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Title

The Inertia of Global Environmental Conventions

or, why HCFCs are treated with a bn$ watering-can and HFCs with carrots

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0. Summary

After eliminating CFCs across the globe, the Montreal Protocol has been extended to HCFCs. What was thought to be its strength, MLF funds covering incremental costs, has actually been a weakness because it was never put to practice. For HCFC as for CFC, MLF funding is available only in relation to the volume of the chemicals irrespective of the economics for the users. One example of a HCFC phase-out plan is described to show that the practice of the MLF is simply continued, via bureaucratic inertia in the triangle MLF, Implementing Agencies and Ministries of the Environment. Ignoring other economic and technical factors, the volume rules of the MP determine the pace of HCFC phase-out.

HFCs are included in the Kyoto Protocol. So far only three types HFC emission reduction projects have been developed as CDM projects. One, pursued by larger companies in India, seems to unlock the kind of technical change impact the CDM is credited for.

Interferences between Montreal and Kyoto appear in particular because of this division between HCFC and HFC. The inertia of both regimes contributes to make a solution defined with a new North-South bargain for HCFC unlikely, interests among the G-77 and the OECD members are too divers. An assessment of organisational efficiency, the UNFCCC versus the MLF, seems unlikely and none is published. The paper proposes a different solution using technical change trajectories. Schumpeterian or evolutionary economics distinguishes scale intensive and specialised supplier trajectories. The first is typical for household appliances (thus for HCFCs) and the second being shaped by much smaller numbers of producers and buyers (thus for HFCs). Since both Montreal and Kyoto seek to accelerate technical change, it is obviously attractive to use an analysis of trajectories to resolve their overlap.

1. HCFC and HFC

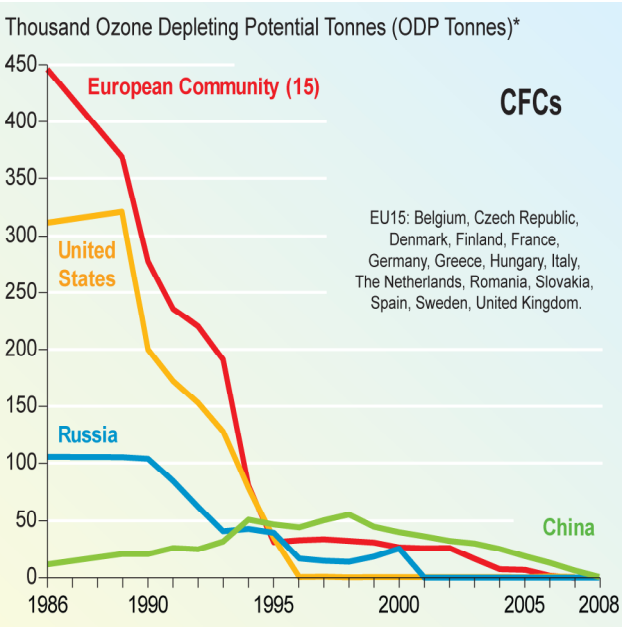
First, a comparison of HFC (hydrofluorocarbons) and HCFC (hydrochloro-fluorocarbons). Most HCFCs and most HFCs are used for the same purposes, refrigeration and insulation foam blowing agents. So HFCs and HCFCs are in many refrigerators, Air-conditioners and other appliances where something

is cooled, ice-cream, beer, salad, medicines or blood. Various other uses in the chemical industry are not relevant. HFCs and HCFCs appear in everyday convenience appliances, things we use without being aware of unless an appliance stops working. There are many HFCs and HCFCs but only one of each is important in volume terms, HFC-134a and HCFC-22 are used in 100,000s tons each year.

The IPCC estimates total global HFC emissions to the atmosphere will be 1.15 Gt CO_2e in 2015 and HCFC to be at 0.8 Gt CO_2e (IPCC 2005, SPM-4). The Global Warming Potential (GWP) of HFC-134a is huge, 1,410 times that of CO_2 and the GWP of HCFC-22 is even 1,780 times CO_2. Even more frightening from 1998 to 2005, the HCFC-22 concentration in the atmosphere increased 38% and HFC-134a concentration 27%. The importance of HCFC for climate change is similar to HFC.

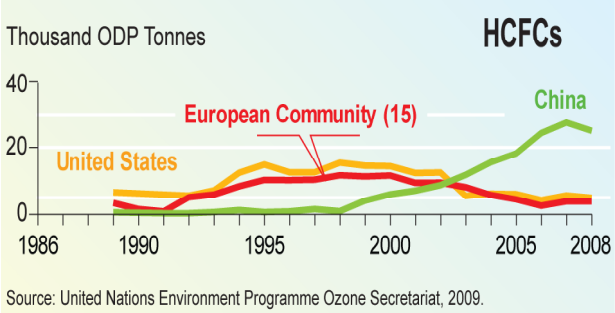
1.1 The Montreal Protocol

The MP has funded investments replacing Ozone-depleting Substances (ODS) with non-ODS since 1992. Its focus has been two gases, CFC-11 and CFC-12, used mainly in refrigeration because of their thermodynamic properties. Other ODS gases such as Halon or Methylbromide played a much smaller role in funds and atmospherically.



Southern countries agreed to phase-out all CFCs by 2010, against funds for converting all CFC uses. The MP thus made OECD countries pay (proportional to GDP) for substituting in Southern countries gases produced by companies such as DuPont, Dow, ICI, Atochem and Hoechst. The Multilateral Fund (MLF) created for the Montreal Protocol, disbursed 2.6 bn US$ so far. In OECD countries, CFCs were replaced by 1995, most Southern countries completed phase-out by 2008, also ahead of the negotiated target, the year 2010.

Some of the chemicals suitable to replace CFCs are HFCs and HCFCs because their thermodynamic properties are similar and they do not destroy ozone. HCFC-22 is unique because it still depletes ozone but only with 5% of the depletion effect of CFCs (ODP = 0.05).



Since HCFC-22 is cheap and can be used to refill existing CFC-using equipment, it was treated as a quick remedy.

In 2007, at the 19th Meeting of the Parties to the Montreal Protocol, parties agreed to extend the operation of the Multilateral Fund (MLF) to HCFCs. Until then, MLF paid for introducing HCFC-22, from then on MLF funds replacing HCFC-22, what is labelled a "double phase-out" (its merit cannot be assessed here but just to mention it, other CFC replacement chemicals with zero Ozone-depletion and zero GWP have been available for many years).

Questions on Geography:
MLF paid for a problem (CFC) originating in the EU and USA then why is MLF now paying for a different problem, originating in China (HCFC-22) ?
And why is disbursement via the MLF (proposals, evaluation, controlling) maintained for HCFC-22 without assessing the technical and economic differences between CFC and HCFC-22 ?

These are open questions and some hypotheses come to mind, however I would like to illustrate why these questions are in urgent need of answering. It is not possible to show that these questions have been excluded because of the bureaucratic reproduction of the MLF and the dependent MLF consulting industry, but this is one plausible conclusion I propose. Also, how to distinguish this reproduction from the influence of the international environmental policy arena and domestic environmental policy (for example, international action by the George W. Bush administration, similar to his father George H. Bush who ridiculed Al Gore as "ozone man" in the 1989 presidential election and then pushed for the MP against reluctance from Europeans) ? I cannot treat these and remain purely at the operational level of the Montreal Protocol implementation.

1.2 How the MLF distributes funds

The MLF funded essentially similar projects in all Southern countries, for example, maintenance of refrigerators, recovery of CFC from chillers and some 30 more project types. In total 6,104 individual projects were approved and realised. The same blueprints were used in all Southern countries. The main vehicles are the "Implementing Agencies" (IA), the only ones allowed to write project proposals to the MLF, which they submit on behalf of each Southern country. The World Bank, UNDP, UNEP and UNIDO are the only multilateral bodies acting as IA. In the first years, there were also many bilateral IAs, in particular governmental development agencies such as DfID, CIDA, USAID, GTZ and so on. Most bilateral IAs have stopped operating after 2000. So four UN agencies are reproducing these project blueprints in country after country. Competition between IAs is intense and the host countries pick and choose between the IAs.

In dollar terms, 81% of all MLF funded projects were "investment projects" involving new equipment, the rest were institutional strengthening, training, technical assistance, demonstration projects etc. (all data in UNEP/Ozl.Pro/ExCom/61/13, consolidated progress report 2009). Of these investment projects, 73% occurred in insulation foam production and refrigeration sectors. The bulk[1] in dollar terms and in project numbers paid for machines using CFC replacements to produce insulation foam and for machines dealing with refrigerant liquids circulating in cooling units of all sorts. With these investment projects, UNDP moved 292 mio$, UNIDO 224 mio$, World Bank 317 mio$ and UNEP 13 mio$ until Dec 2009. In most countries, the same IA that ran the CFC projects have now set up HCFC projects in the same country.

When only (4) UN agencies compete with each other, this particular "nature" of competition should be urgently scrutinised or at least efforts made to document it !

[1] For the second mayor sector for CFCs, foam, five categories were used: general, flexible PUR, integral skin, polystyrene and rigid PUR (UNEP/Ozl.Pro/ExCom/16/20). This material related differentiation, into 5 categories, was possible because the equipment involved in each category is quite distinct.

The principle of incremental cost of a CFC replacing investment was meant to assure that funds are used effectively. The MLF intended to evaluate what investments would happen otherwise and "incremental" meant to correspond to the part replacement of the CFC only. "Incremental" re-appeared in Kyoto as "additionality" (and contrary to Montreal, it survives in the Kyoto Protocol implementation). The MLF never managed to operationalize such an economic assessment because it was analytically not possible to disentangle product quality, product diversity, raw material prices involved in an investment for new refrigeration equipment, neither in industry, commerce or in other sectors[2]. Instead of incremental cost, cost factors in 'US$ per kgODS replaced' were used to distribute these funds because it was the only realistic option. Knowing how much CFCs each country consumed, the funding available was non-negotiable. For CFCs, these were agreed in 1995 (UNEP/Ozl.Pro/ExCom/16/20) and never changed.

The operational needs of the MLF implementation, embodied in these cost factors, have been maintained across all economic sectors, countries and most importantly all technologies. Whether it was a small workshop in Lesotho repairing refrigerators or a hotel operation in Mauritius, 13.76 $/kg of CFC were spent, the same for all possible activities in the domestic refrigeration sector. 15.21 $/kg was used in the commercial sector. No matter what economic context, what skill level the technicians or what growth prospects, all investments were treated with either the domestic or the commercial cost factor. No other distinction was possible only domestic vs. commercial. Reduction of complexity to only two categories was unavoidable. Treating all countries and all technologies the same obviously implies inefficiencies. Economies of scale inherent in refrigeration technologies translated into large profitable companies receiving contributions to new production machines they would have otherwise just as well financed themselves, whereas small companies were offered too little funds so that they could not invest in new technologies and in cases actual closed down. UNIDO stated that phase-out implies substantial increased operating costs for one enterprise but cost savings for another enterprise

[2] Incremental unavoidably also involves subjective factors and these require a suitable process to approximate companies' decision criteria. In the KP, it was also not possible to define investment analysis, even the World Bank refused to propose a general approach while the KP secretariat tried several routes and still maintains it as a goal.

(UNIDO 2009:187) in the same country. At least one IA is honest enough to admit the key deficiency of the MLF disbursement format.

For HCFC-22, all foam is treated as one category, so even less differentiation than for CFC. After 2.5 years negotiation following the 2007 decision, parties agreed:

HCFC phase-out in the foam sector

> *Incremental operating costs for projects in the foam sector will be considered at US $1.60/metric kg for HCFC-141b and US $1.40/metric kg for HCFC-142b consumption to be phased out at the manufacturing enterprise*

HCFC phase-out in the refrigeration and air-conditioning sector

> *Incremental operating costs for projects in the air conditioning sub-sector will be considered at US $6.30/metric kg of HCFC consumption to be phased out at the manufacturing enterprise* (UNEP/OzL.Pro/ExCom/60/54)

Neither UNEP, MLF nor any party published an economic assessment why 6.3$/kg HCFC-22 is suitable, for example by comparing costs of a chiller with HCFC-22 to a chiller with a non-HCFC. Nor was there any scrutiny or controversy among several assessments as would be normal negotiation matter. The factor was determined by dividing the funding likely to become available by the total volume of HCFC-22 in Southern countries (elaborate projections by ICF for the World Bank concluded 573,000 to HCFC-22 in all Southern countries in 2015)[3]. The MP insiders I know and plausibly most MP insiders, admit this only off the record. There is a cost factor for HCFC-22 in refrigeration because there was only one for CFC in refrigeration. It was bad in 1995 and still so in 2007[4].

One could also add observations such as the US government being the most generous of all OECD parties to increase this figure, but this doesn't add to the conclusion based on the fact that economic assessments were not used. In regime theory terms, the willingness to pay more from the US was evident in the 1980s (Breitmeier, 1996:249). Many accounts of the ozone secretariat and the MLF have come to conclude that these are weak

[3] ICF (2007) confronted a lower HCFC-22 projection prepared by the Chinese Ministry of the Environment for which I had been advising the Ministry while working for GTZ-Proklima, Both ICF's and SEPA's projections were discussed at 19th MP MOP.

[4] The MLF's evaluation studies contain evidence of compliance with MLF regulation http://www.multilateralfund.org/Evaluation/evaluationlibrary/default.aspx

institutions, unable to shape the ozone regime or to make it evolve from the state it has since 1987-1990, the period it achieved its final form as Montreal Protocol (Bauer, 2007). The MLF and the ozone secretariat are able to contribute to regime maintenance only. Bauer reveals well the asymmetries in the triangle MLF, Ministries of the Environment in host countries and the IAs, that have grown over the years. Here I describe only their impact, their expression on actual work.

The distribution of these funds took precedence over the concern for the effectiveness of ODS replacement investments. The cost factors create a bias for advanced machinery (using non-ODS) produced in Northern countries, and a bias for inherent secondary economic benefits for Southern machinery users. Secondary benefits continue to be a contested arena within the Ministries of the Environment, who draw these funds via the IAs. Environmental governance among Southern countries means MLF funds remain highly effective in some countries and prone to corruption in so many others.

The institutional inertia of the Montreal Protocol persists and UNDP, UNEP, UNIDO and the World Bank continue to compete intensely among each other to guide Ministries of the Environment on drawing MLF funds for HCFC-22. With the Chinese near-monopoly (~95% of production worldwide) only she will see her HCFC-22 exports and Air-conditioners exports disappear slowly. The competition between UNDP, UNEP, UNIDO and the World Bank is the vehicle for the continuation of the North – South cost-benefit share from 1990, even so this share is part of the new problem of massive HFC-134a and HCFC-22 usage expansion.

1.3 The HCFC phaseout management plan for the example of Sri Lanka

As a typical and representative example for HCFC-22 phaseout management plans (HPMP) I summarize the HPMP for Sri Lanka, prepared by UNDP and adopted by the 26th Meeting of the MLF ExCom in November 2010 (UNEP/Ozl.Pro/ExCom/62/48). In 2009, 212 tons HCFC-22 were used, of which 195t in residential Air-conditioners and 12t in industrial Air-conditioners. 12t HCFC-141b are used by two insulation panel producers,

Regnis and Metecno. Regnes is 47% owned locally and thus gets MLF funds, Metecno is 100% Italian owned and gets nothing. Regnis operates two production lines, one with cyclopentane, the other with HCFC-22 as foam blowing agents. UNDP requests on behalf of Sri Lanka 237,560 $ to support Regnis to convert the second line also to cyclopentane.

> The Secretariat reviewed the proposal for the conversion of Regnis. Based on this review the Secretariat advised UNDP that the cost for converting to cyclopentane for an enterprise with consumption below 30 tonnes would require counterpart funding ranging from 50 to 90 per cent which might be economically difficult for the country.
> Following discussions, UNDP revised the proposal and came with two technology options that could be used by the enterprise. These are cyclopentane and methyl formate.
> UNDP advised that the enterprise had been briefed on Multilateral Fund eligibility and funding criteria and, accordingly, the requirement for counterpart funding. It mentioned that the enterprise is financially sound and could cover the difference required in the investments either by retrofitting existing equipment, and will decide whether to invest in completely new equipment and when.
> The Secretariat and UNDP agreed on the final amount of US $18,866 plus support costs for the investment project. (Ozl.Pro/ExCom/62/48, p.11)

The reduction in MLF funding for the only Sri Lankan HCFC using company from 237,560 to 18,866 $ ignores the economics of Regnis' investment and only reflects MLF disbursement rules and its country investment criteria. In 1997, Regnis has received 265,917 $ from MLF to shift one line from CFC-11 to cyclopentane in foam, from CFC-12 to HFC-134a as refrigerant (project SRL/REF/17/INV/06) and Regnis changed the second line to HCFC independently but neither fact is addressed.

88% of all HCFC in Sri Lanka is used to service residential Air-conditioners, to refill the refrigerant slowly escaping from them during normal usage. Actually, the entire HPMP is about Air-conditioner maintenance, the rest is marginal, as in the majority of Southern countries since there is no industrial use of HCFC-22. Two options are evident, incentives for households to replace their old ones with new ones running without HCFC-22, and second, assist 6,500 formally-trained technicians and 5,000 informal sector technicians in Sri Lanka with training, HCFC-22 recovery equipment and/or leakage detectors to reduce the HCFC-22 leaking from the Air-conditioners.

As part of the CFC phaseout plan, 3,700 technicians have received training in the 1990s. Now as part of the 1.6 mio$ HPMP, 428,000 $ are planned for recovery equipment, 302,000 $ for training, and 137,000 $ for retrofit

incentives (these are the largest budget items). Recovery of HCFC-22 can be done with the same vacuum pump equipment as CFC, so those 3,700 who have learned it can continue to do so. However as is the case for investment projects, for service projects too the actual outcomes of preceding CFC phaseout projects are not taken into account either (UNEP/OzL.Pro/ExCom/52/Inf.2). What these 3,700 are doing now with the recovery machines and skills they were offered would be a necessary basis to decide what to fund next.

There are 11 registered importers for HCFC. As part of the HPMP, the Ministry of the Environment will establish a quota system, including restrictions on importing HCFC-based equipment. No details of this system are given in the HPMP. It is also copied from the CFC programmes. For a test, I have written to the Ozone Office of the Sri Lankan Ministry of the Environment and to UNDP asking for the inventory of HCFC-22 chillers, no response. Possibly the inventory allows to assess the quota system.

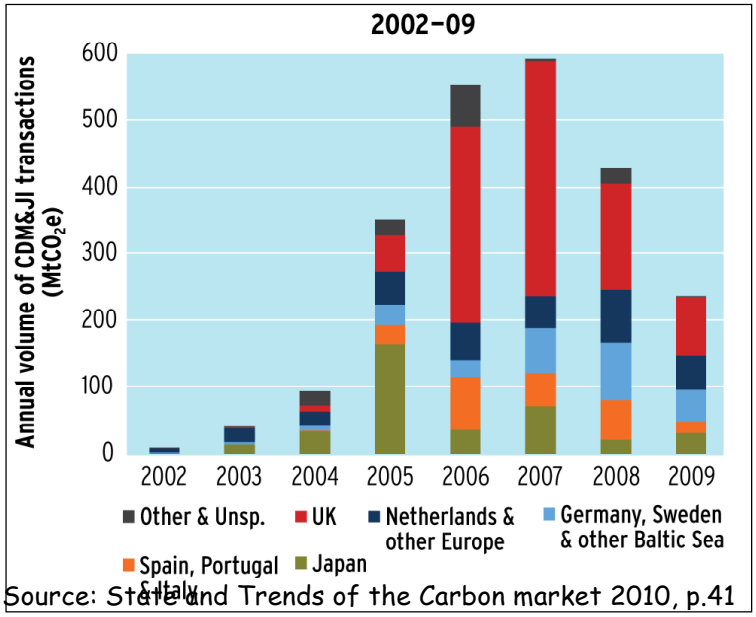
Across the South, all HPMPs continue to use simple cost factors and the same project blueprints to deal with HCFC. These are even less warranted than for CFC because HCFC-22 appears in a narrower range of equipment. Only the relative budget size of these blueprints can be adjusted to country specific conditions.

1.4 Conclusions about Montreal Protocol and HCFC-22

IA business interests seem the only plausible explanation why no questions about the differences between CFC and HCFC are asked, the change in geography, equipments and economics remains unaddressed. It might be an exaggeration to accuse IAs of perverting the MP to get more funds. The MLF needed and created a short-cut around the "incremental cost" and funds were spent on volume and totally ignoring the recipients. The four IAs effectively control who gets funds. On occasion, an IA (UNIDO) admits it. The Sri Lanka case shows that UNDP uped the budget, the recipient did it anyway on its own, and the MLF argued the budget back down. The influence of the Sri Lankan Ministry of the Environment and the Sri Lankan company is low, as in most countries, whereas those in China or India dictate the terms.

2.1 The Kyoto Protocol

The Kyoto Protocol's foremost mechanism, the Clean Development Mechanism (CDM), relies on OECD countries creating markets for Southern emission reductions, known as cap-and-trade systems. The European Emissions Trading System (ETS) regulates the largest 11,000 energy consuming plants in Europe. Each of them decides whether to reduce their own emissions or purchase emission reduction certificates in the carbon markets from the South. The EU decides the cap, thus quantifies a goal of X mio. tons CO_2 to emit, companies choose to reduce their own emissions or pay for Certified Emission Reductions (CER: 1 ton CO_2), representing avoided CO_2 emissions in Southern countries.



Source: State and Trends of the Carbon market 2010, p.41

This chart shows how many CERs European companies bought, rising quickly to 600 mio CERs p.a. in 2007 before declining with the uncertainty about the future of the Kyoto Protocol after the end of the first KP commitment period in 2012 (and US domestic politics). German companies are less active than in the UK, reflecting a preference for in-house reductions although the specific cost per ton CO_2 avoided is much higher in technologically more advanced plants than in Southern countries.

After 2005, when all rules were in place, primary investments in CDM projects have been 3 – 6 bn US$ annually (World Bank estimate). Kyoto is bigger, more sophisticated and fine-tuned but also more costly and challenging to steer than the Montreal Protocol. Crucial is the supply and demand in the CO_2 market, the function that the MLF plays for Montreal.

The rapid increase in CER volumes and the national differences illustrate the market mechanism, the United Nations Framework Convention for Climate Change (UNFCCC) sets commercial conditions for market actors and they decide on the direction and dynamic of the market. Moreover, these actors can propose new rules in a bottom-up procedure. Each CDM project applies so-called methodologies to calculate the CO_2 reduction (thus CERs) and methodologies can be proposed by anyone. Some 400 methodologies, ranging from powerplants to charcoal stoves or composting, have been proposed and the UNFCCC approved 200 of them, as the accounting rules for CDM. UNEP/Risö currently counts 8,000 CDM projects pursued worldwide. Most methodologies are developed for commercial interests of carbon investors such as EcoSecurities or Mitsubishi or of equipment suppliers selling the most efficient turbines, boilers, PV cells, lightbulbs etc.. Other methodologies are developed for policy reasons by the World Bank, NGOs, universities and UNFCCC itself. Judgement of the proposed methodologies by UNFCCC is based on their environmental integrity, irrespective of the commercial or policy interests involved, and all inputs to the judgement are public.

While the merit of CDM is hotly debated, it is generally accepted as playing a strong facilitating role in renewable energy expansion in a variety of ways. Another certain and key effect of the CDM is the transmission of a price signal for CO_2 among otherwise separated markets, for example, between small rural hydropower and large supercritical coal power stations. Thereby creating overall efficiency gains in investment allocations among plants, sectors and countries.

The dynamic of CDM is illustrated by the still evolving market actors. In 2005 governmental funds dominated, in 2006 carbon boutiques blossomed that subsequently folded or merged and the winners such as EcoSecurities or MGM have attracted investors such as JP Morgan, Barclays and BP in 2007. Agrinergy, originally financed from American AES, was the largest to fold and the remains were bought by German RWE. By 2010, a large share of CDM business has been vertically integrated into large energy corporations (explorers and traders of fossil fuels like Vitol and Mercuria). More corporate re-orientation is contingent on the political uncertainty in the UNFCCC negotiations (after Copenhagen, a new start in Cancun and next in Durban). At present, 62% of CERs under Kyoto originate in China, second

India with 11.4% and Brazil at 5%. Countries with no or few CDM projects so far are now getting loans to cover project development costs. CDM's regional impact is indeed changing with Africa gaining a significant share. Commercial judgement of market actors leads to the focus of CER origins and the UNFCCC decides how the rules (methodologies) evolve ("spadework of market making" in MacKenzie 2009).

Having outlined in broad terms the CDM mechanism, as in chapter 1.2 for Montreal and MLF, we now outline the HFC and HCFC issues in CDM. There is one physical link between HFCs and HCFCs, HFC-23, a by-product in HCFC-22 production plants. This was ignored during Montreal and Kyoto Protocol negotiations. This link has thrown a wrench into attempts to shape overlaps between Kyoto and Montreal. AM0001, the CDM methodology for HFC-23, limited to those plants in operation for 3 years, is now "put on hold" as its impacts become evident. Political grandstanding over HFC-23 has not helped consideration of the potential of CDM for other HFCs. It is a unique case and not analysed here because it doesn't reflect the inner logic of either regime. Instead we focus on HFC-134a and HCFC-22 since these are the bulk of these gases.

2.2 CDM project development for HFC gases under Kyoto so far

Prior to 1990, HFCs were not used in significant amounts anywhere. Their rapid spread is entirely due to the need to replace CFCs in refrigeration. All HFC gases are eligible under the current Kyoto (CDM) rules because of their high Global Warming Potentials (as for PFCs and SF_6). No HFC gas affects the ozone layer and so gets no Montreal funds. The most important one is HFC-134a, used in half of all household refrigerators worldwide and many other refrigeration equipment types. It is also one with significant patent royalties for Honeywell, from HFC-13a producers. Ten other HFCs or mixtures thereof are used in lower volumes in narrow equipment types because of thermodynamic properties. Since HFC-134a is by far the most used HFC, the first CDM methodologies target it. Four are approved by UNFCCC:

AMS-III.N Avoidance of HFC emissions in rigid Polyurethane Foam (PUR) manufacturing
AMS-III.X Energy Efficiency and HFC-134a Recovery in Residential Refrigerators
AMS-III.AB Avoidance of HFC emissions in Standalone Commercial Refrigeration Cabinets
AM0071 Manufacturing and servicing of domestic refrigeration appliances using a low GWP refrigerant

AMS-III.N was developed in 2006 by Acme Tele, an Indian company producing Polyurethane (PUR) foam panels. Its main business is infrastructure for telecommunications, also ventures into fuel cells and water technology, it is a globally acting technology corporation. Acme's first version of III.N (submitted as SSC_80) argued that it would invest in new HFC-134a using foam production but instead opts for pentane as blowing agent for the foam. Pentane would involve higher costs because it is flammable, require equipment only available it Europe and most PUR production occurs in the informal sector in India. The UNFCCC secretariat requested III.N to be limited to production for domestic use, 3 years of data to be available and HFC-134a escaping from the foam over time to be accounted for. Acme Tele made the requested changes and III.N was then approved. Soon competitors requested changes (from the UNFCCC), first to include integral skin foam in III.N, and then to apply also to old plants, not only new ones. Jindal stated in its CDM documentation that the additional cost of shifting to pentane compared to HFC-134a is 75,000 $. Then Metecno requested to expand III.N to its production using HCFC-141b (SSC_408), and to make the case, it got a statement from the Indian Polyurethane Association, listing large manufacturers in India:

Company	HCFC-141b using	Phasing out 141b	HFC using	Alternatives used
Acme Tele	No	No	No	Pentane
Metecno	Yes	Yes	No	No
Jindal	Yes	No	No	No
Rinac	No	No	No	Pentane
Sintex	Yes	No	No	No
Lloyd	No	No	No	Pentane
Synergy	yes	no	no	No

Source: http://cdm.unfccc.int/UserManagement/FileStorage/IG5S6D8LEPFVKC102TU73RHBQ9WJAM

Metecno argued that it too could opt for HFC-134a and thus the baseline of III.N would be applicable and it should not be punished for having moved to

HCFC-141b since both were recommendations from Montreal Protocol. This demand to expand III.N was rejected because "hypothetical baselines are not appropriate" under Kyoto rules. The last effort to enlarge III.N was made by Maersk in China (SSC_431), to use it for the production of shipping container insulation and was also rejected. In Sept 2009, Acme Tele finally had its CDM project in final form and it was formally approved by the CDM Executive Board in October. It yields 25,000 CER p.a., at 8 $/CER a substantial contribution to the investment in foam manufacturing.

These companies had the same technology options and chose particular foaming equipment, often on price and positioning in the Indian foam market, and the blowing agent was a minor issue before CDM appeared. Four of them invested in developing CDM projects. No foam company outside India is using the CDM so far. Without knowing how these four evaluate the investment decisions[5], it is plausible to assume that in this country, among those kinds of companies and for those kinds of products, CDM projects are expressions of their commercial strategies. For other countries, other companies and other products this is not the case so far.

AMS-III.X, the second CDM methodology affecting HFC, was developed by Bosch/Siemens Hausgeräte (BSH) and the German development agency GTZ (I was part of this cooperation). BSH tends to dominate the upper price range for households appliances. In Brazil, it managed to gain market share by selling refrigerators to Brazilian utility companies who distribute them to poor households in Favelas (Brasilian slums)[6]. GTZ wanted to create pro-poor CDM projects with an easy-to-use methodology for those households "that can never afford to buy a new refrigerator and always use second-hand ones". The older the second-hand refrigerators, the more they leak refrigerants (and poor maintenance) so poverty multiplies environmental impact. BSH tries to find similar utility companies in China, India and other countries. Eletropaulo of Sao Paulo is the only one so far and once its CDM project is finally approved and registered[7], other utilities hopefully follow. Other refrigerator manufacturers such as Godrej and Videocon in India

[5] The four are unilateral CDM, because unlike most others their CERs remain with the manufacturer to be sold at a later stage, thus betting on increases in international carbon prices.

[6] Either because their political masters told them to or because they attempt to improve their utility operations in Favelas.

[7] http://cdm.unfccc.int/Projects/Validation/DB/ZYPV9HFM96AGO7TCT1VPA776H6G35O/view.html

(AM0071), LG and Samsung in South Korea have chosen different CDM strategies, but their methodologies are costly to apply. "CDM transaction costs" are often prohibitive.

Finally AMS-III.AB was developed by a user of refrigeration equipment, Unilever India. It owns hundreds of thousands of ice-cream selling cabinets that are put in shops offering their ice cream. Unilever replaces HFC-134a with isobutene as refrigerant. Similar companies such as Coca-Cola still use HFC-134a in vending machines. For Unilever there is no economic interest in CDM based on AMS-III.AB because it is a very small part of the cabinets' costs, but Unilever is motivated by marketing reasons.

2.3 Conclusions on the CDM projects for HFC gases

In sum, four CDM methodologies and subsequent projects appeared, each in particular circumstances. Acme Tele, BSH and Unilever are pursing specific commercial objectives. Another HFC methodology that was ultimately rejected, replacing HFC-134a in car Air-conditioners, is another example for CDM project efforts. Using CDM as a competitive tool is opportunistic by design. To judge whether CDM reduces HFC emissions effectively, the main questions concern the influence of potential income from CDM on investment decisions and whether more average companies then embark on CDM as followers (when uncertainties and risks are lower).

For III.N, the answers seem to me positive, for III.X, III.AB and AM-0071 negative. Metecno, Jindal, Rinac and Lloyds Insulations are followers and Acme Tele a stronger innovator and risk taker. Jindal explains in its CDM documents that it started to negotiate with CDM service providers such as PriceWaterhouse Coopers, Deloitte Touche Tohmatsu, Emergent Ventures, Senergy and Zenith Energy after III.N was approved and it took Jindal one year of negotiation to decide from which one to buy the services required. Jindal's additional cost for pentane is 75,000 $, the income from 15,000 CER p.a. at 8 $/CER discounted at 10% has a Net Present Value of 802,000 $ from a total investment of about 1-1.5 mio$. The incentive to replace HFC-

134a is considerable and should be so for the other 260 PUR foam manufacturers in India, and in other countries.

This incentive should also be evident to the specialised equipment manufacturers such as PUMA and Hennecke, so that they offer the PUR producers more machinery using HFC-134a alternatives in the future. The technology choices of manufacturing equipment suppliers have high multiplier effects. For refrigerators, the value chain is such that CDM innovations occur by the manufacturers of equipment, like Bosch/Siemens or LG.

HFCs, like HCFCs, are used in refrigeration in households and industries. So far CDM efforts on HFC have been limited to few companies and few equipment types. In PUR foam manufacturing strong multiplier effects are evident. Few companies are making use of CDM for their commercial strategies, all are technology leaders (in India, Germany and South Korea). The World Bank (with AM0060) and GTZ[8] are the only policy oriented institutions to wade into CDM for HFC and neither of them decided to take it further but for unrelated reasons. The market character and bottom-up orientation in CDM are evident in these CDM projects for HFC, as is the steep learning curve for first movers. Very different CDM types, steel furnaces or power plant equipment, show similarly patterns.

[8] For GTZ, it was the only successful effort ever to produce a CDM methodology. The German Ministry of the Environment funded other methodologies but these were rejected by the CDM authority, so obviously this record reflects only the difficulties in GTZ of creating policy for CDM methodology making and has nothing to do with HFC or the MP.

3. Current interferences between Kyoto and Montreal for HCFC and HFC

Both regimes are prolonged, MP to HCFC and KP to HFC, following their logic. Oberthür (2006) predicts regimes to pass each other like oceanliners at night, ignoring each other, blinded by their own light (logic). For Montreal, what worked for CFC is continued without declared lessons learned. For Kyoto, project development efforts result so far in few companies taking the risks, so the impact is small.

From the company perspective, at least four types of interferences are certain, more from the regimes' perspectives. First, when HFC and HCFC are alternatives for new installations (in industrial plants or for households) MP and KP rules interact. Other interferences appear where MP and KP rules apply differently to competitor companies. Thirdly, some appliances even contain physically MP and KP impacts when an HCFC is in foam and an HFC is the refrigerant. Fourthly, interferences over time, for example, refrigerator manufacturers who replaced both HFC and HCFC 10 or 15 years ago are affected when MP or KP create new incentives changing these options. So there are four types of interferences, resulting from KP – MP rule differences, from technology and via company differences, and then temporal and regional variations of the two.

The four interferences from the company perspective are strengthened or weakened depending on company decision-making. When Regnis' (the Sri Lankan company mentioned on page 9) switched its first line with MLF funds in 1997, it could not anticipate that 10 years later its use of HFC-134a enables it to create a profitable CDM project with that HFC-134a consumption. Regnis changed its second line to HCFC-22 on its own probably because it could not get more MLF funds and so it used it for the more expensive switch to cyclopentane[9]. Thus, the 1997 limits to MLF funds started HCFC. Metecno in India tried CDM being excluded from MLF. Metecno's competitors pursue CDM projects even so some of them are eligible for MLF funding in India. When doing so they gauge their

[9] Both CDM projects and MLF funds lead to cyclopentane as blowing agent (with a factor 100 lower GWP). Cyclopentane has been used for PUR since 20 years and was always available for PUR producers willing to pay more for their machinery.

confidence in the national Ministry's HPMP and compare it to the regulatory risks in the CDM process and the uncertain price for CO_2 in international carbon markets. CDM (in III.N) requires three years production data, whereas MLF has a cut-off in Sep 2007. The first sets a baseline over time, the second prevents production changes after the MP decision was taken. HFC and HCFC using companies such as Regnis can see such eligibility criteria as arbitrary and perhaps choose to ignore MP and KP rules as unpredictable *force majeure*, and in this case they have less influence.

Interferences are specific to industry sectors. Refrigerator production implies other interferences than PUR foam. The former has also geographical patterns (UNEP 2002). Europe, Japan and Middle East countries had already replaced most HCFC and HFC in refrigerators, whereas the US, Latin America and SE Asia rely on HCFC. South Asia and Africa still used CFC. Early actions by strong governments have removed HCFC and HFC uses. Both the MP as well as the KP treat all countries the same. In Latin America, SE Asia and Africa most companies probably wait to for MLF funds before investing and, since they are the majority, the respective Ministry of the Environment in discussion with the IAs anticipating what the MLF approves, decide on the speed and orientation of technical change. The volume of MLF funds creates and solidifies its own pace. Some companies probably cannot take the financial risks of moving faster because a competitor getting MLF funds could undercut its product prices. HFC using companies with the management capacity required can use the CDM to undertake a bigger investment and move to more lucrative parts of the markets, as in the Indian case. Were this to appear in other countries, this effect could be dynamic. Regional differences in HCFC and HFC consumption augment the interferences between KP and MP.

Through its bottom-up setup, CDM project developers can alert to the interferences while the MLF's uniform cost factors exclude them everywhere. Metecno argued in its (above-mentioned in III.N) CDM submission that the influence of the MLF funding in India on its choice of chemicals should be taken into account and the CDM authorities refused (response to request SSC_408[10]). This is logically inconsistent because every CDM project must define anew what the alternative scenarios are and for PUR foam, they compare HFC-124fa, HFC-365mfc, HFC-152a, HFC-134a

[10] http://cdm.unfccc.int/UserManagement/FileStorage/GA98M3VYI4B6FW2COH05RQLJKDSXET

and pentane as potential blowing agents. HCFC-141b is the most plausible alternative and this is not hypothetical as the CDM authority wrote in its response to Metecno. This is an excuse and a defensive exaggeration of KP rules by the "Methodology Panel". So here the interference appeared but was not resolved[11] (future CDM rule-making could be more ambitious).

For the MP, costs and benefits differ among companies more than among countries, while the KP rules address these differences to an extent in the definition of business-as-usual and additionality at the level of each CDM project. The MP is a crude watering-can in light of company differences, technology differences and country differences. For the MP's extension to HCFCs these differences are bigger than before for CFCs. The KP creates carrots (incentives) that so far seem insufficient for HFC. The insufficiency is augmented by companies choosing to wait for the funds that the MP makes available for HCFC phase-out (HPMPs).

Regimes ignoring each other as in Oberthür's oceanliners-at-night metaphor is one issue when the interferences result from country differences since both regimes must apply to all countries. Both KP and MP have created voluminous documents for the interferences but nowhere are these really dealt with. This might be *Realpolitik*, the CDM authorities and the MLF resign quickly because each regime has a fragile North/South balance. Mutual ignoring is, on the contrary, entirely avoidable when interferences result from technology and company conditions. Both MP and KP rules can differentiate for technology, products and business economics. Most of this ignoring appears to be community-of-experts habits, for example continuing to deal with HCFC as they dealt with CFC. CDM methodologies would allow to address the interferences and to include criteria (eligibility, baseline, additionality) for past MP funding decisions.

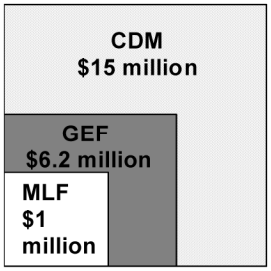
- interferences in HFC and HCFC are not reflected in KP and MP rules
- interferences are variable but treatable with already used criteria
- the "watering-can" funding of HCFC replacements is intrinsic in MLF operation
- KP is weakened by MP because companies anticipate the impact of MLF funds by their competitors

[11] A first effort to address this was during CDM Executive Board meeting EB34 (2007), see http://unfccc.int/resource/webcast/cdm/eb34/downl/Annex%20A%20gases.pdf

4. Ideas for the future

What improvements of the MP and KP implementations would allow to deal with the interferences ?
Several proposals for HFC and HCFC have appeared. HCFC replacements cost can arrive at 1 bn US$ via the MLF (replenished from OECD countries). The MP secretariat provides expert fora to produce the necessary justifications. Some G8 policy proposals reflect the historic sequence of events, large MLF funds were spent before the KP was defined and discovered that the ODS replacement HCFC-22 became a Greenhouse problem because the volumes increase. Implementing Agencies (IAs) act out of budget interest and the World Bank and UNDP fail to deal with the nature of the HCFC-22 and HFC-134a economic interests.

The World Bank proposes to add the funding mechanisms in a top-down manner and to undertake this assembly itself. Each country would get an overall programme, combining 3 and more sources of funding to pay for replacing HCFC using equipment:



Source: "Leveraging Support for HCFC Phase-out: Opportunities and Modalities for Pursuing Linkages with the Climate Change Agenda", World Bank, 28th OEWG, 2008 [12]

This proposal has the advantage of speed, however, it does not address the incompatible aspects such as MLF funds in relation to volume used, versus CDM income in relation for CER prices, and many more. The body to get the MLF funds, the GEF funds and the CDM incomes would act beyond the current MLF, GEF and CDM rules and would have to be exempt from them, an implausible solution (especially from the WB).

The US proposes (together with Canada and Mexico, UNEP/Ozl.Pro.22/5) to leave HFC gases in the KP as they are now while also spending MLF funds on

12 http://siteresources.worldbank.org/INTMP/Resources/HCFCflyer_June2010.pdf?&resourceurlname=HCFCflyer_June2010.pdf

HFC reduction. This proposal has reappeared at several Meetings of the Parties to the MP (again in Nov 2010 in Bangkok). Especially China and India continue to reject this. Micronesia proposes a different HFC inclusion to MP, with a more aggressive phase-out schedule until 2030 (UNEP/Ozl.Pro.22/6), reaching the quantitative goals 5 years earlier than in the US proposal. The US and the Micronesia proposals do not address the differences between KP and MP nor do they modify either one. They maintain the co-existence of conflicting regimes while addressing HFCs with the same MLF funding approach that was used for CFCs. None of these proposals compares advantages and disadvantages of MP and KP even so these are quite distinct in light of the HFC and HCFC usages. The above discussed interferences would also be strengthened when MLF funds become available for HFC in parallel to CDM projects.

4.1 Industry context for HFC and HCFC uses

Leaving again political interests or factors aside, what aspects of the technologies involved should be addressed so that the experience of MP and KP speed up HCFC and HFC phase-outs ?

HCFC is dominated by Air-conditioners in households, so a mass consumer market where a small number of large corporations compete. These corporations produce thousands of different AC models, introducing new designs rather rapidly and maintain a cut throat margin competition among them. In this technical and corporate context, mass consumers and a small number of huge corporations, the most effective way of HCFC-22 phase-out is to assure these corporations include it in the normal course of their innovation. Chinese Haier, Greee, and so on, American Whirlpool, Maytag and so on, South Korean, German, Mexican and Brazilian multinationals are beyond one government's reach. Only three of these ventured into CDM, BSH, Samsung and LG but so far they fail to use it for their marketing[13]. A key aspect is the principle-agent problem, households' preferences are limited to the ACs available in a shop and their preferences are far removed from the reasons that make the multinationals choose technologies. The main driving force at present are the energy labels in Europe or Japan,

[13] Only one methodology was proposed for ACs (NM72), by the Ghanaian Energy Association, and unfortunately rejected by UNFCCC. It is quite telling than only a small Southern NGO pursued this energy use expanding massively and creating large demand peaks for power.

leading to a succession of innovations, but these are not required in Southern countries and margin competition among producers keeps new efficient appliances out.
HFC is a quite different technical and corporate context because most is used in larger installations so the number of consumers is not many millions of households but thousands of plants or commercial units such as supermarkets. The HFC using equipments are not produced by a few multinationals but there are many producers in each country specialising in certain types of customers. This is the case for HFCs as refrigerants, for example in chillers, and for HFCs as blowing agents. The companies producing chillers and those producing foam blowing machines are medium sized companies, quite technology oriented, using patent protection, and the number of units of one batch or model is often only a few hundreds. Production is not automatized but using skilled craftsmen.

4.2 HFC and HCFC technologies as types of innovation

This opposition of the industry context between HCFC and HFC corresponds well to innovation types defined in economics. A broad school of Schumpeterian economics nowadays informs innovation policy, R&D strategies, selections of research funding criteria and theories about transition to sustainability. This school uses historical assessments of innovations, observations in corporate laboratories and data on patents and R&D. Nelson and Winter's "An Evolutionary Theory of Economic Change" from 1982, and Giovanni Dosi's "Technological paradigms and technological trajectories", also 1982, are the starting points of the renewal of Schumpeterian analysis that had placed the entrepreneur at the centre of economics. Some call it the "Sussex-Yale-Stanford-synthesis", referring to the universities where the most influential researchers are located. Their common denominator is that firms acquire technology capacity that pre-determines their R&D and future products. The organisational properties of firms, how they scan information, hire people, reward them, try products and capture competitive advantages together create certain trajectories. Computers, drugs, plastics, planes as well as consumer white goods are prominent industrial sectors where research reveals furthermore how successful firms copy these organisational properties from each other. The

OECD is a proponent of this school of economics and translates it into influential economic policy. Current methodological problems are to overcome the variety of case studies and their idiosyncrasy and formalise variables that allow to model innovation in firms. The rediscovery of the importance of institutional issues is visible in many fields of economics.

HCFC and HFC related technologies are suitable objects for this economics because they are of course products of recent industrial innovation and the companies who invented HCFCs and HFCs are the standard objects of analysis in this school. A popular innovation typology was produced by Pavitt (1992: 216, 1984: 354, at SPRU in Sussex University):

Basic technological trajectories (right column added)

Definition	Source of technology	Trajectory	Typical products	Innovation drivers	CDM barriers
Science-based	R&D laboratory	synergetic new products	electronics, chemicals	scientists, patents	Additionality
Scale-intensive	production engineering and specialized suppliers	efficient and complex production and related products	basic materials, durable consumer goods	political power	Baseline is policy
Information intensive	software / systems dept. and specialized suppliers	efficient (and complex) information processing, and related products	financial services, retailing	marketing, advertising	Monitoring
Specialized suppliers	small-firm design and large-scale users	improved specialized producers, goods	machinery, instruments, speciality chemicals, software	techno-economic paradigms	Integrated systems, „conservative ness“

Pavitt used large databases of patents to define these four trajectories for innovation (the rows). The columns are the major aspects of these trajectories which together distinguish them. "Source of technology" is the type of firm or department of the firm providing the main innovation elements. "Trajectory" are the properties of the products that define their succession or quality improvements. "Typical products" are the sector where the trajectories appear most often. "Innovation drivers" are the key decision makers, who or what maintains or changes the trajectory.

What does this description of technological trajectories imply for Kyoto and Montreal Protocols regarding HCFC and HFC ?

HFCs are in many cases in a specialized supplier trajectory (bottom row of the above table) and innovations happen when suppliers agree with important customers to pursue alternatives. This is also adequate because alternatives to HFC-134a as refrigerants require new skills among the users, for examples chillers using HFC-134a are replaced with chiller using ammonia or CO_2 as refrigerants. Equipment suppliers also provide training and information to ascertain these skills. HFC-134a phase-out efforts can target specialized suppliers' ability to provide these. The interaction between specialized suppliers and customers varies between countries in particular with the presence of industry associations. Industry associations provide neutral and trusted platforms that facilitate coordination. This is a function that the MLF is more suitable to fund and the relation between Ministry of the Environments and Implementing Agencies (IA) can be effective. The MLF would define how chiller suppliers and chiller operators exchange information and how specialised suppliers can be paid for enabling operators to acquire skills for alternatives to HFC-134a. Metecno's use of the PUR industry association statement is a case to the point. HFC phase-out is effective when pursued by a neutral industry body that helps specialized suppliers and their customers cooperate. Rather than funding individual HFC-using companies at the discretion between IAs and the national Environment Ministries, the MLF would pay for enabling information services to replace HFC uses.

HCFC is in a scale intensive trajectory (second row) because Air-conditioners are produced in automatized production lines, each with more than 100,000 up to 1 mio. units per year. It is not possible to change the principle-agent relation. Multinational corporations pursue elaborate marketing strategies. The MP instruments are not adequate because not only are the corporations beyond government control, but their margin competition cannot be influenced by uniform funding cost factors. Neither Kyoto nor Montreal are regimes where political power is build up to affect large systems. Multinational companies cannot be incentivised with CDM projects income from CER sales, nor from the funds available from the MLF. These companies are not able to let their marketing strategies be influenced by funds from MP or KP. Multinational companies can easily replace all

HCFC-22 in Air-conditioners with alternatives, refrigerant choice is a minor issue to them (irrelevant costs), it is predominantly a question of who can assure that they all must do it at the same time. The innovation process in AC (as in many household appliances) can be influenced by measures that address the scale-intensiveness.

5. Final remarks

Two CFC replacement chemicals, HFC-134a and HCFC-22, are significant contributors to global warming, although replacements for all uses are tested and already realised in some countries. The MP blueprints are less adequate for HCFCs than for CFCs. This paper tried to demonstrate this with evidence from MP documents that companies' reasons for replacing HCFCs are not reflected in HPMPs. In the non-investment part of HPMPs, where HCFC-22 is used for AC servicing, the continuation of the MP operational rules is particularly unsuitable to reflect what MP did with CFCs. The MP inertia is an expression of bureaucratic reproduction in the triangle between MLF, Ministries of the Environment and IAs, probably including "donor dynamics" among the governments providing MLF funds. Regime theory distinguishes inertia from cognitive factors in the expert community, from economic power of chemical companies, from arena interactions around the MLF and from control of solutions by insiders. This paper points to the latter since the inadequacies of HPMPs are so evident. It is not a policy-practice gap as in many development areas.

The division of HCFC for MP and HFC for the KP is a historical accident. That HCFC-22 is the only HCFC that depletes stratospheric ozone has no reflection in the differences MP – KP. The division HFC under KP and HCFC for MP makes mutual ignoring the easy solution especially because regional differences in foam and refrigerants redistribute costs and benefits between countries that is not reflected in the decision-making bodies of each regime. The mutual ignoring goes beyond what would be obligatory via

the difficulty to discriminate between Southern countries and is also due to regime inertia.

Montreal's North-South bargain divides cost and benefits between countries whereas Kyoto's North-South regime leaves the additionality to be established for each project and the criteria for business-as-usual to be determined in each methodology. This difference between the two regimes also creates opportunities to shape their interferences. The inertia of Montreal is most evident in the absence of basic adaptation to HCFC usages' economics, what happened for CFC is simply repeated. CDM methodologies could include criteria about past MLF funds, in other words, Kyoto rules can and should refer to Montreal outcomes. CDM methodologies could address the MP outcomes but this has not occurred and several unforeseen corrections were required (AM60 and AMS-III.X). And vice versa, the distribution of MLF funds can reflect the CDM projects that appear in a sector and country. But neither do Kyoto rules reflect Montreal nor vice versa. Not referring to rules of the other is another manifestation of regime inertia. The Kyoto Protocol implementation, the creation of CDM projects, is more hampered by the companies waiting for MLF funds, than Montreal is affected by Kyoto. Both can benefit significantly by aligning rules for HFC and for HCFC.

Besides "harmonising" regulations and their implementation, the defining principles of each regime can also be scrutinised for their relative effectiveness with the help of the industrial innovation economics. This would reduce the watering-can character and strengthen the carrots alike. Technological trajectories indicate that HFCs would be better addressed with Montreal than with Kyoto, especially if the MLF gives funds to industry association – type activities (totally unlike CFC because there CFC producers were all OECD-based chemicals corporations). The innovation character of the HFC substitution should be effectively addressed with MLF means, but not by continuing what was used for CFCs. Addressing the innovation character might help to call for changing MLF implementation.

Large regional differences in foam blowing agents make Kyoto's additionality and BAU tools more effective for HCFC than Montreal could ever be. CDM methodologies' arguments are public and the public nature has already been purposefully used by HCFC users. Users could furthermore address

Montreal – Kyoto interferences in their inputs and they should be invited to do so in a transparent format. Certainly there will be many occasions in the CDM process to account for MLF funding outcomes while there is nothing in the MLF that would weaken its inertia.

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Abbreviations

CER Certified Emission Reduction
CDM Clean Development Mechanism
CFC chlorofluorocarbons
HCFC hydrochlorofluorocarbons
HFC hydrofluorocarbons
HPMP HCFC-22 phaseout management plans
MLF Multilateral Fund for the implementation of the Montreal Protocol
ODS Ozone-depleting Substances
UNFCCC United Nations Framework Convention for Climate Change