsets from verified ODS extraction and destruction.

2. Require rigorous protocols so that only verified ODS extraction and/or destruction projects, with clear additionality and emission reductions, qualify for offsets.

3. Include incentives for accelerated development and adoption of advanced replacement technologies that avoid substitution with other high-GWP GHGs.

Banks of ODSs represent a potential source of emissions that could undo climate protection achieved by phasing out production of these chemicals (*20*). There is little time in which to address this issue: Most easily reachable ODS banks, under business as usual, will be released to the atmosphere in 5 to 10 years (*4*). By recognizing ODS banks as GHGs in domestic legislation and international agreements, ODS destruction projects would be rapidly mobilized, the transition to more advanced technologies would be accelerated, and the legacy of the Montreal Protocol secured.

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Supporting Online Material

www.sciencemag.org/cgi/content/full/1176958/DC1

10.1126/science.1176958

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