Rethinking Development in an Age of Scarcity and Uncertainty
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Does the right hand know what the left hand does?

Similar Problem, Opposing Remedies – A Comparison of the Montreal Protocol and Kyoto Protocol's Clean Development Mechanism

1. **The Overlap between the Montreal Protocol and the Kyoto Protocol: Statement of the Problem**

The Montreal Protocol (MP) and the Kyoto Protocol (KP) are led by different actors in separate processes and they have developed an institutional overlap because each one deals with chemicals used for the same purposes and in the same machines. In the design of policies and methods by the two conventions to support the substitution of these chemicals, different methodologies and funding criteria are applied which lead to different results. Neither the Montreal nor the Kyoto Protocol have managed to address this overlap. The MP funds the replacement of hydrochloro-fluorocarbons (HCFCs) and the KP the replacement of hydrofluorocarbons (HFCs). This division between HCFC and HFC leads to significant interferences between the MP and the KP: The inertia of both regimes as well as diverging interests among the Group of 77 (G77) and the members of the Organization for Economic Cooperation and Development (OECD) make the elimination of the overlap or a reduction of its negative effects unlikely. Due to different interests a comparative assessment of the KP and the MP is difficult and none has been published so far.

The perspective of the recipient side (companies) as the basis for such an assessment is explored. Since both the MP and the KP seek to accelerate technical change, this paper proposes a new solution to overcome the overlap and resultant lack of impact using the *technological trajectories* from Schumpeterian or evolutionary economics.

This paper first describes the MP operation in general (3.1) only as far as necessary to then account for the MP extension to HCFC (3.2 for the example of Sri Lanka). The extension of the MP to HCFC is then summarily judged (3.3) very briefly and without attention to the negotiations that took place, because the paper seeks to pursue only the direct industrial and technical conditions. Similarly, the general operation of the KP is described (4.1) in order to understand the applications of the KP to HFC that occurred until today (4.2). This description of the KP is too selective to judge the KP as such but it should be enough to see what motivates the companies to put the KP to use and allow to judge the strength of the incentives the KP can offer for HFC replacement (4.3). With this empirical description of the MP used for HCFC and the KP used for HFC, it is then quite obvious (5) to define four types of interferences, and illustrate the comparison metaphorically, the MP as a watering-can and the KP as carrots. The paper seeks to illustrate without ascribing blame or credit for this outcome. The cause for the interferences is not the companies or the politics but the cause is only that HCFC and HFC are used for the same purposes. Finally chapter 6 deals with the future. First by briefly describing the current proposal to extend the MP a second time (by the World Bank and the US), to HFC (6.1), and then by proposing to use innovation economics (6.2) to better separate what the MP and what the KP is used for.

2. The technical problem: HFCs and HCFCs, a Comparison

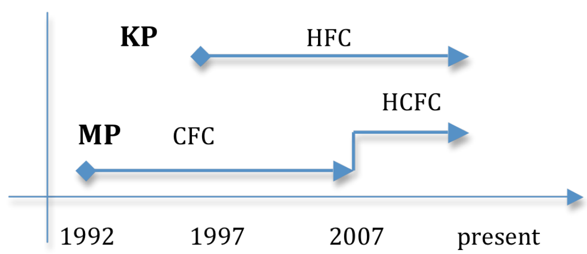
The comparison of HFCs and HCFCs clarifies the problems arising from the interference between the MP and the KP. Most HCFCs and most HFCs are used for the same purposes, and are mainly found in refrigerators, air conditioners (AC) and other appliances for cooling. Of several HFCs and several HCFCs only two, HFC-134a and HCFC-22 are important for climate change because they are used in 100,000s tons each year. All other HFCs and HCFCs are used only in smaller quantities. HFC-134a and HCFC-22 both were first introduced as replacements for chlorofluorocarbons (CFCs), in other words, both spread rapidly in the1990s when the ozone hole was an urgent problem and it was felt that CFCs had to be replaced as quickly as possible.

Table 1: Comparison of Overlapping KP and MP gases	HFC-134a	HCFC-22
Contained in refrigerators, air conditioners (AC) and other electrical appliances for cooling	yes	yes
Global emissions estimated for 2015	1.15 Gt CO_2e[1]	0.8 Gt CO_2e
Global Warming Potential GWP compared to CO_2	1,410 times	1,780 times
Increase in concentration in the atmosphere 1998 - 2005	27 %	38 %
Replacements	hydrocarbons, NH_3, CO_2	

Source: Intergovernmental Panel on Climate Change: IPCC 2005, SPM-4

One difference between HFC-134a and HCFC-22 is however relevant for the division between MP and KP. HFC-134a has no effect on the atmosphere's ozone layer, but HCFC-22 has an "ozone-depleting potential" (ODP) of 5% compared to CFCs. Because of this difference, parties to the MP have claimed and succeeded in justifying the inclusion of HCFC in the MP in 2007.

Graph 1: Conventions and Eligible Gases



Air conditioners (AC) are a particular problem in terms of resilience because of the negative feedback loop (demand for air conditioning rises with average temperatures) and high sensitivity of demand to economic growth[2]. 80% of the global sales of ACs stem from Chinese manufacturers and contain HCFC-22 (BSRIA market research). By replacing HCFC and HFC, GHG emissions could be reduced significantly without reducing the use of ACs because their replacements[3] have GWPs between 1 and 5, compared to 1,410 and 1,780. There are no thermal efficiency differences since high efficiency AC with HFC-134a is as efficient as high efficiency AC with HCFC-22, all of these chemicals cover the whole range of highest to lowest thermal efficiency depending on the appliance price (quality of manufacturing).

[1] Gigatonnes of carbon dioxide equivalent.

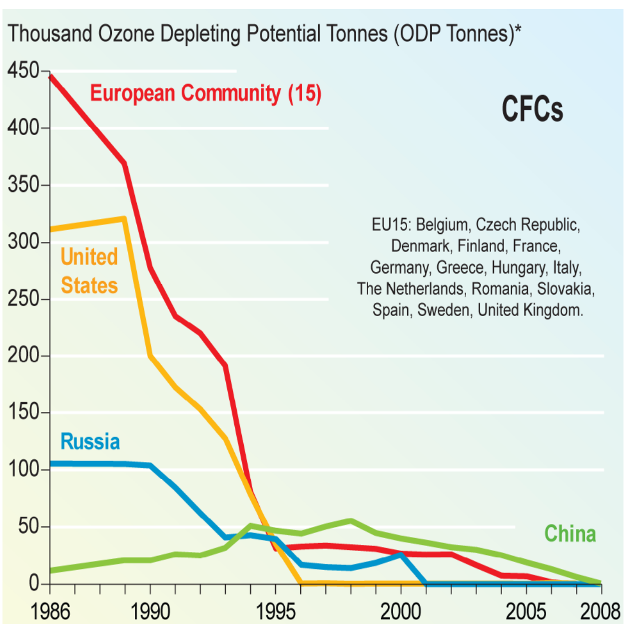
[2] For example, in peak times of summer in the Gulf states, ACs are responsible for the exceptionally high daily load variation in the electricity grid of 20% (Lennox 1996).

[3] Most replacements are simple hydrocarbons, mainly isobutane and cyclopentane. Large cooling units use also NH_3 and CO_2. There are no technical or economic barriers for any of these replacements. The same simple hydrocarbons are also used in CDM projects to replace HFC-134a. For example, Regnis replaces HCFC-22 with cyclopentane with the MP, while Acme Tele substitutes HFC-134a with pentane as CDM.

3. The Montreal Protocol: How Ozone-depleting Substances (ODS) Are Regulated

Since 1992, the MP has funded investments which replace ODS with alternative chemicals that do not harm the ozone layer, focussing CFC-11 and CFC-12, which were used mainly in refrigeration. Other ODS such as Halon or Methylbromide played a much smaller role. Developing countries agreed to phase-out all CFCs by 2010 if all conversions of CFC used were funded. Thus the MP made OECD countries pay proportionally to their GDP for the replacement of CFCs in developing countries, as those had been produced by OECD based companies (e.g. DuPont, Dow, ICI, Atochem, Hoechst). So far, the MP has disbursed 2.6 bn US$ through the MLF, its financial institution established in 1991. In OECD countries, CFCs were replaced by 1995. Most developing countries completed their phase-out by 2008, ahead of the agreed target (2010). The following graph illustrates how the total global production of CFCs was brought down very rapidly. Therefore, the MP is considered as the single most efficient environmental treaty.

Graph 2: Global production of main ozone depleting substances (ODS)



Source: UNEP, Vital Ozone Graphics 2.0

After eliminating CFCs (chlorofluorocarbons) in all development countries, the MP has been extended to HCFCs at the 19th Meeting of the Parties to the MP, in 2007. In this paper, one example of a HCFC phase-out plan will be described in order to show that the practice of the MLF has not changed due to an institutional path dependency and due to bureaucratic inertia in the triangle composed by MLF, Implementing Agencies (IAs) and Ministries of Environment.

As HCFC-22 is cheap and can be used to refill existing CFC-using equipment, it was considered a quick remedy in 1992 despite its small ozone depletion effect. Fifteen years later, this was reversed and it was agreed to extend the operation of the MLF to HCFCs and fund their replacement. This “double phase-out” had previously been rejected by some parties to the MP as absurd: i.e. to first fund the introduction of HCFC-22 in order to replace CFCs; and, since 2007, to fund the phasing out of these HCFC-22 in order to switch to alternatives with zero ozone-depletion and zero global warming potential (GWP). While the MLF paid for a problem originating in OECD countries (CFC producers), it now pays for getting rid of HCFC-22, 80% of which comes from China (2012: China produced 353 ktonnes HCFC-22, all OECD countries 90 ktonnes, McCulloch 2010). An unforeseen regional bias in the MLF in favour of China has been created (we'll later return to this "regime inertia"). And why did this happen and why is the disbursement procedure via the MLF (proposals, evaluation, controlling) maintained for HCFC-22 without assessing the technical and economic differences between CFC and HCFC-22?

We next review the key aspects of the MLF operation as they were applied for CFC and continue for HCFC. Privileging the implementation side over the negotiation side of a climate convention requires justification but in this paper it is simply taken as a premise. Ch. 3.1 to 3.3 describe HCFC project implementation to suggest therein lie the reasons for this continuation from CFC to HCFC, and to then further strengthen this argument by describing the overlap between MLF and the KP projects.

3.1 The Multilateral Fund: How Funds are Distributed and Managed

What was thought to be a strength - the possibility to cover the so-called incremental costs[4] - has actually been a weakness of the MP: it was never put to practice. For both HCFC as before CFC, MLF funding is available only in relation to the volume of the chemicals used, irrespective of the user's costs/benefits. The MLF has funded some 30 project types in all developing countries, for example, maintenance of refrigerators, recovery of CFC from chillers, replacing CFC as insulation foam blowing agent, etc.. In total, 6,104 individual projects were approved and realised (MLF consolidated progress report 2010), the same blueprints used in all developing countries by the four "Implementing Agencies" (IA): the World Bank, the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the United Nations Industrial Development Organisation (UNIDO). These four institutions have the exclusive right to write project proposals to the MLF and submit them on behalf of developing countries, the more so as most of the bilateral IAs, in particular public development agencies

[4] Cost difference between technology with and technology without CFC use.

(DfID, CIDA, USAID), have stopped operating in this arena after 2000. Thus, four UN agencies reproduce the project blueprints in all developing countries[5].

The principle of incremental cost was chosen to assure the effective use of the funds. The MLF intended to evaluate what investments would happen in a business as usual scenario with use of ODS substances, and in comparison defines the "incremental" cost of an investment which replaces CFC. The MLF never managed to operationalize such an economic assessment because it was analytically impossible to disentangle product quality, product diversity, raw material prices involved in an investment in new refrigeration equipment, neither in industry, commerce, nor in other sectors[6]. Instead of incremental costs, cost factors of 'US$ per kg ODS replaced' were used to allocate these funds as the only realistic option. Once the consumption of CFCs by a country was defined, the funding available was non-negotiable. For CFCs, the cost factors were agreed in 1995 (UNEP/Ozl.Pro/ExCom/16/20) and never changed since then.

These cost factors have been maintained across all economic sectors, countries and, most importantly, all technologies: Whether funds were provided for small workshops in Lesotho replacing CFC in the refrigerant circuit of refrigerators or for luxury hotels' air conditioners in Mauritius, 13.76 $/kg of CFC replaced were spent, for all possible activities in the domestic refrigeration sector. 15.21 $/kg was used for the commercial sector[7]. No matter what economic context, what skill level the technicians required or what growth prospects, all investments were treated with either the domestic or the commercial cost factor, declaring the reduction of complexity to only two cost numbers as unavoidable. Economies of scale inherent in refrigeration technologies translated into large profits for companies which received subsidies for the purchase of new production machines they would have otherwise just as well financed themselves; on the contrary, small companies were offered too little funds so that they could not invest in new technologies, and in some cases they had to close down. UNIDO stated that phase-out implies

[5] As the host countries can choose the IA which best suits its own interests, competition between IAs is intense. This particular "nature" of competition between only four UN agencies deserves scrutiny and at least an effort to document the selection processes and their results. Until Dec 2009, these investment projects amounted to 292 mio $ (UNDP), 224 mio $ (UNIDO), 317 mio $ (World Bank) and 13 mio $ (UNEP) (*Ibid.)*. In most countries, the same IA that formerly ran the CFC projects, now sets up HCFC projects.

[6] Incremental cost 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 this goal. (response to Call for Public Input on Investment Analysis, World Bank 2011).

[7] UNEP/OzL.Pro/ExCom/16/20, p.8

substantially increased operating costs for one CFC-replacing company, but cost savings for another such company (UNIDO 2009:187) in the same country: So only UNIDO as IA admitted publicly the key deficiency of the MLF disbursement approach, the use of only two cost factors instead of the compensation of the actual incremental cost.

For HCFC-22, all foam is treated as one category, so even less differentiation than for CFC is applied, and this after two and a half years of negotiation following the 2007 decision by the parties:

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, the MLF nor any other institution or party to MP published an economic assessment why 6.3 \$/kg HCFC-22 is suitable, for example when comparing costs of a cooler using HCFC-22 to costs of a cooler operating with a non-HCFC substance. It is surprising that various assessments were neither scrutinized nor was there any kind of controversy on these issues. As MP insiders admit off the record, the factor was determined by dividing the funding likely to become available by the total volume of HCFC-22 consumed in developing countries[8]. There is only one cost factor for HCFC-22 in refrigeration because there was only one for CFC in refrigeration. This oversimplification was bad in 1992 and is still so in 2007[9].

The main result of this introduction to MLF is that the two key aspects, the role of the IAs and the uniform cost factors per kg, as they were developed for CFC, are now being applied in the same manner for HCFC-22. This paper does not address the negotiations between MP parties and only accounts for the direct industrial and technical outcomes.

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[8] Elaborate projections by ICF for the World Bank estimated 573,000 t HCFC-22 in all developing countries in 2015. ICF International (2007) confronted a lower HCFC-22 projection prepared by the Chinese Ministry of the Environment on which I had been advising the Ministry while working for GTZ-Proklima (UNEP/OzL. Pro/ExCom/51/Inf.3. of 19 Feb 2007). These projections were discussed at 19th MP MOP (sept 2007).

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

3.2. The HCFC Phase-out Management Plan: the Example Sri Lanka

The HCFC-22 phase-out management plan (HPMP) for Sri Lanka, prepared by UNDP and adopted by the 26th Meeting of the MLF ExCom in November 2010 is analysed here as a typical and representative example for the adequacy in the local context (UNEP/Ozl.Pro/ExCom/62/48). In 2009, 212 tons HCFC-22 were used, 195 t in residential and 12 t in industrial air conditioners. Regnis and Metecno are the two HCFC-22 using manufacturers. As 47% of Regnes is owned locally, it gets MLF funds, whereas Metecno, being 100% Italian, cannot get funds. Regnis operates two production lines, one with cyclopentane[10], the other with HCFC-22 as foam blowing agents. On behalf of Sri Lanka, UNDP requested 237,560 $ to support Regnis in the conversion of the second line also to cyclopentane, to which the MLF responded as follows:

> "Based on this review of the proposal for the conversion of Regnis, the [MLF] 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 up 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 investment either by retrofitting existing equipment, and will decide whether to invest in completely new equipment and when. The [MLF] 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 $ ignored the economics of Regnis' investment and only reflected MLF disbursement rules and its country investment criteria. The MLF response cited UNDP as "mentioning" that Regnis was financially sound, which is a coded expression that the MLF trusts UNDP to judge whether Regnis can use the funds and replace the HCFC. Neither the UNDP proposal nor the MLF's response mentioned that in 1997, Regnis had received 265,917 $ from the MLF to shift one line from CFC-11 to cyclopentane in foam, from CFC-12 to HFC-134a as a refrigerant (project SRL/ REF/17/INV/06) and Regnis changed the second line to HCFC-22 with its own

[10] Cyclopentane has been used as blowing agent for polyurethane foam (PUR) since 20 years and was always available for PUR producers willing to invest more in their machinery. Cyclopentane is typical for the simple hydrocarbons that can replace most HCFC-22 and HFC-134a.

funds, not knowing that this would make them eligible for new funds 12 years later. Without assembling more such cases, this one should illustrate the importance of the relations between IAs and MLF, and we assume that Regnis is typical for the funding for HCFC using companies in most HCFC Phase-out Management Plans.

88% of all HCFC in Sri Lanka is used to service residential air conditioners, refilling the refrigerant which slowly escapes during normal usage. In many HPMPs, air conditioner maintenance is the largest part. Two options are evident: first, give incentives for households to replace their old ACs with new ones which run without HCFC-22; second, assist 6,500 formally-trained technicians and 5,000 informal sector technicians (UNEP/OzL.Pro/ExCom/62/48 p.4) in Sri Lanka with training and provide them with HCFC-22 recovery equipment and/or leakage detectors to reduce the HCFC-22 seeping from the air conditioners. As part of the CFC phase-out 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 and use the same pumps for HCFC-22 (and HFC-134a). To know what these 3,700 persons are doing now with the recovery machines and the acquired skills would be a necessary basis for a decision on what to fund next. However, as is the case for Regnis above, the actual outcomes of preceding CFC phase-out projects are not taken into account (UNEP/OzL.Pro/ExCom/52/Inf.2) in the HCFC phase-out projects.

3.3 Criticism of the MLF and conclusions with respect to HCFC-22

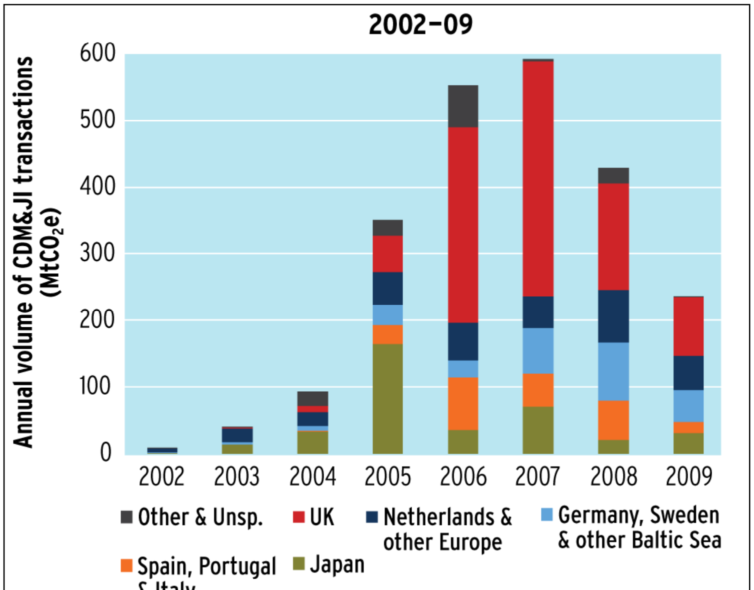
Several assessments of UNEP's Ozone Secretariat and the MLF have come to the conclusion that these are weak institutions which are unable to shape the ozone regime or to reform the institutions (Bauer, 2007, p.10), contributing regime maintenance only. Bauer reveals well the asymmetries in the triangle composed by MLF, the Ministries of Environment in host countries, and the IAs, that have grown over the years. The focus here is on the outcome of MLF funding, the results in the industries concerned, not what the MP parties (might have) intended. The project blueprints, used for CFC in all developing countries, are being reproduced for HCFC in all developing countries and the roles of the IAs and the uniform cost factors are also the same.

The Sri Lankan HPMP (Regnis and the air conditioner maintenance) illustrates that the allocation of the MLF funds took precedence over the concern for the effectiveness of investments, for HCFC as was the case for CFC before. It is plausible that depending on environmental policy and governance, MLF funds can be highly effective in some developing countries because the Ministry of the Environment makes good use of the IAs, or can be prone to corruption in others. The institutional inertia of the MP persists and UNDP, UNEP, UNIDO and the World Bank continue to compete intensely among each other to guide Ministries of Environment on drawing MLF funds for HCFC-22 replacement. The business interests of the IAs also seem the most plausible explanation why no questions about the differences between CFC and HCFC are asked and why the changes in geography, equipment and economics remain unaddressed. The MLF needed and created a short cut around the "incremental cost" issue and funds were spent on volume of ODS and ignoring the recipients' concerns (admitted among the IAs only by UNIDO).

Before ch.5 returns to Regnis and similar companies, ch.4 describes the Kyoto Protocol. Much more detail about the Sri Lankan case would be needed to understand the exact role of UNDP and the results this HPMP achieves. This brief case shall suffice to illustrate the interactions between the MLF funding and the KP (ch.5), which is the objective of this paper. Since the MLF funded HCFC replacements and the KP funded HFC replacements take place in the same sector, refrigeration, comparing the two funding methods and their interference leads to a bigger picture where new solutions become evident. In this bigger picture, ch. 6.2 will characterise technical change in HCFC as a *scale intensive trajectory* of innovation.

4.1 The Kyoto Protocol's Clean Development Mechanism (CDM)

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.

4.2 CDM Project Development for HFC gases under Kyoto up to date

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[11], 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

[11] 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.

gain market share by selling refrigerators to Brazilian utility companies who distribute them to poor households in Favelas (Brasilian slums)[12]. 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[13], other utilities hopefully follow. Other refrigerator manufacturers such as Godrej and Videocon in India (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.

4.3 Conclusions on the CDM Projects for HFC Gases

Overall, four CDM methodologies and subsequent projects appeared in particular circumstances: Acme Tele, BSH and Unilever are pursing specific commercial objectives and use CDM as a competitive tool. To judge whether CDM reduces HFC emissions effectively, the main questions to be answered are whether the potential income from CDM can change investment decisions and whether others follow the first cases. Jindal's additional cost for pentane is 75,000 $, while income from the respective 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$). Hence, the incentive to replace HFC-134a is considerable and should be so for the remaining 260 PUR foam manufacturers in India, and in other countries.

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

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

Few companies, all technology leaders (in India, Germany and South Korea), make use of CDM for their commercial strategies. That leaders have the most incentive is intrinsic in the CDM[14]. The market character and bottom-up orientation in CDM are evident in CDM projects for HFC substitution, as is the steep learning curve for first movers to establish methodologies. Very different CDM types, steel furnaces or power plant equipment, show similar patterns. The potential income from CER stimulates the identification of the most efficient emission reductions, but only few companies are ready by now to invest in the preparation of a CDM project. Because of the bottom-up procedures in CDM, the evidence from these four cases can be interpreted with more certainty than the HCFC projects in the MP, where a representative example had to be selected (Sri Lanka). For assessing the CDM, HFC projects by companies such as Jindal, Acme Tele, Metecno, BSH and Unilever are a good basis.

5. Current Interferences between KP and MP for HCFC and HFC

Both regimes were extended, MP to HCFC and KP to HFC, following their own logic. Oberthür (2011:138) predicts that regimes can pass each other like ocean liners at night, ignoring each other, blinded by their own light. For the MP, what worked for CFC is continued without acknowledging lessons learned. UN agencies (IAs) shape HCFC projects to fit these MP rules. For the KP, few companies take the risks so far, and the bottom-up structure of the CDM leads innovative companies to shape the methodologies. The overlap between KP and MP arises out of the substitutability of HFC-134a and HCFC-22 and their use in the same sector. This is and has always been evident, so a bold question is why was this overlap allowed to happen? One answer is to assess each regime's coherence to see whether the respective extension to HCFC and HFC was compelling.

Instead, we continue to consider the direct industrial and technical context and show types of interferences between MP and KP that occur in this overlap because this reveals how counterproductive the overlap is in practice. While those working in the regimes (secretariat staff etc.) see their own rules, the companies are in a different position. From their perspective, four

[14] The World Bank (with AM0060) and GTZ are the only public policy oriented institutions to wade into CDM for HFC and they decided against expanding on their first methodology-making success for unrelated reasons. For GTZ, it was the only successful effort ever to produce a CDM methodology and this reflects only the difficulties in GTZ of creating a policy and has nothing to do with HFC or the MP.

types of interferences between the KP and the MP are certain (from the policy side there are several more).

1. when HFC and HCFC are alternatives for use in new installations (in industrial plants, for example Regnis, or for households such as for BSH);
2. where MP and KP rules apply differently to competing companies (Regnis versus Metecno);
3. when an HCFC is contained in the foam and an HFC is the refrigerant, appliances even contain physically both MP and KP impacts, as for Regnis or BSH;
4. interferences over time, e.g. when refrigerator manufacturers who replaced both HFC and HCFC 10 or 15 years ago are affected when MP or KP create new incentives that change these options (BSH).

These four interferences are strengthened or weakened depending on the decision-making of the company. Regnis changed its second line to HCFC-22 on its own and used MLF funds for the more expensive switch to cyclopentane (1.interference). Being excluded from the MLF unlike Regnis (ch.3.2), Metecno in India tried the CDM (2.interference). Metecno's competitors pursue CDM projects even though some of them are eligible for MLF funding in India. When doing so, they gauge their confidence in the national Ministry's HPMP and compare it to the regulatory risks in the CDM and the uncertain price for CERs (similarly BSH's Indian competitors). HFC and HCFC using companies such as Regnis can see eligibility criteria as arbitrary and perhaps choose to ignore MP and KP rules as an unpredictable *force majeure*, reducing in this case their influence. Opinions about the MP and KP among competitors can create strong herd effects, more than the technology itself, which is explained in ch. 6.2. for *innovation trajectories*.

Interferences are specific to industry sectors. Refrigerator production implies other interferences than insulation foam. In Latin America, Southeast Asia and Africa, many companies probably wait for MLF funds before investing. In a country where these companies are the majority, the respective Ministry of Environment and co-operating IAs define the speed and orientation of technical change, when deciding what projects to propose to the MLF. For the MP, costs and benefits differ more among companies than among countries. The MP is a crude watering-can distributing funds among countries ignoring differences between companies and technologies. For the MP's extension to HCFCs these differences are bigger than before for CFCs. In contrast, the CDM rules of the KP address these differences in the definition of "business-as-usual" and "additionality" that each project proposal must demonstrate for the particular case. Each CDM project is assessed for its financial and technological merits. The KP creates "carrots", i.e.

incentives that so far seem insufficient for HFC phasing out in most countries and for most companies. The insufficiency increases through companies which choose to wait for the funds MP will make available for HCFC phase-out (HPMPs). Watering-can versus carrots is the clearest and best fitting metaphor for the KP versus MP.

Regimes ignoring each other as in Oberthür's (2011:138) "oceanliners-at-night" metaphor is one issue when the interferences result from country differences since both regimes must apply to all countries. Both the KP and the MP have created voluminous documents[15] on scientific aspects but nowhere are the KP and MP projects' results assessed and the observable interferences evaluated. The mutual ignorance is however entirely avoidable when interferences result from technology and company conditions: Both MP and KP rules can differentiate for technology, products and business economics reasons. Most of this ignorance appears to be habits of the "community-of-experts", who, for example, continue to deal with HCFC as they dealt with CFC. CDM methodologies would allow to address the interferences and include criteria (eligibility, baseline, additionality) for past MP funding decisions. To sum up:

- interferences in HFC and HCFC are not reflected in KP and MP rules,
- interferences are variable, but treatable with criteria already applied by CDM,
- the KP is weakened by the MP because companies anticipate the impact of MLF funds available to their competitors.

The four interference types, here distinguished from the Sri Lankan HPMP and four CDM methodology efforts, are considerable. As suggested before, this adds strength to the first insight from the HPMP case, the "blanked" continuation of the MP's blueprints for HCFC. Because of the interferences, the watering-can has become more diffuse than it was for CFC. The Implementing Agencies could counter this by referring in a particular HPMP to all companies that use or could use HCFC in a particular country. So far this has not occurred. The blanked continuation of MP blueprints for HCFC and the inability to address the interferences (despite the voluminous studies) between HCFC phase-out and CDM projects for HFC are good evidence that Oberthür's ocean liner metaphor applies.

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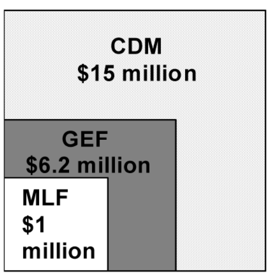
[15] The specific Webpages http://ozone.unep.org/Meeting_Documents/dialogue_on_high_GWP/index.shtml http://unfccc.int/methods_and_science/other_methodological_issues/interactions_with_ozone_layer/items/522.php http://cdm.unfccc.int/about/hcfc22/index.html (accessed oct 2011)

6. How to Overcome Institutional Interferences? Ideas for the Future

At present, there are no proposals from any party to the KP or the MP that addresses the overlap. The interferences are being ignored. There only exist three proposals to extend the MP a second time, the first was to add HCFC to the gases the MLF pays to replace (in 2007), and now to add also HFC to the MLF. By extending the MP a second time, the overlap between MP and KP would become even stronger. Strikingly, none of the three proposals refer to advantages and disadvantages of the MP and the KP or to their outcomes so far. These proposals are another illustration of regime inertia and also an indicator of the significance of HFC. Again a class of chemicals is tackled as a class and the context of the users is not analysed.

First, the World Bank proposes to assemble the funding mechanisms in a top-down manner and the Bank intends to do this herself. Each country would get an overall programme, combining three and more sources of funding to pay for replacing equipment which uses HCFC:

Graphic 3: World Bank's Proposal Combining Kyoto and Montreal Protocols



Source: "Leveraging Support for HCFC Phase-out: Opportunities and Modalities for Pursuing Linkages with the Climate Change Agenda", World Bank, 28th OEWG, 2008 [16]

This proposal has the advantage of being faster than bottom-up approaches. However, it does not address the incompatible aspects, e.g. the determination of MLF funds according to the volume of HCFC used versus CDM, where income is related to CER volume and price. A first comment is that the entity to get the MLF, the GEF funds and the CDM incomes would have to act beyond and outside the current MLF, GEF and CDM rules, an implausible solution (especially for the World Bank). The Meeting of the Parties of the MP has not yet put this proposal on the agenda.

A second proposal by the US (together with Canada and Mexico, UNEP/Ozl.Pro.22/5) is to leave HFC gases in the KP as now, while, at the same time, spending MLF funds on HFC substitutions.

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[16] The original World Bank document for this proposal, submitted to the MP, is available on http://siteresources.worldbank.org/INTMP/Resources/HCFCflyer_June2010.pdf?&resourceurlname=HCFCflyer_June2010.pdf (accessed oct 2011)

This proposal has reappeared at several Meetings of the Parties to the MP, where it was rejected especially by China and India, most likely in order to defend the KP regime. As a third option, Micronesia proposes a different inclusion of HFC into the MP, with a more aggressive phase-out schedule until 2030 (UNEP/Ozl.Pro.22/6), in order to reach the quantitative goals five years earlier than in the US proposal. The US and the Micronesian proposals maintain the co-existence of conflicting regimes while addressing HFCs with the same MLF funding approach used for CFCs. This implies to repeat the regime inertia that extended MP to HCFC for a second time by including HFC.

In the following an approach that harnesses general technical change for the replacement of HFC and HCFC will be explored. As in other climate policy, a sociology of actors (companies) and a typology of behaviour (co-operation between companies) allow for defining new ways for using funds. Since none of the three proposals above addresses the outcomes of the KP or MP, the variation in HFC and HCFC use among regions, or the MP-KP interferences, we simply leave the proposals and the underlying policy reasons aside and explore what is missing in the proposals. Innovation criteria might allow to find new policy elements that physical (volumes of consumption and production of GHG) parameters do not reveal. Besides new ideas[17], other reasons why the KP and MP implementations are stuck could be found as well.

6.1 Industry Context for HFC and HCFC uses: What to learn for KP and MP

HCFC use is dominated by air conditioners, i.e. a mass consumer market with a small number of large corporations, competing with thousands of different AC models, frequent new designs, and "cut throat profit margins". In this context of a **mass of consumers and a few huge suppliers** the most effective way of HCFC-22 phase-out is to include it in the corporations' normal course of innovation. Chinese Haier or Greee, American Whirlpool or Maytag, South Korean, German, Mexican and Brazilian multinationals are beyond an individual government's reach. Only three of these engaged in the CDM, namely BSH, Samsung and LG. A key aspect is a principal-agent problem[18]: households' preferences are limited to the ACs available in a shop and their

[17] Such attempts to move beyond the "project-by-project" accounting are frequent and in the CDM policy debate these are subsumed as "Nationally Appropriate Mitigation Actions" (www.namadatabase.org). No such actions have been developed for HFC or HCFC.
[18] The average end-user pays the electricity bill but his cash preferences reduce his choices (IEA 2007).

preferences are only one part of the multinationals' strategies. At present, the main driving force is the energy labels in Europe or Japan that lead to a succession of innovations. But in absence of labels in developing countries, multinationals keep offering their low efficiency appliances since the profit margins are higher than with new efficient appliances.

The context of HFC usage is quite different, as most of the HFC are used by a limited number of larger installations, such as industrial plants or supermarkets. HFC-using equipments are not produced by a few multinationals but there by **many producers in each country who specialise on certain types of customers.** This is the case for HFCs as refrigerants, for example in chillers, and for HFCs as blowing agents in foam blowing machines, where the mostly medium sized companies are quite technology-oriented, use patent protection, and produce a limited number of units per batch or model, applying skilled craftsmen instead of automatisation.

6.2 HFC and HCFC Technologies as Types of Innovation

The different industry context of HCFC and HFC corresponds well to innovation types. A broad school of Schumpeterian economics is nowadays applied to design innovation policy, R&D strategies and research funding criteria (even theories about transition to sustainability). Nelson and Winter's (1982) "An Evolutionary Theory of Economic Change", and Giovanni Dosi's (1983) "Technological paradigms and technological trajectories", are the starting points of the renewal of Schumpeterian analysis. Some call it the "Sussex-Yale-Stanford-synthesis" (Dosi et al. 2006: 1450), 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 create together certain *trajectories*. Computers, drugs, plastics, planes, as well as "white" consumer goods are prominent industrial sectors where research reveals how successful firms copy these organisational tools from each other. The OECD Secretariat is a proponent of this school of economics and translates it into influential economic policy. The rediscovery of the importance of institutional issues is visible in many fields of economics.

HCFC and HFC related technologies are product of recent industrial innovation, and the companies who invented HCFCs and HFCs are the standard objects of analysis by this school. A popular innovation typology was produced by Keith Pavitt at SPRU at Sussex University:

Table 2: Trajectories of Technical Change

Definition	Source of technology	Trajectory for innovation	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"

Source: Pavitt 1992: 216, 1984: 354.

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. "Typical products" are the sectors 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 both the analysis of KP and the MP regarding HCFC and HFC? In many cases, HFCs are in a specialized supplier *trajectory* (bottom row of the above table) and innovation happens 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 example, when chillers using HFC-134a are replaced with chillers using ammonia or CO_2 as refrigerant, for which equipment suppliers also provide training and information. HFC-134a phase-out efforts can target specialized suppliers' ability to provide such training and information. Often, industry associations provide neutral and trusted platforms that facilitate co-ordination; this is a function that the MLF is more suitable to fund than CDM. The relation between Ministries of Environment and IAs can be effective. The MLF would define how chiller suppliers and operators exchange information, and how specialised suppliers can be paid for enabling operators to acquire skills for operating alternatives to HFC-134a. Metecno's use of the PUR industry association statement is an example in this respect. HFC phase-out is effective when pursued by a neutral industry body that helps specialized suppliers and their customers to co-operate. Rather than funding individual HFC-using companies at the discretion of a co-operation 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, with 100,000 to 1 million units per year. Multinational corporations pursue elaborate marketing strategies. The MP instruments are not adequate because the corporations are beyond government control, and their low profit margin competition cannot be influenced by uniform funding cost factors. Neither the KP nor the MP are regimes where political power is build up to affect large systems. Multinational companies cannot be stimulated with CDM projects where income comes from CER sales, nor by the funds available from the MLF. Mass-producing multinational companies can easily replace all HCFC-22 in air conditioners with alternatives, as refrigerant choice is a minor issue to them at irrelevant additional cost. It is mainly a question of how to assure that they all do it at the same time. The innovation process in ACs (as in many household appliances) can be influenced by measures which address the scale-intensiveness of production. In the CDM policy literature, this is often done by referring to the role of the Designated National Authorities (DNAs), the governmental authority that must formally approve each CDM project and can define country specific sustainability criteria and standardized baselines. Cement production is an example for a scale-intensive *trajectory* where DNAs play a role in defining technical change criteria for CDM.

The striking differences in *trajectories* between HFC and HCFC can suggest different change projects than the criteria used at present by MP and KP. The *trajectories* are not direct outcomes of project activities but they clearly separate types of project activities[19]. If, as suggested, DNAs define CDM criteria in mass-production of air conditioners and the MLF were to fund specialized supplier – client support for HFC substitution, decisions in companies such as Regnis and Metecno would be affected differently and the current interferences would change radically. Enhancing technical change has always been part of MP and KP but regulations have only

[19] Exceptional and atypical HFCs are in scale intensive trajectories and exceptional HCFC in a specialized suppler trajectory. So when industry context factors shall be addressed in full, it is also necessary to stop treating HFC and HCFC as homogeneous groups.

sometimes used company size criteria. *Trajectories* distinguish decision-making in companies, especially regarding their co-operation with their clients and customers, whereas until now, the KP and the MP only reflect companies' volume of HFC and HCFC consumption. The evidence for the difficulties for companies to use phase-out funding in ch. 3.2 for HCFC-22 and ch. 4.2 for HFC-134a underlines the scope for harnessing technical change in companies' efforts of innovation. This observation might seem straight-forward, but it merits to be stressed again, the present problems of companies (esp. Metecno's) to use present MP and KP regulations allow to re-define the MP and KP projects according to *technological trajectories*.

7. Conclusions

methods lead to different results

Two chemicals, HFC-134a and HCFC-22, which replaced CFC, are significant contributors to global warming; their production continues to increase, although replacements for all uses of both are tested and applied in some countries. The MLF applies funding criteria for replacing HCFC-22 that create conflicts with the CDM methodologies for HFC-134a replacement. The division of HCFC and HFC between MP and KP seems set to continue although it ignores that they are used for the same purposes and that the co-existence of different methods and criteria is itself counterproductive. The current proposals for changing the division between MP and KP are blocked and none of them any lessons from the current HFC and HCFC projects. This paper highlighted three manifestations of regime inertia: the blanked continuation (project blueprints, uniform cost factors, role of IAs, absence of lessons learned especially for air conditioner maintenance) of the MLF for HCFC, the ignoring of the interferences between MP and KP, and the simplicity of the current proposals to extend the MLF a second time.

The MP inertia is an expression of bureaucratic reproduction in the triangle composed by MLF, Ministries of Environment and IAs, probably including "donor dynamics" among the governments who provide MLF funds. Regime theory[20] distinguishes inertia from different sources:

- cognitive factors in the expert community,
- economic power of chemical companies,
- arena interactions around the MLF and
- control of solutions by insiders.

[20] For the Montreal Protocol in particular by Peter Haas (2005).

This paper points to the latter since the inadequacies of the HCFC-22 projects are so evident and do not suggest a policy-practice gap as in many development areas. The division between HFC under the KP and HCFC under the MP makes mutual disregard the easy solution, especially because regional differences in foam and refrigerants use redistribute costs and benefits between countries that is not reflected in the decision-making bodies of each regime.

Based on one country example for the MLF's HCFC phase-out and four cases of CDM methodologies for HFC, four types of interferences have been defined. These are immediately salient when one considers the MLF and CDM criteria from the perspective of companies. The methodologies and funding criteria of the MLF and the CDM already contain the parameters necessary to shape their interferences. Some companies which invest in new equipment choose between MLF and CDM support, others got MLF funds in the past and now develop CDM projects, and yet others are excluded from both. Currently, neither do Kyoto Protocol rules reflect Montreal's, nor vice versa. Irrespective of the unjustifiably ineffective division of the gases, this paper stressed that CDM methodologies should include criteria about past MLF funding and refer to MLF outcomes if funds are to be used effectively and efficiently. Vice versa, the distribution of MLF funds can reflect the CDM projects that appear in a sector and country. The KP implementation and the creation of CDM projects is more hampered by the companies waiting for MLF funds, than the MP is affected by the KP. Both could benefit significantly by aligning rules for HFC and for HCFC phase-out. This paper has shown that a comparative assessment of the MP and the KP is feasible when both are approached from the perspective of the companies, from the direct technical and industrial conditions. Since no such comparative assessment has been published before we cannot predict if the comparative approach in this paper would help to overcome the mutual ignoring between MP and KP.

A preferable alternative to the aligning of MLF and CDM regulation is to re-define both in light of the general technical change occurring in the sectors where HFC-134a and HCFC-22 are used. This paper explored the economics of innovation (as pursued in SPRU at Sussex University) for criteria, the MP and the KP could learn to apply as funding criteria. *Technological trajectories* indicate that HFCs would be better addressed by the MP than by the KP, especially if the MLF gave funds to neutral industry association activities[21]. The innovation character of the HFC substitution should be effectively addressed with MLF means, abandoning the blueprints used for CFCs. Alternative replacement activities can be defined that are specific to *technological*

[21] Totally unlike CFC phase-out where the producers were all OECD-based chemical corporations.

trajectories. The interferences between the MP and the CDM are severe and visibly counterproductive. The rejection from China of the three current proposals (from WB, US and Micronesia) could be influenced when air conditioner exporters get other support than what is foreseen in the current HPMP for China. So addressing the innovation character might help to call for a change in MLF implementation. MLF projects to support specialized suppliers' relations with key customers and CDM projects to support scale-intensive mass-producers would require more efforts in project definition, but the companies concerned could decide that such projects are much closer to their own objectives and efforts.

Refrigerators and air conditioners partially and locally increase resilience for heat waves but the increasing use for general convenience dwarfs the resilience benefit and contributes significantly to global warming. Between 1993 and 2009 the number of air conditioners in US households increased from 64 to 100 mio., but in China 50 mio. units were sold alone in 2010 (Cox, 2012). Chinese air conditioner manufacturers have an 80% global market share (BSRIA market research). HCFC-22 from air conditioners produced in China is the largest single part of the projected 0.8 Gt CO_2e of HCFC in 2015 (IPCC 2005, SPM-4). Phasing-out HCFC-22 is a rare technology-based mitigation that reduces the impact of the expanding consumption of air conditioning. The driver behind the inappropriateness of the current HCFC-22 projects is the combination of the double phase-out agreed for the MP in 2007 and the Chinese expansion of global trade. This mitigation is barred and to attain significant resilience impacts faster would require halting the MP's inertia and redesigning its tools.

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Rinac
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Montreal Protocol documentation

//www.afeas.org

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Abbreviations

AC air conditioner
CER Certified Emission Reduction
CDM Clean Development Mechanism
CFC chlorofluorocarbons
GWP global warming potential (relative to CO_2)
HCFC hydrochlorofluorocarbons
HFC hydrofluorocarbons
HPMP HCFC-22 phase-out management plans
IA Implementing Agency
MLF Multilateral Fund for the implementation of the Montreal Protocol
ODS Ozone-depleting Substances
UNFCCC United Nations Framework Convention for Climate Change