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Making Climate Change and Ozone Treaties Work Together to Curb HFC-23 and Other "Super Greenhouse Gases"

Principal Investigators

Stephen O. Andersen

K. Madhava Sarma

Editor

David Doniger, NRDC

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THE EARTH'S BEST DEFENSE

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About the Principal Investigators

Stephen O. Andersen is co-chair of the Technological and Economic Assessment Panel of the Montreal Protocol. He undertook this project in his personal capacity. K. Madhava Sarma was founding executive director of the United Nations Ozone Secretariat from 1991 to 2000. NRDC is responsible for the policy views expressed in this paper.

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Dedication to K. Madhava Sarma

K. Madhava Sarma died on 30 September 2010, shortly before this paper was finalized. He was a pioneer in ozone protection, an outstanding statesman, and founding executive director of the United Nations Ozone Secretariat from 1991 to 2000. A tribute to Sarma has been posted by the Ozone Secretariat at http://ozone.unep.org/Assessment_Panels/madhava_sarma.shtml

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GLOSSARY

CDM	Clean Development Mechanism	HCFC	Hydrochlorofluorocarbon
CER	Certified Emission Reduction	HFC	Hydrofluorocarbon
CFC	Chlorofluorocarbon	ODS	Ozone-Depleting Substance
EB	Executive Board	TEAP	Technology and Economic Assessment Panel
GHG	Greenhouse Gas		
GWP	Global Warming Potential	UNFCCC	UN Framework Convention on Climate Change

Introduction

This paper presents a review of problems with Clean Development Mechanism (CDM) climate change mitigation projects intended to destroy HFC-23, a powerful greenhouse gas. The CDM is a mechanism under the Kyoto Protocol (the international climate change treaty) that allows developed countries to get credit for emission reductions achieved through approved projects they finance in developing countries. HFC-23 is a greenhouse gas controlled by the Kyoto Protocol that is an unwanted byproduct of the production of HCFC-22. HCFC-22 is a chemical that contributes to both depletion of the ozone layer and climate change; it is being phased out under the Montreal Protocol (the international ozone layer treaty that also protects climate).

Paradoxically, current arrangements under the CDM are doing both too much and too little.

- *Too much* because projects currently supported under the CDM are receiving vastly greater compensation than required to pay for installing and operating the technology for destroying HFC-23, and this over-compensation is perversely encouraging excess production of both HFC-23 and HCFC-22
- *Too little* because HFC-23 emissions continue unabated from other, nearly identical facilities located elsewhere in developing countries that are not currently eligible for CDM incentives to change their practices

What are needed are reforms to the CDM, complementary actions by the Montreal Protocol, and national policies that will achieve these key objectives:

- *Stop overpayment for HFC-23 destruction, ending perverse incentives to increase emissions harmful to the climate and the ozone layer*
- *Control HFC-23 emissions from all plants in all countries, not just those currently enrolled in CDM projects, on the basis of actual control costs, plus a reasonable return*
- *Harmonize policies under two treaties to accelerate reductions of HCFCs and HFCs*

This paper proposes specific solutions to meet these objectives.

Solutions to Better Protect the Climate and the Ozone Layer

CDM Reforms:

- Suspend issuance of carbon credits (CERs) for HFC-23 projects until the current flawed crediting methodology is fully revised
- Suspend renewal of HFC-23 projects' crediting period (do not extend for a second seven-year period) until the methodology is fully revised
- Revise the methodology to eliminate over-compensation and perverse incentives to overproduce HCFC-22 and HFC-23 by:
  - Paying a reasonable amount for HFC-23 destruction—"agreed incremental costs"
  - Supporting the closure or transition of HCFC-22 plants to other products

Montreal Protocol Reforms:

- *Control HFCs (including HFC-23) under the Montreal Protocol*
  - The Montreal Protocol produces huge climate benefits and is accountable for the safety of replacements for ozone-destroying chemicals
- Extend the HCFC-22 phase-out to feedstock uses, with essential use exemptions
- Use the Montreal Protocol Multilateral Fund to support HFC-23 destruction and a faster HCFC-22 phase out.

CHAPTER 1

HFC-23 and HCFC-22: Background on Manufacture, Risks, and Regulation

This paper concerns two greenhouse gases from related families of man-made chemicals: hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). Most HCFCs and HFCs are intentionally produced for a variety of uses, including as refrigerants in cooling equipment, blowing agents in plastic foams, and chemical feedstocks (e.g., for fluoropolymer manufacture).

HFC-23—the focus of this paper—is unique in that for the most part, this chemical is not produced for intended uses; rather it is an unwanted byproduct of producing HCFC-22.[1] HFC-23 (trifluoromethane or CHF_3) is a potent greenhouse gas (GHG), with a 100-year global warming potential (GWP) currently estimated at 14,800 and an atmospheric lifetime of about 270 years.[2] (By comparison, carbon dioxide has a GWP of 1.0.) HCFC-22 (chlorodifluoromethane or $CHClF_2$) is itself an ozone-depleting substance and greenhouse gas. (Its ozone-depleting potential (ODP) is 0.055 and its GWP is 1,810, with an atmospheric lifetime of about 10 years).[3] Because the manufacture of these chemicals is intertwined, understanding the causes of and solutions to HFC-23 emissions requires a familiarity with HCFC-22 production and HCFC-22 regulatory requirements.

There are three strategies for reducing HFC-23 emissions: (1) reduce production of HCFC-22, (2) reduce the amount of HFC-23 produced per unit of HCFC-22 production through chemical process optimization, and (3) destroy the HFC-23 inadvertently produced, through incineration.

HCFC-22 Production

HCFC-22 production is divided between emissive and feedstock uses. Emissive HCFC-22 uses include refrigeration, air conditioning and plastic foam blowing; HCFC-22 is eventually emitted to the atmosphere due to leakage during equipment life or when equipment is discarded. HCFC-22 is also used as a feedstock in the manufacture of fluoropolymers, widely used in building construction as liners, barriers against air and water intrusion, wire insulation, packaging, and nonstick coatings.

Production of HCFC-22 for emissive uses is controlled under the Montreal Protocol, the treaty to protect the ozone layer. This treaty has a strong track record of success, having already accomplished a global phase-out of the original ozone-depleting chemicals, chlorofluorocarbons (CFCs) and halons. Last year the Montreal Protocol achieved universal participation; every member of the United Nations is now a party.

A phase-out schedule for HCFCs was first adopted in 1992 and subsequently strengthened. Following the model established for CFCs, the HCFC schedule provided for developed countries to act first and for developing countries to follow, with financial assistance provided by developed countries through the Multilateral Fund (MLF) operated under the Montreal Protocol.

A 2007 report of the Montreal Protocol's Technical and Economic Assessment Panel (TEAP) shows that overall production of HCFCs, including HCFC-22, for both emissive and feedstock uses was declining in developed countries, which were already far along in their phase-out schedules. HCFC production had increased rapidly, however, in developing countries, so that these countries already account for the majority of global production.[4] Scientific studies in 2007 projected rapid growth, with significant consequences to climate and the ozone layer.

To address this situation, the Montreal parties agreed on an accelerated schedule in 2007. For developed countries, the Protocol will terminate production and consumption for emissive uses by 2020, except for a small amount that can be made until 2030 to service existing equipment. For developing countries, the schedule freezes HCFC production and consumption in 2013. The developing country phase-out will be essentially completed in 2030, with a small service tail until 2040.[5]

The feedstock uses of HCFC-22, however, are exempt from the Montreal Protocol's control measures, based on assumptions that feedstocks are produced without emissions and that all product designated feedstock will be transformed into other materials, and will not be emitted. The feedstock exemption is allowing existing plants to increase their production even as the Montreal Protocol's phase-out schedule requires them to reduce production for emissive purposes. The feedstock exemption is also allowing the construction of new HCFC production capacity.

Options for accelerating the phase-out of HCFC-22 (and thereby also curbing HFC-23 emissions) are discussed later in this paper.

HFC-23 Byproduct Emissions

HCFC-22 production results in the creation of HFC-23 as a byproduct. Unless properly managed under regulations, incentives, or voluntary commitments, the HFC-23 byproduct is emitted into the atmosphere. Over the past two decades, techniques have been developed (1) to reduce the amount of HFC-23 produced per unit of HCFC-22, and (2) to incinerate HFC-23 instead of discharging it into the atmosphere. However, these techniques have not been evenly deployed worldwide.

Before the emergence of concern for climate protection, HFC-23 emissions accounted for 3 percent or more of the output of HCFC-22 production, and nearly all of the HFC-23 waste was discharged into the atmosphere.

Most HCFC-22 plants operating in developed countries have installed incineration equipment that nearly eliminates HFC-23 emissions, and many such companies have reduced the amount of HFC-23 produced to 1.0 to 1.3 percent of HCFC-22 production. Some Japanese companies report an average HFC-23/HCFC-22 ratio of just 0.6 percent.[6] Properly done, process optimization increases HCFC-22 yield and reduces HFC-23 incineration expenses.

All U.S. HCFC-22 production facilities capture and destroy their unwanted HFC-23, according to the U.S. Environmental Protection Agency (EPA). Individual U.S. companies have also reported efforts to minimize HFC-23 production through chemical process optimization. In contrast, not all HCFC-22 plants in the European Union have incineration units; plants without incineration report using process optimization to reduce the quantity of HFC-23 emissions. Data through 2007 submitted to the United Nations Framework Convention on Climate Change (UNFCCC) by the E.U. member states, when coupled with confidential HCFC-22 production data, indicate an average HFC-23/HCFC-22 ratio of less than 0.3 percent, but that may represent the average of plants operating with near-zero emissions due to incineration and plants operating without incineration.[7]

In developing countries, 19 HCFC-22 plants have qualified as emissions mitigation projects under the Clean Development Mechanism (CDM) and are compensated for incinerating HFC-23. Eleven of these projects are located in China, five in India, and one each in South Korea, Mexico, and Argentina. Other plants produce HCFC-22 in developing countries without destroying their HFC-23 emissions. According to a recent research report by S.A. Montzka et al., the 19 CDM plants account for 43 percent to 48 percent of developing country HCFC-22 production.[8]

Montzka et al. estimate that global emissions of HFC-23 were from 11.5 gigagrams to 15.5 gigagrams per year between 2006 and 2008, which is equivalent to 170 million to 230 million tonnes per year of carbon dioxide equivalent (CO_2-e). This represents a 55 percent increase over average levels during the 1990s.[9] Breaking these global figures down, trends in developed and developing countries are quite different. Over this period, HFC-23 emissions in developed countries decreased from 6 to 8 gigagrams per year to 2.8 gigagrams per year as HCFC-22 production fell, HFC-23/HCFC-22 ratios improved, and incinerators were installed. Over the same period, HFC-23 emissions in developing countries increased from 1 to 3 gigagrams per year to 9 to 13 gigagrams per year as HCFC-22 production grew, HFC-23/HCFC-22 ratios were not optimized, and incinerators were installed on only the 19 CDM plants.[10]

Referring to CDM data showing that 5.7 and 6.5 gigagrams per year (84.4 and 91 million tonnes per year CO_2-e) of HFC-23 were destroyed at the CDM plants in 2007 and 2008, respectively, Montzka et al. infer that total developing country HFC-23 emissions would have been correspondingly higher without the CDM.[11] As of August 2010, cumulative reductions reported by the CDM projects equalled 14.8 gigagrams, or 218.6 million tonnes CO_2-e.

It bears noting, however, that the HFC-23 reductions achieved at the CDM plants do not necessarily represent a global reduction in greenhouse gas emissions. As explained below, under the rules of the CDM, these HFC-23 reductions gave rise to emissions credits that allow sources in developed countries to avoid reducing their emissions of carbon dioxide or other greenhouse gas emissions by a corresponding amount.

The Clean Development Mechanism (CDM)

The CDM was created in Article 12 of the Kyoto Protocol. Article 12(2) of the protocol states that the CDM has two objectives:

> The purpose of the clean development mechanism shall be *to assist Parties not included in Annex I in achieving sustainable development* and in contributing to the ultimate objective of the Convention, and *to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.* (emphasis added)

("Annex I Parties" refers to developed countries; "Non-Annex I Parties" refers to developing countries.)

As described on the website of the United Nations Framework Convention on Climate Change (UNFCCC):

> The CDM allows emission-reduction (or emission removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO_2. These CERs can be traded and sold, and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol.
>
> The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction limitation targets.
>
> The projects must qualify through a rigorous and public registration and issuance process designed to ensure real, measurable and verifiable emission reductions that are additional to what would have occurred without the project. The mechanism is overseen by the CDM Executive Board, answerable ultimately to the countries that have ratified the Kyoto Protocol.[12]

CERs have financial value because they can be used by developed countries to comply with their emission limitation targets under the Kyoto Protocol. The prospective value of the CERs provides the economic incentive for investment in the CDM projects. These investments are made by developed country governments, by industrial firms in developed countries that have compliance obligations, and by other financial interests, including the World Bank and private sector investors. CERs can be purchased from the original party that makes the reduction (the primary market) and can be resold (the secondary market).

The European Union has established an Emission Trading Scheme (ETS) which requires various types of industrial emission sources to surrender E.U.-issued emissions allowances for each tonne of CO_2-equivalent emitted. The E.U. generally allows operators of such installations to use CERs issued under the CDM to comply with their E.U. obligations to surrender allowances The E.U. is currently considering restrictions on the use of CERs from HFC-23 projects.

The original vision of the CDM was that it would be a large source of financing for clean energy investment in developing countries, and that competition among projects would assure climate mitigation at market prices. The size of the CDM's financial flow to clean energy projects and other climate mitigation has been limited, however, for a number of reasons, including the fact that the highest-emitting developed country (the United States) did not ratify the Kyoto Protocol and thus does not participate in the CDM.

Another important limitation on clean energy investment, however, was the unanticipated emergence and CER market dominance of HFC-23 destruction projects. As of mid-October 2010, there were 2,439 registered CDM projects, 19 of which were HFC-23 destruction projects.[13] While these 19 projects account for less than 1 percent of all projects, as of August 2010, they had accrued 218.6 million CERs, *49 percent* of CERs issued thus far.[14] The vast majority of HFC-23 CERs went to projects in China and India. The abundance of CERs from HFC-23 destruction has reduced the market value of CERs, further limiting the flow of capital to developing country clean energy investments. The reforms proposed in this paper could help restore the CDM's focus on clean energy investment and promote a more equitable geographic distribution of the CDM's benefits.

The Role of the CDM Executive Board

The CDM is supervised by an Executive Board under the authority and guidance of the parties to the Kyoto Protocol. The duties of the Executive Board can be divided into four stages.

First, the Executive Board approves the methodologies for projects eligible for participation in the CDM. Such methodologies address, among other things, the criteria needed to assure that credits are given only for emission reductions that are actually achieved and that are additional, i.e., that would not have occurred without the CDM project incentives. These criteria include baselines, monitoring plans, and project boundaries. The Executive Board approved the original methodology for HFC-23 destruction (AM0001) in September 2003 and has revised it five times.[15]

Second, the Executive Board reviews individual projects. A project must first have the approval of the host nation. The Executive Board then reviews proposed projects and approves those that comply with approved methodologies. Project developers must choose between two options for accruing CERs. A project may elect a single, nonrenewable 10-year crediting period. Alternatively, a project may elect a seven-year crediting period, with the possibility of two renewals, for a maximum of 21 years.

Third, the Executive Board reviews periodic reports on project performance and whether emission reductions have been achieved. It then issues CERs in appropriate amounts.

Fourth, the Executive Board may revise a methodology at any time on its own initiative or in response to public input. The board also reviews projects which are applying for renewal of their seven-year crediting periods. As will be seen below, some HFC-23 projects elected the seven-year renewable approach while others chose the 10-year nonrenewable crediting period.

A petition for revision of the HFC-23 methodology is now pending before the Executive Board, and the first HFC-23 project to seek renewal of its crediting period (the South Korean project) is also under review by the

board. It is not yet clear whether the renewal of an existing project will be evaluated under the current methodology or a revised one. It is not yet clear whether the renewal of an existing project will be evaluated under the current methodology or a revised one. It is also unclear whether a revised methodology can be applied to requests for issuance of CERs during the current crediting period of an approved project.

The Problemmatic HFC-23 Project Methodology (AM0001)

The existing HFC-23 methodology establishes eligibility criteria for HCFC-22 production facilities. While these eligibility criteria were intended to address problems of perverse incentives, there is strong evidence that they are not adequate. The main current criteria are as follows:

1. To address the concern of additionality, credit is available only if a plant is not subject to a regulation requiring the incineration of HFC-23.

2. To address a concern that the availability of CERs could perversely encourage the construction of more HCFC-22 plants or encourage existing plants to increase their HCFC-22 production, the HCFC-22 production facility has to have an operating history of at least three years between 1 January 2000 and 31 December 2004, and the facility has to have been in operation from 2005 until the start of the project activity.

3. To address a concern that the availability of CERs could perversely encourage a plant to tune its process chemistry to maximize, rather than minimize, formation of the formerly unwanted HFC-23 byproduct, the methodology places a cap on the annual quantity of HFC-23 destruction eligible for CERs, set at the lowest amount of HFC-23 released in the three most recent years of operation through 2004, but not to exceed an HFC-23/HCFC-22 production ratio of 3 percent (0.03 tonnes of HFC-23 produced per tonne of HCFC-22 manufactured). If data on the quantity of HFC-23 produced (and likely released) in these three years are unavailable, a 1.5 percent (0.015) default value is used for the HFC-23/HCFC-22 production ratio.

As mentioned, 19 HFC-23 destruction projects at HCFC-22 plants have been approved under the current CDM methodology. While one application was withdrawn, no HFC-23 project was rejected by the Executive Board. The 19 plants represent less than half the HCFC-22 production capacity in developing countries. The other plants do not qualify for the CDM mainly because they began operation after the cutoff date in condition (2) or lacked the data required by conditions (2) or (3).

CHAPTER 2

How the CDM HFC-23 Projects Are Generating Counterproductive Results

Nongovernmental organizations (NGOs) have raised a broad range of concerns regarding overpayment, perverse incentives, miscalculations, and failure to satisfy the CDM's sustainable development criteria.

The CDM Executive Board is conducting three separate proceedings related to HFC-23 destruction projects.

- **Issuance of CERs.** As noted above, as of August 2010, 218.6 million CERs had been issued to the 19 current HFC-23 projects. In September, however, the CDM Executive Board agreed to conduct a retrospective review of CER issuance to a number of HFC-23 projects in response to allegations of accounting errors and potential fraud, such as bypassing incinerators or claiming credit for destruction in periods when incinerators were not running. The issuance of further CERs has been suspended pending this review.[16]

- **Petition to amend methodology AM0001.** The Executive Board also agreed to consider a petition to revise the HFC-23 destruction methodology submitted by Det Norske Veritas Certification with the support of three environmental organizations: New Economic Orientation for the 21st Century (NEO21), CDM Watch, and the Environmental Investigation Agency (EIA). The board also agreed to consider recommendations from its own methodology panel.[17, 18, 19]

- **Request for crediting period renewal.** The Executive Board is also reviewing the first application for renewal of the crediting period (for a second seven years), submitted by an HFC-23 project in South Korea.[20]

The CDM's consideration of these matters comes amid increasing evidence that the methodology to control HFC-23 emissions is leading to highly perverse results. The primary problem is that the CER compensation rate allowed under the methodology is up to 100 times greater than the capital and operating costs of the incineration equipment (depending on the CER price and actual amortized cost of destruction).

High Profits Generated through CERs are Problematic

DuPont estimates the cost of destroying HFC-23 at US$ 0.28 to 0.37 per tonne CO_2-e. The range in the estimated cost can be attributed to the relative ease of retrofitting incineration equipment (including the availability of convenient space), differences in discount rates, equipment lifetime, and electricity and labor costs. In comparison, the market price of CERs (as of the end of October 2010) was just over US$ 20.00.[21]

The high profits available from these projects encourage the following negative outcomes:

- There is evidence that perverse CDM incentives reward project operators to *maintain or even increase* their ratio of HFC-23 byproduct to HCFC-22 production instead of adopting process chemistry improvements to minimize the ratio of unwanted HFC-23 byproduct to HCFC-22 production.

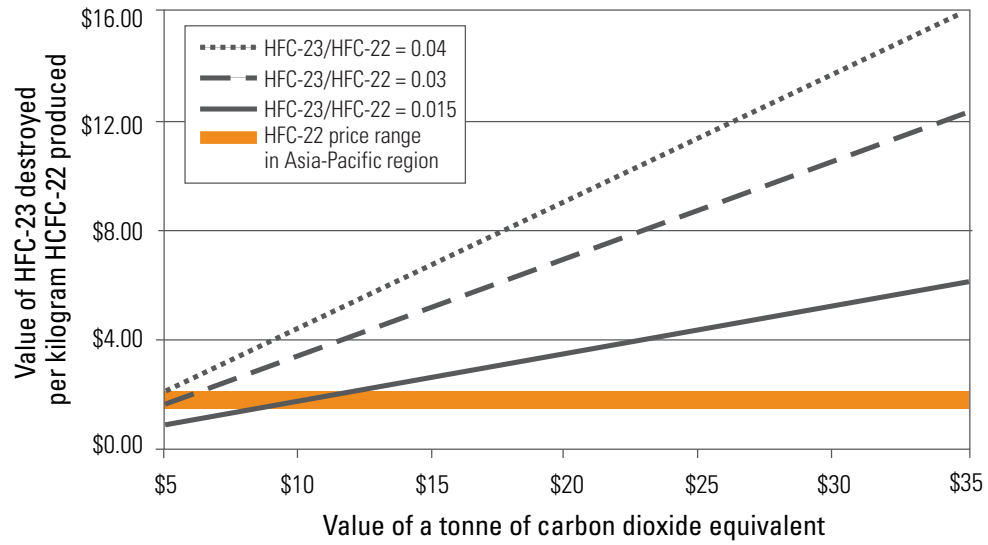
- There is evidence that perverse CDM incentives encourage project operators to overproduce HCFC-22, above levels that otherwise would be produced just in response to underlying HCFC-22 demand, in order to maximize HFC-23 formation and destruction. The extra HCFC-22 production is dumped into the marketplace at reduced prices, thus overstimulating demand for HCFC-22 for both emissive and feedstock uses. The high payments for HFC-23 destruction may even encourage firms to discharge unwanted HCFC-22 directly into the air. The incentive to overproduce HCFC-22 undermines the objectives of the HCFC phase-out required by the Montreal Protocol.

Evidence of Perverse Results

The Technical and Economic Assessment Panel (TEAP) of the Montreal Protocol concluded in 2007: "the net revenue per year for HFC-23 destruction could easily exceed the revenue from HCFC-22 sales."[22] In a "high impact" scenario, TEAP estimated that the revenues from CERs exceed the HCFC-22 production costs by a factor of four to five. In the worst case, these perverse incentives could result in HCFC-22 production that is not used, but instead is released into the atmosphere.

The figure below from the TEAP illustrates the relationship between CER revenues and HCFC-22 production costs for different CER prices and HFC-23/HCFC-22 ratios.[23] Notice the wide range of likely conditions where

Figure 1: Comparison of CER revenues and HCFC-22 prices



Source: UNEP Technology and Economic Assessment Panel.[24]

CER revenues can easily exceed HCFC-22 production costs. These factors imply that the CDM itself can drive the production and emission of GHGs even when those chemicals have no market value.

A review of CDM-approved HCFC-22 plants demonstrates the impact of the perverse incentives flowing from overpayment under the HFC-23 methodology.

For example, the data show that 12 facilities drastically reduced their production of HCFC-22, or stopped producing HCFC-22 altogether, when they reached their annual cap for CER generation.[25] For example, in the 2007 to 2008 crediting year, CDM Project 0767—Zhonghao Chenguang Research Institute of Chemical Industry, China—reduced and then completely stopped its HCFC-22 production once it had reached the cap.[26] The following year, the same plant once again reduced its production of HCFC-22 by 85 percent once it had reached its CDM cap. In both cases, the facility immediately resumed HCFC-22 production once the new crediting year began.

These production patterns demonstrate that over-compensation for HFC-23 destruction is driving decisions whether or not to produce HCFC-22. These patterns strongly suggest that the plants are producing HCFC-22 well above the amount warranted by market demand and pricing for HCFC-22. Plant operators will produce HCFC-22 when revenue exceeds marginal production costs. For an ordinary plant, revenue comes from HCFC-22 sales, whereas CDM plants receive a combined revenue stream from HCFC-22 sales and HFC-23 destruction payments. The fact that these plants stop or dramatically reduce HCFC-22 production when annual CDM payments have "maxed out" reveals that the returns from HCFC-22 production alone are insufficient to warrant running the plant. Thus, the CDM payments are driving excess HCFC-22 production.

Likewise, the data show that CDM plants operate at much higher HFC-23/HCFC-22 ratios than non-CDM plants in developing countries. In fact, the data show that CDM plants operate at higher HFC-23/HCFC-22 ratios at times of the year when they are earning CERs than at times when they are not. In one case involving the Arkema Changshu Haike plant in China (CDM Project 1105), the HFC-23/HCFC-22 ratio during a non-CER crediting period dropped to 1.1 percent from 2.26 percent, demonstrating that the lower ratio can be reached in the normal course of business with no significant additional cost to the plant operator.[27] In another case (CDM Project 0151), the HFC-23/HCFC-22 ratio decreased from an average of 2.9 percent during the crediting period to 1.38 percent after the cap on CER generation was reached.[28]

Other plants demonstrate that lower ratios are achievable. The Arkema Changshu Haike plant operated at a ratio of 1.87 percent in 2002, 1.64 percent in 2003, and 1.84 percent in 2004 and is capped for credit generation purposes at a maximum ratio of 1.64 percent.[29] The ratio is routinely lower for plants in developed countries. DuPont has sustained a ratio of 1.37 percent and reported that the savings from converting a larger portion of feedstocks into marketable product (HCFC-22) pays for the superior technology that minimizes unwanted HFC-23 production.[30]

Nonadditional Reductions

As described in Section 2.4, CERs must be issued only for emission reductions that are "additional." There are two essential questions regarding additionality: whether the emissions would have occurred absent the CDM incentives, and whether the reductions in those emissions would have occurred absent those incentives.

Ordinarily, attention is paid only to the second question—whether the reductions would have occurred without CDM incentives—because the prior existence of the emissions is taken for granted. In this instance, a portion of the HFC-23 byproduct *would never have been created* absent the CDM incentives. To be sure, income from CERs is motivating participating plants to incinerate their HFC-23 byproduct. What is also apparent, however, is that the income from CERs is leading at least some of the plants to *create more HFC-23 byproduct than would otherwise have existed in the first place*—by operating during crediting periods at elevated HFC-23/HCFC-22 ratios and by producing more HCFC-22 (and, as a result, more HFC-23) than warranted by the underlying economics of the HCFC-22 market. The destruction of the extra HFC-23 byproduct—material that is created only because of the CDM incentives—should not be considered "additional" under the Kyoto Protocol.

Large payments to CDM projects may also encourage shifts in *where* HCFC-22 is produced. Production may be shifted to CDM plants (1) from plants in developed countries, or (2) from other plants in developing countries that are not eligible under the current CDM methodology. To the extent that HCFC-22 production is shifted to the CDM plants from plants in *developed countries*, the HFC-23 destroyed does not reflect an actual emissions reduction, because it would have been destroyed just the same in the developed country plants. To the extent that HCFC-22 production is shifted from other plants in *developing countries*, the case for additionality is cloudy. On the one hand, the HFC-23 byproduct would have been emitted from those non-CDM plants. On the other hand, the CDM incentives may have led to a higher HFC-23/HCFC-22 ratio at the CDM plants than at the non-CDM plants.

One mitigating factor that must be acknowledged is China's tax on CER revenue received by that country's HCFC-22 plants. China reports that it collects two-thirds of the CER revenue received by those plants and the government says those funds will be dedicated to renewable energy investments. China's tax removes a substantial portion, but not all, of the overcompensation flowing to Chinese HCFC-22 plants participating in the CDM.

Undermining Sustainable Development

The present HFC-23 CDM projects do not meet the CDM's objective of promoting sustainable development in developing countries. As previously mentioned, the CDM has not unleashed as large a flow of investment in clean energy technologies as was expected, in part because a disproportionate share of CDM investment has gone into HFC-23 destruction.

Further investment in HCFC-22 production capacity does not well serve developing countries' sustainable development objectives. Because HCFCs are being phased out under the Montreal Protocol, HCFC-22 production is an obsolescent industry. Even the production of HCFC-22 for feedstock purposes, i.e., for fluoropolymer production, is of questionable sustainability. In Chapter 4, we elaborate on a proposal to replace the Montreal Protocol's blanket exemption for feedstocks with a more limited essential-use exemption. This change would give industry the right signal to develop alternative methods of making fluoropolymers, and to develop alternatives to replace them.

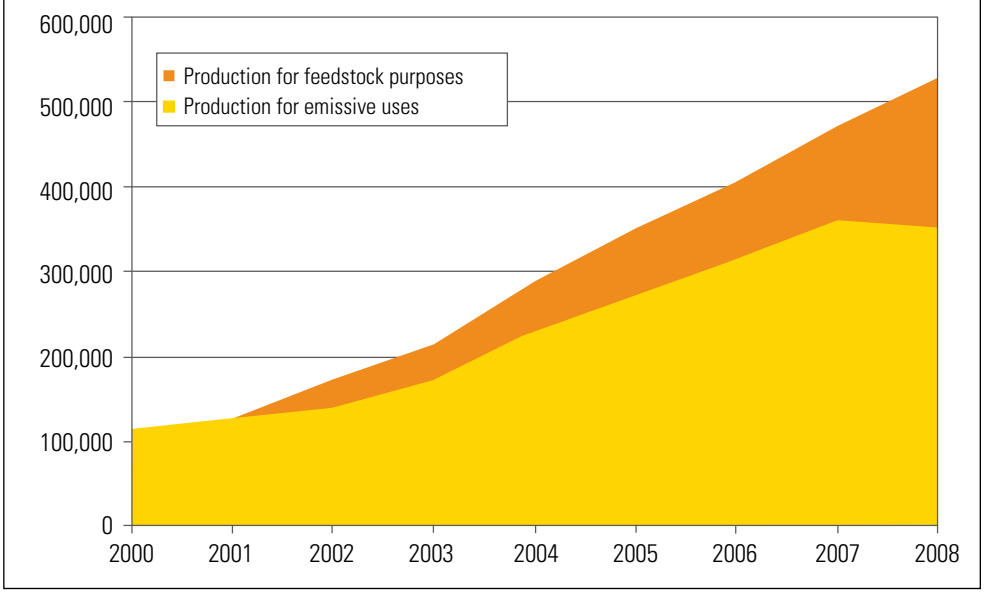
Undermining the Montreal Protocol's HCFC Phase-Out

Payments to HFC-23 destruction projects are also undermining the Montreal Protocol's objective of phasing out HCFCs, with adverse consequences for both the ozone layer and climate system. HCFC-22 is both a significant ozone-depleting substance and greenhouse gas. In 2007, the parties to the Montreal Protocol agreed to accelerate the phase-out of HCFCs in both developed and developing countries. In particular, the agreement imposes a freeze on HCFC production and consumption in developing countries in 2013, followed by steady reductions. The phase-out schedule should be regarded as an upper boundary, because developing countries typically implement their commitments earlier than required with assistance from the Montreal Protocol's financial mechanism, the Multilateral Fund.

Payments for HFC-23 destruction may undermine the HCFC-22 phase-out in two ways. First, they are encouraging inflation of HCFC-22 production prior to the 2013 freeze and subsequent phase-out. Under the HCFC phase-out schedule, each developing country's baseline will be fixed at the average of its production in 2009 and 2010. Starting in 2013, each country must reduce production and consumption to specified percentages of its baseline level by specific dates in the future. The figure below shows that HCFC-22 production in developing countries grew rapidly from 2000 to 2008. Part of this growth may be attributable to the CDM incentives which are subsidizing overproduction of HCFC-22. The result is to inflate countries' baseline HCFC levels and to increase allowable HCFC production and consumption at each stage of the subsequent phase-out.

Second, the prospect of continuing future payments for HFC-23 destruction can reasonably be expected to lead plant operators to delay decisions to convert or close those plants under the Montreal Protocol.

Figure 2: HCFC-22 production in developing countries (tonnes)



Source: UNEP Ozone Secretariat as referenced by Det Norske Veritas[31]

Third, as the Montreal Protocol phases down HCFC production, the cap on annual CER accrual will become vestigial and no longer serve its intended function of preventing HFC-23 destruction payments from encouraging HCFC-22 production increases. When HCFC-22 demand drops below the quantity of HCFC-22 that is eligible for CERs, the current cap specified in methodology AM0001 will serve only to create a perverse incentive to produce unnecessary quantities of HCFC-22 and HFC-23 byproduct. Continuing CER revenue will give plant operators an incentive to continue HCFC-22 production even though market demand for HCFC-22 has dropped. Furthermore, dumping of HCFC-22 at prices subsidized by CER payments will displace HCFC-22 production from other facilities with lower HFC-23/HCFC-22 production ratios, undercutting voluntary efforts by companies in developed countries and punishing companies operating under regulations to minimize HFC-23 emissions. By depressing HCFC-22 prices, CDM payments will also slow efforts by HCFC-22 users (such as manufacturers of refrigeration and cooling equipment) to adopt substitutes.

Disincentives for National Regulation

Any country with legislation for mandatory destruction of HFC-23 is ineligible for CDM project benefits because the CDM does not pay for mitigation that is already required by law. This is a disincentive for key developing countries to act responsibly to protect the climate system by enacting laws that require process optimization to minimize production of HFC-23 in the first place and/or destruction of HFC-23 byproduct.

Discouraging Support for More Economic and Sustainable Solutions

Some countries currently benefiting from HFC-23 destruction projects are opposing proposals to change the current CDM methodology. They are also opposing proposed changes in the Montreal Protocol to phase down HFC production and consumption and create a specific program under the Multilateral Fund to finance destruction of HFC-23 at non-CDM plants.

CHAPTER 3

Review of Existing Proposals for Reforming the CDM's Treatment of HFC-23

To address the perverse incentives identified earlier, the Det Norske/NGO proposal to amend the HFC-23 methodology asks the CDM Executive Board to cap the HFC-23/HCFC-22 ratio at 0.2 percent in the formula for calculating CERs. The Executive Board is aiming to decide on the petition to revise the HFC-23 methodology this fall.

In the meantime, the board has requested the methodology panel to continue its work on the methodology, taking into account many issues, including:

- Developments of supply and demand in the global HCFC-22 market, whether CDM HCFC-22 facilities are increasing their production, and whether more HFC-23 had or could have been generated than would have otherwise occurred without the CDM
- Possible economic impacts of influencing the ratio between HFC-23 generation and HCFC-22 production for existing facilities, including swing plants, for both CDM and non-CDM HCFC-22 facilities.
- Lifetimes of operating HCFC-22 installations, including an assessment of the impact of any possible prolonged lifetime on the generation of HFC-23.

The Det Norske/NGO proposal is a step in the right direction, but it will not halt overpayments and the perverse results that flow from them. The proposed reforms would reduce overpayments for a new installation from more than 100-fold to about 13-fold. For a project like the South Korean plant that is seeking a second seven-year crediting period, overpayments would be even higher because that project has already incurred its capital costs and now bears an operating cost estimated to be less than US$ 0.10 per tonne of CO_2-e destroyed.

Thus, even at the reduced HFC-23/HCFC-22 ratio proposed by Det Norske, overcompensation will continue to promote nonadditional reductions, overproduction of HCFC-22 at depressed prices, and the diversion of CDM resources from clean energy and other investments that better protect the climate and support sustainable development. Moreover, these reforms would do nothing to address HFC-23 emissions from factories that are ineligible for payments under the CDM.

What is needed is an alternate approach, one based on a sufficient, nondistorting level of compensation, similar to the "agreed incremental cost" basis for financial support under the Montreal Protocol's Multilateral Fund for developing country projects to phase out ozone-depleting substances. The Global Environment Facility has a similar incremental cost approach for climate mitigation projects and other environmental protection projects.

CHAPTER 4
Broader Solutions to Protect Our Climate and Ozone Layer and Encourage Sustainable Development

RECOMMENDATION 1:

Suspend Credit Issuance and Crediting Period Renewals Until Methodology AM0001 is Revised

The CDM Executive Board should continue the suspension of CER issuance for existing projects until methodology AM0001 is revised to reduce the over-issuance of CERs and related windfall profits. Likewise, the Executive Board should suspend consideration of requests for seven-year extensions of the crediting period for current HFC-23 projects, including the Ulsan project in South Korea, until completion of the revision of the methodology.

RECOMMENDATION 2:

Broaden Reform of Methodology AM0001

The pending Det Norske proposal would reduce, but not eliminate, the perverse incentives of the current methodology. Reducing the HFC-23/HCFC-22 ratio in the formula for calculating accrual of CERs is only a partial remedy. It would reduce, but not eliminate, overcompensation for current projects. Because the revised methodology would still overcompensate, it would not eliminate objections to expanding participation to include developing country HCFC-22 plants that are currently ineligible.

The Executive Board should consider two more basic reforms to the methodology:

- ***Compensate HFC-23 projects on the basis of agreed incremental costs.*** This is the model successfully employed by the Montreal Protocol and the Global Environment Facility, among other institutions. The goal is to provide the agreed incremental costs of projects, including a reasonable rate of return for investment. This model is appropriate for CDM projects with underlying economics like HFC-23 projects, where compensation under the standard CDM approach produces so much revenue that it distorts the economic and emissions-producing behavior of underlying enterprises.

  Under this approach, the CDM could issue a smaller number of CERs for such projects—the number necessary to generate revenue equal to the projects' agreed incremental costs. This approach would also generate *a net reduction in global emissions*; the genuine decrease in emissions achieved by the projects would be larger than the increase in developed country emissions due to use of the CERs issued to the project.

- ***Restructure HFC-23 projects to support the closure or transition of the underlying HCFC-22 plants.*** The current methodology assumes that the underlying HCFC-22 plants will continue to operate indefinitely—the sole goal of the methodology is to mitigate the HFC-23 byproduct emissions. This approach ignores, and undercuts, the objectives of phasing out HCFC production under the Montreal Protocol. A better approach would be to restructure the methodology to support and place priority on closing HCFC-22 plants or transitioning them to produce alternative sustainable products. The methodology should provide support,

financed through CERs, to cover the agreed incremental cost of closing or transitioning those plants. This approach would produce dual net benefits for the climate and the ozone layer.

RECOMMENDATION 3:

Control HFCs (Including HFC-23) Under the Montreal Protocol

The Montreal Protocol has produced huge climate benefits as a side effect of controlling ozone-depleting chemicals. The worldwide elimination of CFCs has delivered a climate protection bonus equivalent to 11 billion tonnes of CO_2 reductions in this year alone.[32] That is equivalent to delaying the expected growth in global CO_2 emissions by 7 to 12 years.

The Montreal Protocol also recognizes the need to manage the chemicals that replace CFCs and HCFCs, even if they are not themselves ozone-depleting substances. Demand for HFCs is driven by the phase-out of CFCs and HCFCs. The Montreal Protocol and its technical bodies also have substantial expertise and experience that is directly applicable to HFCs, which are members of the same chemical family (fluorocarbons) and are produced and used by the same industries that produce and use CFCs and HCFCs. The Montreal Protocol also has a highly successful track record of delivering technological cooperation.

Two proposals to phase down HFCs under the Montreal Protocol have been advanced— one by Canada, the United States, and Mexico and the other by Mauritius, Micronesia, and other small island nations.[33] Under these proposals, developed countries would take the lead in phasing down HFCs, and developing countries would do the same after a reasonable grace period and with financial assistance provided through the Multilateral Fund. Both proposals would set limits in the form of the global warming potential of the covered chemicals, thus creating a strong incentive to shift from high-GWP HFCs to low-GWP HFCs—for example, replacing HFC-134a (GWP 1430) in mobile air conditioning with HFC-1234yf (GWP 4)—and to other chemical and non-chemical alternatives. As part of an HFC phase-down, it would be essential for governments to replenish the Multilateral Fund with sufficient additional resources to support the agreed incremental costs of developing country actions.

These proposals offer the opportunity to manage all HFCs, including HFC-23, in a manner that coordinates the objectives of ozone-layer and climate protection. Coordinating the phase-down of HFCs with the ongoing phase-out of HCFCs will allow many companies and their customers to leapfrog high-GWP HFCs entirely and save billions of dollars in future mitigation costs. Phasing down HFCs under the Montreal Protocol would not affect the operation of the UNFCCC or Kyoto Protocol, which require countries to account for HFC *emissions* as part of a basket of six greenhouse gases. The Montreal Protocol would control the *production* of and *international trade* in these chemicals, complementing the Kyoto Protocol's emissions-based approach.

The North American proposal includes specific provisions to use the Multilateral Fund to support HFC-23 destruction for plants not eligible for the CDM. The North American proposal could be further improved if Multilateral Fund resources were made available to support HCFC-22 plant closure or transition. The protocol's Multilateral Fund is a proven mechanism for assisting developing countries to meet their obligations.

RECOMMENDATION 4:

Improve and Accelerate HCFC Phase-Out

Improvements could be made to the accelerated HCFC phase-out adopted in 2007.

- The Montreal Protocol parties should agree to make HFC-23 destruction *mandatory* at HCFC-22 plants in all countries, with Multilateral Fund support provided for developing countries.

- The parties should take a range of measures to achieve an even faster phase-out of HCFC-22 in both feedstock and non-feedstock applications.

- This should include removing the blanket feedstock exemptions for HCFC-22 and replacing it with essential-use exemptions, comparable to the existing exemptions for some other chemicals (e.g., CFCs, halons, and methyl chloroform). Parties would request an exemption for specific annual quantities of HCFC-22 as

feedstock. The TEAP would evaluate the proposed exemptions based on agreed-upon criteria, with the parties deciding on a case-by-case basis. Special conditions could be applied, including the authorization of categorical exemptions for specific uses as is now done for most laboratory and analytical ODS uses. The TEAP should be asked to assess the potential to produce fluoropolymers, or to adopt substitutes, to reduce the need for HCFC-22 as a feedstock.

- A faster phase-out, and coverage of feedstock uses, would require devoting additional resources to the Multilateral Fund.

Now is the Time to Align Our Goals for Reducing Emissions of the Super Greenhouse Gases and Protecting Our Climate

Taken together these four recommendations would do more than fix the current dysfunctional CDM methodology for HFC-23 destruction. They would phase down HFCs broadly and accelerate the HCFC phase-out in a manner that aligns protection of the climate with protection of the ozone layer through the climate treaties—the UNFCCC and the Kyoto Protocol—and the Montreal Protocol. This comprehensive approach would help developed and developing countries work together for better protection of both the climate and the ozone layer.

Appendix

Currently Registered HFC-23 CDM Projects

PROJECT TITLE AND CDM REFERENCE NUMBER	REGISTERED	HOST PARTY	OTHER PARTIES	ANTICIPATED REDUCTIONS PER YEAR (TONNE CO_2-E)	CREDITING PERIOD:	RENEWABLE*
Project for GHG Emission Reduction by Thermal Oxidation of HFC 23 in Gujarat, India (0001)	08 Mar 05	India	Switzerland and U.K.	3,000,000	02/13/06 – 02/12/16	No
HFC Decomposition Project in Ulsan (0003)	24 Mar 05	Republic of Korea	Switzerland and Japan	1,400,000	01/01/03-12/31/09	Yes
GHG Emission Reduction by Thermal Oxidation of HFC-23 at Refrigerant (HCFC-22) Manufacturing Facility of SRF Ltd (0115)	24 Dec 05	India	Netherlands, Italy, France, Germany, U.K., and Switzerland	3,833,566	07/01/04 – 06/30/14	No
HFC23 Decomposition Project of Zhejiang Juhua Co., Ltd, P. R. China (0193)	03 Mar 06	China	Japan	5,789,682	08/01/06 – 07/31/13	Yes
Shandong Dongyue HFC23 Decomposition Project (0232)	13 Mar 06	China	Switzerland, Japan, and U.K.	10,110,117	01/01/07 – 12/31/13	Yes
Project for GHG Emission Reduction by Thermal Oxidation of HFC-23 in Jiangsu Meilan Chemical CO. Ltd., Jiangsu Province, China (0011)	04 Jun 06	China	Canada, Netherlands, Italy, Denmark, Finland, France, Sweden, Germany, U.K., Switzerland, Japan, Norway, and Spain	8,411,432	12/01/06 – 11/31/13	Yes
Quimobásicos HFC Recovery and Decomposition Project (0151)	14 Jun 06	Mexico	Switzerland, Japan, Netherlands, and U.K.	2,155,363	06/14/06 – 06/13/13	Yes
Project for HFC-23 Decomposition at Changshu 3F Zhonghao New Chemical Materials Co. Ltd, Changshu, Jiangsu Province, China (0306)	08 Aug 06	China	Canada, Netherlands, Italy, Denmark, Finland, France, Sweden, Germany, U.K., Switzerland, Japan, Norway, and Spain	10,437,249	12/22/06 – 12/21/13	Yes
Project for HFC-23 Decomposition at Limin Chemical Co., Ltd. Linhai, Zhejiang Province, China (0550)	27 Oct 06	China	Switzerland, Netherlands, Italy, and U.K.	4,783,753	01/01/07 – 12/31/13	Yes
Project for HFC-23 Decomposition at Zhejiang Dongyang Chemical Co., Ltd., China (0549)	27 Oct 06	China	Switzerland, Netherlands, Italy, and U.K.	3,656,598	11/01/06 – 12/31/13	Yes
Destruction of HFC-23 at Refrigerant (HCFC-22) Manufacturing Facility of Chemplast Sanmar Ltd (0499)	16 Feb 07	India	Switzerland and U.K.	539,163	02/16/07 – 02/15/17	No
Frio Industrias Argentinas S.A ("FIASA") Hydro-fluorocarbon 23 ("HFC-23") Capture, Storage and Decomposition Project (0807)	10 Mar 07	Argentina	Spain	1,434,143	10/15/07 – 10/14/14	Yes
GHG Emission Reduction by Thermal Oxidation of HFC-23 at Navin Fluorine International Limited (NFIL), Surat, Gujarat, India (0838)	30 Mar 07	India	Switzerland, Japan, France and U.K.	2,802,150	05/01/07 – 04/30/17	No
No.2 HFC-23 Decomposition Project of Zhejiang Juhua Co., Ltd, P. R. China (0868)	05 Apr 07	China	Switzerland and U.K.	4,809,631	04/06/07 – 04/05/14	Yes
HFC-23 Decomposition Project at Zhonghao Chenguang Research Institute of Chemical Industry, Zigong, SiChuan Province, China (0767)	01 May 07	China	Switzerland, Netherlands, Italy, and U.K.	2,065,533	05/01/07 – 04/30/14	Yes
China Fluoro HFC-23 Abatement Project in China (1194)	14 Sep 07	China	Switzerland, Japan, and U.K.	4,248,092	09/14/07 – 09/13/14	Yes
Changshu Haike HFC-23 Decomposition Project (1105)	15 Feb 08	China	U.K.	3,473,385	05/01/08 – 04/30/15	Yes
GHG Emission Reduction by Thermal Oxidation of HFC-23 at Refrigerant (HCFC-22) Manufacturing Facility of HFL Ltd. (1867)	14 Nov 08	India	—	442,310	11/14/08 – 11/13/18	No
Yingpeng HFC-23 Decomposition Project (1947)	20 Apr 09	China	Italy, Ireland and U.K.	7,865,277	04/20/09 – 04/19/16	Yes

*Projects may elect a one-time 10-year crediting period or a 7-year period with possibility of two renewals

Endnotes

1 A small amount is used as a fire extinguishing agent and as a low temperature refrigerant.

2 For CDM purposes, the GWP value for HFC-23 is based on an earlier estimate, and is 11,700. The most up-to-date GWP value for HFC-23 is 14,800. *See* Intergovernmental Panel on Climate Change, Fourth Assessment Report, Climate Change 2007: The Physical Science Basis, Technical Summary, p. 32, Table TS.2 (Cambridge University Press 2007).

3 Ibid.

4 *See* Technical and Economic Assessment Panel, Response to Decision XVIII/12, Report of the Task Force on HCFC Issues (With Particular Focus on the Impact of the Clean Development Mechanism) and Emissions Reduction Benefits Arising from Earlier HCFC Phase-Out and Other Practical Measures (2007), p.36, *available at* http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/TEAP-TaskForce-HCFC-Aug2007.pdf.

5 Decision XIX/6: Adjustments to the Montreal Protocol with regard to Annex C, Group I, substances (hydrochlorofluorocarbons), UNEP's Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Eighth edition 2009, at 108, http://www.unep.ch/ozone/Publications/MP_Handbook/MP-Handbook-2009.pdf.

6 Information provided to the author (Andersen).

7 Ibid.

8 S.A. Montzka et al., "Recent increases in global HFC-23 emissions," *Geophysical Research Letters* 37 (2010).

9 Ibid.

10 Ibid.

11 Ibid.

12 UNFCCC*t* http://cdm.unfccc.int/about/index.html.

13 UNFCCC, Oct. 19, 2010, http://cdm.unfccc.int/Statistics/index.html.

14 UNEP Risoe CDM/JI Pipeline Analysis and Database, Oct. 19, 2010, http://www.cdmpipeline.org.

15 For further information on methodology AM0001, *see* http://cdm.unfccc.int/methodologies/DB/0MKGF12PM6TSNFNJZUESTSKG581HN6/view.html.

16 CDM Executive Board, 56th Meeting, Report, 17 Sept. 2010,,http://cdm.unfccc.int/EB/index.html.

17 CDM Executive Board, 55th Meeting, Report, 30 July 2010, http://cdm.unfccc.int/EB/index.html.

18 Det Norske Veritas, Revision to AM0001 to address methodological issues, AM_REV_0186, 8 March 2010, http://cdm.unfccc.int/methodologies/PAmethodologies/revisions/58215

19 CDM Methodology Panel, Forty-Fourth Meeting Report, Annex 2, Note on AM0001 ".Incineration of HFC 23 Waste Streams," at 1, http://cdm.unfccc.int/Panels/meth/meeting/10/044/mp44_an02.pdf.

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21 Carbon Market Daily, 2 Nov. 2010, http://www.pointcarbon.com/polopoly_fs/1.1483727!CMD20101102.pdf.

22 *See* Technical and Economic Assessment Panel, Response to Decision XVIII/12, Report of the Task Force on HCFC Issues (With Particular Focus on the Impact of the Clean Development Mechanism) and Emissions Reduction Benefits Arising from Earlier HCFC Phase-Out and Other Practical Measures 5-7 (2007), http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/TEAP-TaskForce-HCFC-Aug2007.pdf.

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24 Ibid, p. 6.

25 CDM Methodology Panel, Forty-Fourth Meeting Report, Annex 2, Note on AM0001 "Incineration of HFC 23 Waste Streams," at 1, http://cdm.unfccc.int/Panels/meth/meeting/10/044/mp44_an02.pdf.

26 Fourth Monitoring Report of HFC23 Decomposition Project at Zhonghao Chenguang Research Institute of Chemical Industry, Zigong, SiChuan Province, China, UNFCCC CDM Ref. No. 0767, Monitoring period: November 26, 2007 to

February 25, 2008, Version: 01, 3 March 2008, p. 25, http://cdm.unfccc.int/Projects/DB/JQA1163409153.5/iProcess/DNV-CUK1204887073.94/view.

27 *Compare* Changshu Haike Chemical Co. Ltd., Second Monitoring Report of Changshu Haike HFC 23 Decomposition Project, UNFCCC CDM Ref. No. 1105, Monitoring period: Jul 1, 2008 to Nov 30, 2008, Version: 01, 5 Dec. 2008, at 3, http://cdm.unfccc.int/UserManagement/FileStorage/M7D2ILF93OA6EZCXHUS4K5JGVBQTRN (operating ratio of 2.26% in period of CER generation) *with* Changshu Haike Chemical Co. Ltd., Third Monitoring Report of Changshu Haike HFC 23 Decomposition Project, UNFCCC CDM Ref. No. 1105, Monitoring period: Dec 1, 2008 to Apr 30, 2009, Version: 01, 26 May 2009, http://cdm.unfccc.int/UserManagement/FileStorage/LW01CUNDGI4OA2FJBT39SK67XRYQ8P. (indicating the operating ratio dropped to 1.1% during the non-crediting period).

28 *Compare* Quimobasicos S.A. de C.V., CDM Monitoring Report of Quimobasicos HFC Recovery and Decomposition Project – Reference Number 00000151 CDMP: Monitoring period: 31st of March 2008 to 30th May 2008 - Version 06, 6 Aug. 2007, at 36, http://cdm.unfccc.int/UserManagement/FileStorage/Q6DNANUYW5UHYYESJZ3Z922LDWKFTB *with* Quimobasicos S.A. de C.V., CDM Monitoring Report of Quimobasicos HFC Recovery and Decomposition Project – Reference Number 00000151 CDMP: Monitoring period: 31 of May 2008 to 13 of June 2008, Version 08, 4 Aug. 2008, at 34, http://cdm.unfccc.int/UserManagement/FileStorage/UGN1YI9QVXW3R06COKMDSA5T8F7LJP (indicating the operating ratio dropped to 1.38%).

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40 West 20th Street
New York, NY 10011
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Fax 212 727-1773

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