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Tipping the Balance

Towards Climate Protection through the HCFC Phase-Out

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Choosing the Best AC and Refrigeration Equipment to Protect Ozone and Climate

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The Montreal Protocol has the necessary technical expertise, stakeholder networks, and financing under the Multilateral Fund to implement the current accelerated phase-out of ozone depleting hydrochlorofluorocarbons (HCFCs) while leapfrogging high-GWP HFCs. The challenge is to choose the best technology for each application.

Making this selection is not as straightforward as choosing refrigerants by their chemical nomenclature or picking the option with the lowest GWP, because nomenclature and GWP are not reliable indicators of overall environmental performance. Neither takes into account toxicity, atmospheric fate, safety, or energy efficiency. And the GWP depends on the time period concerned (20, 100, or more years) and ignores the charge size and leak rates that vary substantially by application.

One solution is to use the comprehensive approach of Life-Cycle Climate Performance (LCCP), which takes everything into account: refrigerant greenhouse gas emissions (including those resulting from refrigerant production); the energy emissions from manufacturing, using, and recycling the product; the carbon content of electricity generation; and more.

Consider the advantages of a practical five-step selection process:

❶ **Screen for safety:** Compare products configured to satisfy reasonable standards of health and fire safety, and then calculate the 'safety-screened energy efficiency'.

❷ **Compare LCCPs:** Calculate the LCCPs of the safety-screened systems, taking into account annual ambient temperature and humidity, electricity carbon intensity and owner preferences, in the location where the equipment will be used.

❸ **Select the technology with the lowest LCCP:** In some cases, one alternative may have a clear LCCP advantage, but in cases of comparable LCCP the choice can favour the lowest GWP.

❹ **Proceed with investment:** Unless an emerging technology under development is far superior and worth waiting for.

❺ **Manage atmospheric fate:** By engineering, economic incentives, and training, with the goal of reducing life-cycle emissions to acceptable levels.

This approach has already identified the following climate-superior technology:

- **HC in small refrigerated units:** This category includes domestic refrigerators and small refrigerated food and beverage cases. HC has a very low GWP (<3 for 20- or 100-year time intervals), equals or exceeds the energy efficiency of the HFC alternatives, and is penetrating all markets including the United States.
- **CO_2 in commercial beverage coolers:** Coca Cola and other companies under the 'Refrigerants Naturally' partnership have engineered equipment to use ultra-low GWP CO_2 refrigerant (GWP~1 for 20- or 100-year time intervals), while equalling or exceeding the energy efficiency of systems that use high-GWP HFC alternatives.
- **HC in very small room air conditioners (AC):** Companies in Asia and elsewhere have developed very small room AC systems that use efficient HC refrigerant and meet all applicable safety standards; however, HC is not an acceptable alternative in larger systems where refrigerant leakage into a room could result in a flammable HC concentration.
- **HFC-32 for larger room ACs:** The Japan-Indonesia Partnership selected HFC-32 as the best alternative: (1) moderate GWP (20-year GWP = 2330; 100-year GWP = 675) compared to alternative HFC-410a (20-year GWP = 4340; 100-year GWP = 2088), (2) 30 per cent smaller charge size compared to HFC-410a, and (3) higher energy efficiency than lower-GWP alternatives.
- **HFC-1234yf for vehicle AC:** Global automakers used LCCP to identify HFC-1234yf as the next-generation refrigerant with very low GWP (~4 for 20- or 100-year time intervals) and high energy efficiency and cooling performance in a wide variety of climates, especially those that are hot and humid for long periods. Systems can be designed to be nearly leak-free to avoid issues of atmospheric fate.

The Technology and Economics Assessment Panel (TEAP) and its Technical Options Committees (TOCS) have documented a wide range of additional options to replace high-GWP HFCs in many applications and new ideas and technologies are rapidly emerging. Chinese companies are commercializing next-generation refrigeration and Heating, Ventilation, and Air Conditioning systems utilizing low-GWP alternatives; Japanese manufacturers are leaders in high-efficiency CO_2 heat-pump water heaters and the new Indonesia-Japan R-32 partnership (see box) is an important development. In addition, the United States Department of Energy is investing heavily in the development of a refrigerant roadmap so "US industry will be positioned to be a supplier rather than a purchaser of next-generation alternative technologies" *(www.anl.gov/renewables/research/building_emerging_tech_roadmap.html)*. Only time will tell who will be the winners of this race to save the world.

INDONESIA-JAPAN HFC-32 PARTNERSHIP

The Indonesia Ministry of Environment and Ministry of Industry and the Japan Ministry of Economy Trade and Industry (METI), plus Daikin, Panasonic, Fujitsu, Hitachi and Toshiba – with the support of the United Nations Development Programme (UNDP) and the Institute for Governance & Sustainable Development (IGSD) – will introduce high-efficiency HFC-32 (R-32) air conditioners that are safe for the ozone layer and will reduce life-cycle greenhouse gas emissions by more than 50 per cent under typical conditions in hot and humid climates. The first-stage strategy is for Indonesia and other developing countries to replace HCFC-22 (R-22) with R-32, leapfrogging the HFC-410A (R-410a) technology that most developed countries selected for their earlier transition away from ozone-depleting substances.

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