POLICY BRIEF

RESOLVING THE IPR ISSUE DURING HFC PHASE-DOWN

A case study of HFO 1234yf in the mobile air-conditioning sector

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SUMMARY

In the ongoing negotiations to amend the Montreal Protocol to phase-down the use of hydroflourocarbons (HFCs), Intellectual Property Rights of substitute chemicals—mainly unsaturated HFCs (also called HFOs) and its blends—have become a major point of difference between developed and developing countries. Developing countries have expressed major concerns on this issue as two companies hold most of the patents to these chemicals, creating a monopoly. They have, therefore, asked for clarification and resolution of IPR issues before an amendment to the Montreal Protocol is adopted.

To understand the impediments that IPR poses for a successful phase-down of HFCs in developing countries, Centre for Science and Environment (CSE) and Council for Scientific and Industrial Research-Unit for Research and Development Information Products (CSIR-URDIP) carried out a study of the number and nature of patents filed in India around the manufacture and use of HFO 1234yf and its blends, especially in the mobile air-conditioning (MAC) sector.

The study finds that a large number of patents have been filed and many have been granted for the process of producing HFO 1234yf (Process Patents) for modifications in air-conditioning equipment that will use HFO 1234yf and its blends (Equipment Patents) and for the use of these chemicals in the refrigeration and air-conditioning (RAC) sector themselves (Application Patents).

We find that the Application Patents are so broad that they restrict the use of HFOs and its blends in nearly all applications. They are so broad that they even impede research in the use of HFO 1234yf, negating the very premise of patents, which is to promote innovation.

We find that the Application Patents are so broad that they restrict the use of HFOs and its blends in nearly all applications

Our study also concludes that the companies have adopted a 'ring-fencing' strategy to create a near-monopoly. The combination of Process, Equipment and Broad-Application Patents means that chemical manufacturers in developing countries will become 'contract manufacturers', equipment manufacturers will have to seek licenses to make modifications in their RAC equipments and users will have to pay a royalty fee to use these chemicals.

Recent reports[1, 2, 3] have contended that the impediment posed by Intellectual Property Rights of HFOs is not significantly different from the impediments faced in the past and can be dealt with by using the mechanisms already available under the Montreal Protocol.

We do not agree with their analysis. The basic fact is that in the past, the Multilateral Fund (MLF) had to deal only with Process Patents; it has no experience of dealing with Application Patents. Also, the MLF has only funded a few patent projects in

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the past and of relatively small amounts. During the HFC phase-down, the number of projects and amounts are going to be very high. So the past is not a guide to the future.

The key recommendation of these reports is that the MLF would pay for this transition. The other recommendations are that the patents can be challenged and revoked by developing countries and, finally, that developing countries can move to HFOs when the patents expire.

We find some of these recommendations unworkable and not relevant to the discussions on the amendment proposal. Firstly, challenging patents is a commercial decision best left to companies. Secondly, the assumption that developing countries will move to HFO 1234yf in the MAC sector when the patents expire is akin to disregarding past trends and the current market situation in the automobile sector. All facts indicate that the MAC sector will quickly switch over to HFO 1234yf and not wait for the patents to expire. In such a situation, the only option is for the MLF to pay for this transition. But our analysis shows that if the MAC sector moves to HFO 1234yf within five years of the amendment (very possible considering the legislations in the US, EU and Japan. Also the MAC sector switched over from CFC to HFC in three to five years in most parts of the world), the MLF will not have the money to support this transition. Even if developed countries are able to put together resources (at least three to five times the current level of funding) to support the MAC sector, there will be insufficient funding to support other important sectors, small manufacturers and the servicing sector.

If companies from other sectors also want to phase down HFCs during the same time period, there should be 'flexibility' to also include them and provide them with agreed support

Despite these uncertainties and lacunae, we are not rejecting this recommendation. But we believe there are many other viable options. The options available to us to deal with IPR issues are:

Option 1: The amendment proposal categorically states that MLF will pay for the switchover to HFO 1234yf in the MAC sector in developing countries, even if a developing country decides to prioritize MAC as the first sector.

Option 2: The amendment proposal unequivocally agrees that MLF will arrange with the patent holders to make their Process, Equipment and Application Patents freely available to all. Until this is done, MLF continues to pay for the switchover.

Option 3: The amendment proposal categorically states that the MLF will not fund HFO 1234yf until the patent expires. This will give a clear indication to the manufacturers in developing countries not to use HFO 1234yf in the MAC sector till the patents expire.

Option 4: The amendment proposal decides to exclude the MAC sector from the phase-down schedule for 10 years until we get clarity on the IPR issues as well as alternative refrigerants are developed and commercialized for the MAC sector. The MAC sector under the business-as-usual scenario is likely to contribute only 10 per cent of HFC consumption in developing countries by 2030. So, this postponement is not likely to significantly impact an ambitious phase-down schedule as countries can compensate this by phasing down HFCs in other sectors.

Whichever option parties decide to choose, they will also have to clearly define the term 'flexibility' being discussed as part of the amendment.

There is ongoing discussion to give 'flexibility' to developing countries to prioritize the sector they want to address first. In the past, the MLF 'dictated' sectors based on cost efficiency; a sector that had the lowest cost of phase-down went first. As the MLF only funds projects that are part of the national phase-down plan, any phase down out of the national plan is not supported. In the HFC phase-down, some changes will have to be made to this.

The 'flexibility' provided to developing countries during the HFC phase-down should include the flexibility to have a multi-sectoral plan. That is, apart from the sectoral proposal, if companies from other sectors also want to phase down HFCs during the same time period, there should be 'flexibility' to also include them and provide them with agreed support.

If we do not do this, the MAC sector across the developing world will move to HFO 1234yf without the MLF paying a single penny for this transition, putting the burden of transition (however high or low) squarely on the consumers of developing countries, while profiting very few transnational companies. This should be unacceptable to all.

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THE STUDY

Centre for Science and Environment (CSE) joined hands with India's premier patent research institute, Council for Scientific and Industrial Research-Unit for Research and Development Information Products (CSIR-URDIP) to analyse the number and nature of patents filed in India around the manufacture and use of HFO 1234yf and its blends in the refrigeration and air-conditioning (RAC) sectors, with special focus on the mobile air-conditioning (MAC) sector (see Box: *Methodology*). This was done to understand the scale of the impediments posed by patents to phase down HFCs.

Global chemical giants like Honeywell International, DuPont and Arkema Chemicals have filed most of the 107 patents in India on production and use of HFO 1234yf in the RAC sector

Our study aimed to answer the following questions:

- What is the extent/nature of IPR protection for production and use of HFO 1234yf and its blends in the RAC sector, especially in the MAC sector? Are these protections an impediment to phase down HFCs in the MAC sector?
- Has the recent spurt in transfer of technology to manufacture HFOs dulled the IPR impediment to the phase-down of HFCs?
- How valid are the recommendations, given in recent reports, around solving the IPR impediment?
- Does the Multilateral Fund of the Montreal Protocol have experience in dealing with similar IPR issues? Can the past be a guide to the future?
- How do we deal with IPR issues (especially in the MAC sector) as part of the HFC phase-down amendment?

METHODOLOGY

The patent search was conducted in freely available public databases such as USPTO Espacenet, INPASS as well as subscribed value-added patent databases such as Patseer, Questel Orbit, Thomson Innovation and PatBase. The search included the use of keywords, concepts and related patent classification codes and combinations thereof to retrieve data from various databases. The concepts used for searching the compounds under analysis included their Chemical Abstracts Registry (CAS) number and other names such as HFO 1234yf and HFO1234ze. These concepts were combined with the patent classification codes for the application/use as refrigerants.

The search was restricted to patents filed or granted in India and related to either the process of manufacturing or use of HRO1234yf or its blends. Patent documents that did not have a corresponding Indian patent application or granted patents were not considered for analysis. With respect to industrial applications, the focus was primarily on patents that either claimed or disclosed the use of HFO-1234yf as refrigerants or blends thereof in automobile air-conditioning systems.

The search retrieved around 250-plus records with India as one of the members considered for further screening. The screening of the records resulted in 107 patent documents that claimed HFO1234yf and its blends as refrigerants which find applications in RAC as well as MAC systems.

Extent of the IPR protection for HFO 1234yf

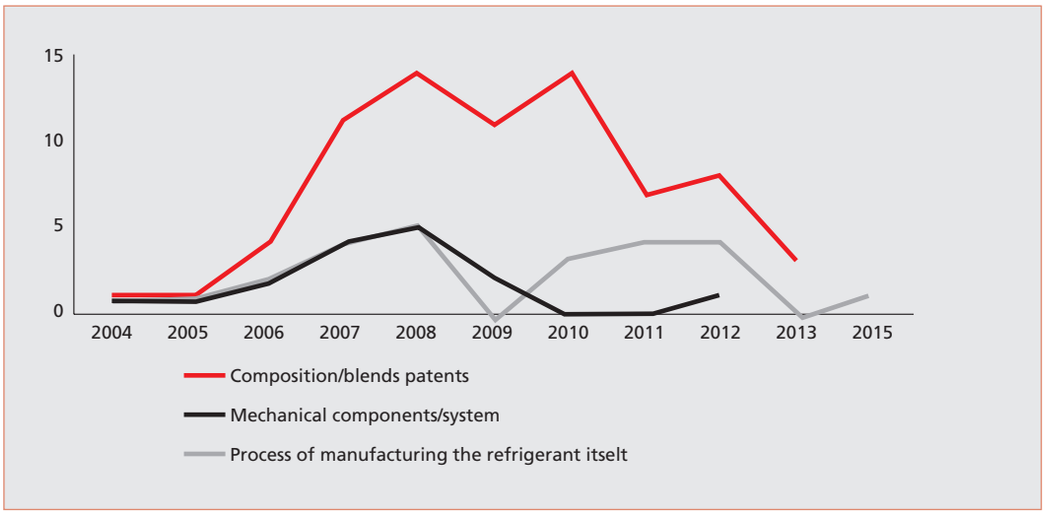
As per the CSE/CSIR-URDIP study, global chemical giants like Honeywell International, DuPont (which has shifted its flourochemical business to a new company Chemours) and Arkema Chemicals have filed most of the 107 patents in India on production and use of HFO 1234yf in the RAC sector (see Table 1: *Extent of IPR protection for HFO 1234yf*). The highest number of patents was filed during 2008–10, coinciding with the start of discussions under the Montreal Protocol to phase down HFCs (see Graph 1: *Patents filed by year and type*).

TABLE 1: EXTENT OF IPR PROTECTION FOR HFO 1234YF

Type of patent	Number of patents
Total patents related to HFOs in RAC sector, including MAC	107
Patents related to the MAC sector	46
Production Process Patents on HFOs	20 filed, 3 granted
Equipment Patents for HFOs in the MAC sector	11 filed, 0 granted
Application Patents for HFO blends in RAC sector, including MAC	76 filed, 5 granted
Application Patents for HFO blends in the MAC sector	35 filed, 3 granted

As Graph 1 illustrates, the major focus of these companies is on getting patents for composition/blends of HFO 1234yf. These are Application Patents, which restrict the use of HFO 1234yf in combination with other substances in specific applications. So far, five Application Patents have been granted in the RAC sector. Three of these patents are in the MAC sector. Three patents have also been granted for the process of producing HFO 1234yf.

GRAPH 1: PATENTS FILED BY YEAR AND TYPE (HFO 1234YF AND BLENDS)



Source: CSE/CSIR URDIP patent study

Our analysis of the patents filed indicates that there is a strong case to establish that these transnational companies are filing patents in sequence to 'evergreen' the patents, though this needs to be studied further and established.

Nature of the patents

CSE/CSIR-URDIP have analysed a few application patents to understand the nature of the patent itself. We find that the application patents being granted are very broad and overly restrictive. They are so broad that they make it virtually impossible for any company to come out with a new blend/composition.

Take the case of patent number IN250569 granted to Honeywell in India in 2012. This patent specifically claims a method of transferring heat to provide cooling in automobiles. The following points enlist the technical scope of the granted claims:

- The independent claim covers the composition/blend encompassing a range of C3 and C4 fluoroalkene and its use in MAC systems.
- The claims preferably encompass R-134a, HFO-1234yf and HFO-1234ze in combination with each other and with other C2 or C3 fluorohydrocarbons.
- The patent claims include a broad range of percentages of each of the claimed HFOs used in the composition. The percentage of HFO 1234yf which falls within the scope of the claims varies from 5 per cent by weight to 99 per cent by weight.
- Specific lubricants, flammability suppressants, operating temperatures and the phases of the individual components are also claimed.

We find that the application patents being granted are very broad and overly restrictive

The above claim scope is so broad that it will restrict the use of HFO 1234yf in MAC systems either in the form of single configurational isomers, single stereoisomers or any combination or the mixture thereof with other C2 or C3 fluorohydrocarbons. The percentage of HFO 1234yf, which falls within the scope of the claims, is so wide (5 per cent by weight to 99 per cent by weight) that it restricts any scope of research to find a new blend/composition. This impedes the very basis of patents. Patents are granted to further innovation and not to restrict research.

The implication of this patent is that it imposes restrictions on the freedom to practise options of refrigerant compositions or blends comprising HFO 1234yf, compelling a license agreement to use it in MAC systems in India. This is a monopoly. Period.

Technology transfer or outsourcing

In the last two years, two companies in China and one in India have collaborated with Honeywell to manufacture HFO 1234yf. This HFO 'technology transfer' is taking place through:[4]

- Joint ventures for which new companies are formed and both patent holders and developing-country companies own stakes. The only major variation is the arrangement of HFO sales.
- Joint-venture companies that produce and sell HFO products within agreed quantities and to specific markets/regions

- Joint-venture companies produce and are compensated for production costs by the patent-holding partner company and the partner company sells all products manufactured by the joint-venture company. This is referred to as 'contract production'.

Recently, an Indian manufacturer of fluoro-chemicals, Navin Chemicals, has signed an agreement with Honeywell to produce HFO-1243yf and sell it exclusively to Honeywell. Honeywell would then sell the chemical to users. This is 'contract production'. **It is akin to outsourcing of production and not technology transfer.**

The 'ring-fencing' strategy

Our conclusion is that the companies have adopted a 'ring-fencing' strategy to create a near-monopoly. The combination of Process, Equipment and Broad-Application Patents means that chemical manufacturers in developing countries would become 'contract manufacturers', equipment manufacturers would have to take license to make modifications in their RAC equipments and the user would have to pay a royalty fee to use these chemicals.

POPULAR WISDOM ABOUT THE IPR ISSUE

Recent studies have proposed solutions to the IPR impediments that may be faced during the HFC phase-down. The main consensus of the reports is that the IPR issue can be dealt with by using the mechanisms already included in the Montreal Protocol.

The following is an analysis of some solutions recommended by organizations like Institute for Governance and Sustainable Development (IGSD), Center for Climate and Energy Solutions (C2ES) and the United Nations Environment Programme (UNEP) Ozone Secretariat:

Solving IPR impediment through legal actions

Challenge patents

According to a 2016 report of IGSD, the broad IPR protection acquired for HFO 1234yf has been challenged with some success in patent courts in the US and EU. These patent litigations, however, have not as yet had any concrete outcomes. C2ES 2016 also recommends that companies in developing countries can challenge the patents and get them revoked. We find this recommendation unworkable.

The main consensus of the reports is that the IPR issue can be dealt with by using the mechanisms already included in the Montreal Protocol

Firstly, challenging patents is a commercial decision of a company and has nothing to do with arriving at a resolution at the Montreal Protocol. Some patent challenges will work; others will not. Some will take years; other will take less time. Challenging patents, therefore, is not a solution that can be proposed to arrive at a resolution before October 2016, when an amendment proposal is likely to be adopted.

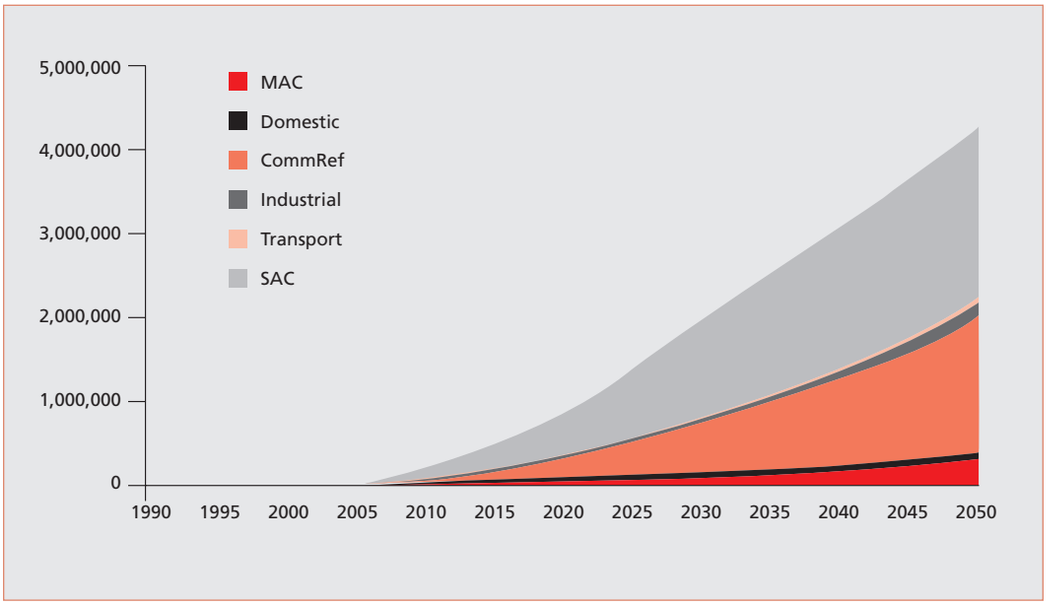
In India, so far none of the patents granted for HFO 1234yf and its blends have been challenged. Such challenges require strong interested parties with deep pockets and patience. From past experience, Indian companies are unlikely to challenge patents.

Compulsory licensing

Another path recommended by some experts has been compulsory licensing. The mechanism is available to countries when patents have been filed on products/processes of pressing social importance. When compulsory licensing is operationalized, the IPR in question can be open-sourced locally for a modest fee. This mechanism is used rarely except in exceptional emergency cases. In India, compulsory licensing has been used only once in healthcare sector.

Use of HFO 1234yf in MAC cannot be considered exceptional emergency as even in 2030 HFCs in MAC will only account for 8 per cent of total HFC consumption in developing countries.[5] As illustrated in Graph 2: *Sector-wise HFC consumption by 2050* (CO_2 equivalents), stationary air-conditioning and commercial refrigeration account for more than 80 per cent of all HFC consumption.

GRAPH 2: SECTOR-WISE HFC CONSUMPTION BY 2050 (CO_2 EQUIVALENTS)



Source: TEAP Report, 'Further Information on alternatives to ozone depleting substances', 2016

Delay transition to HFO 1234yf in MAC sector until patents expires

Another solution that has been recommended by 2016 studies by IGSD, 2016 and C2ES, 2016 is to delay the phase-out of HFCs in the MAC sector until the patent protection expires. We find this proposal unworkable because it ignores the reality of the automobile industry and the past experience of the MAC sector.

Firstly, the global automobile industry is highly concentrated. About 85 per cent of the cars manufactured globally are manufactured in China, USA, EU, Japan, South Korea and India.[6] Additionally, about 70 per cent of global car sales are accounted for by the top ten automobile manufacturers, all of whom are based in Japan, EU, USA and South Korea.[7] These countries have strong IPR protection for the manufacture and use of HFO 1234yf (see Box: *Will HFO 1234yf affect all developing countries?*).

There is no alternative to HFC 134a in the MAC sector other than HFO 1234yf in the short term. A quick transition to HFO 1234yf in the MAC sector is imminent once an amendment proposal is adopted

Secondly, regulations incentivizing the use of HFO 1234yf are already in place in the EU (EU MAC Directive) and the US (US CAFE Standards). The concentrated nature of the automobile industry implies that a change in the prominent refrigerant used by the major automobile manufacturers will translate into changes all over the world much before the patents expire.

This is exactly what happened during CFC phase-out, when the MAC sector was the first sector to move to HFC 134a from CFCs. And, this transition happened in a very short duration of two to three years in most parts of the world.

WILL HFO 1234YF AFFECT ALL DEVELOPING COUNTRIES?

C2ES, 2016 has contended that IPR protection for HFO 1234yf is not global, i.e. the patents are only filed in a few countries and therefore most developing countries are not affected. This analysis is 'inadequate', to say the least.

An analysis of the global patent landscape for HFO 1234yf shows that the patent protection is very comprehensive in countries where automobile manufacturing is concentrated. There is no incentive to file patents in countries where there is no manufacturing of automobiles or MAC equipments. By filing patents in automobile manufacturing countries, the patent holders have covered all importing countries as well.

According to the 2016 report of the Technical and Economic Assessment Panel (TEAP), there is no alternative to HFC 134a in the MAC sector other than HFO 1234yf in the short term. A quick transition to HFO 1234yf in the MAC sector is imminent once an amendment proposal is adopted.

MLF pays for technology transfer and royalties

The Multilateral Fund, instituted under the Montreal Protocol, is tasked with administering financial support for transitions in various sectors. In the case of HFO 1234yf, the 2016 C2ES report has contended that IPR impediments can be dealt with the help of funding from the MLF by operationalizing mechanisms already existing under it. The 2016 IGSD report suggests the following options for using the MLF to deal with the IPR ring-fencing for HFO 1234yf:

1. MLF bears the cost of technology transfer/licensing fees
2. MLF can procure the patents for HFO 1234yf for use by all Article 5 countries

Can MLF pay?

The 2016 C2ES report suggests that MLF foot the bill for a transition to HFO 1234yf. They cite examples (metered dose inhalers, tobacco expansion and certain foam applications) from the past where technology transfer had been funded by MLF. However, such funding has taken place only in a handful of cases, where a small portion of the total cost of the technology costs was compensated by the MLF. The cost borne by the MLF for technology transfer was nowhere near the support that will be needed to facilitate a successful phase-down of HFCs from the MAC sector.

Unlike in previous instances, paying for the complete phase-down of HFCs in the MAC sector will be a difficult and very expensive proposition. Royalties for the use of HFO 1234yf in the MAC sector could be far in excess of $300 million per year by 2020 (see Box: *Moving to HFO 1234yf in MAC sector in developing countries*).

Public procurement of patents by MLF

Another recommendation has been the creation of an R&D pool for climate-friendly technologies funded by the MLF. Although the mechanism for this approach exists under the MLF, the implementation would require a comprehensive study of

MOVING TO HFO 1234YF IN MAC SECTOR IN DEVELOPING COUNTRIES

The cost of transition to HFO 1234yf in the MAC sector in developing countries can only at best be 'guess-estimated'. No accurate figures are available for the cost of refrigerant, cost of HFO-based MAC equipment, cost of constructing plants to produce HFO 1234yf, or MAC equipment.

Informal discussions with industry indicate that the present price of HFO 1234yf in the European market is about $75 per kg. This is at least five times the price of HFC 134a. Similarly, it is estimated that the cost of a new MAC system using HFO 1234yf could be in the range of $200–300, depending on the cooling capacity of the equipment.

In India and China, many manufacturers are already using HFO 1234yf systems in cars being exported to the US and Europe. If we assume that the HFC amendment proposal is adopted in 2016, a large number of automobiles for the domestic market in developing countries is likely to shift by 2020 to the HFO 1234yf system.

If we assume that only 50 per cent of the domestic automobiles in developing countries have shifted to HFO 1234yf MAC systems by 2020, the costs are likely to be as follows:

- Demand for HFC 134a in 2020 in MAC sector in A5 countries: 66,680 tonne (TEAP, 2016)
- Demand of HFO 1234yf for MAC sector by 2020 in developing countries (assuming 50 per cent conversion): Approx. 33,000 tonne
- Assume royalty of $10 per kg of HFOs (*this is a gross underestimation as the current cost difference between HFC 134a and HFO 1234yf is at least $50 per kg*)
- Annual royalty to be paid: 33,000 tonne x $10 = $330 million/year in 2020

The current annual budget of the MLF is $160 million. Less than $100 million of this has been allocated for the HFC phase-out/down.[8] It will, therefore, be very difficult for the MLF to pay for a complete transition from HFCs to HFOs in the MAC sector in the short term. This would mean that the cost of transition to HFOs will be borne largely by Article 5 countries. These costs may be in excess of $1 billion per year in India alone. This is evidenced by the computations given below:

- Average cost of shifting to HFO1234yf per car: $200
- Estimated car production in India in 2020: 5 million
- The cumulative cost of transition for India: 50,00,000 x $200 = $1 billion per year

commercial feasibility and cost effectiveness for providing IPR to Article 5 countries. Currently, the only examples of such pools have been for technologies developed by the Government of India that have been made available in specific sectors.

This approach would ideally need to be accompanied by a liability clause/ mechanism under which the companies that own the IPR would be held liable for any environmental impacts caused by the new refrigerants.

It is important to take into account the fact that HFO 1234yf may also have significant impact on the environment. Trifluoroacteic acid (TFA) is a byproduct of breakdown of HFCs and is now fairly ubiquitous in the environment. It is a phototoxic compound that may lead to considerable negative impacts on crops and aquatic life. It is estimated that the large-scale use of HFO 1234yf will contribute five times more TFA than HFC 134a. According to a TEAP report on TFA, studies on the impact of TFA on the environment have been inconclusive.

Public procurement of patents therefore would be too complicated and widespread consensus on such a mechanism may not be possible by October 2016.

THE WAY AHEAD

Our analysis shows that the companies have adopted a 'ring-fencing' strategy to create a near-monopoly. The combination of Process, Equipment and Broad-Application Patents means that chemical manufacturers in developing countries would become 'contract manufacturers', equipment manufacturers would have to take licenses to make modifications in their RAC equipment and the user would have to pay a royalty fee to use these chemicals.

The Montreal Protocol must address the issue of monopoly before it mandates a changeover from one chemical (HFC 134a) to another (HFO 1234yf). There are options to deal with this issue:

Option 1: The amendment proposal categorically states that the MLF will pay for the switchover to HFO 1234yf in the MAC sector in developing countries, even if a developing country decides to prioritize MAC as the first sector. In this case, developed countries would have to increase their contributions by at least two to three times in the short term (i.e. before 2020).

The Montreal Protocol must address the issue of monopoly before it mandates a changeover from one chemical (HFC 134a) to another (HFO 1234yf)

Option 2: The amendment proposal categorically agrees that the MLF will do a deal with patent holders to make their process, equipment and application patents freely available to all. Until this is done, the MLF will continue to pay for the switchover. This option would require a liability clause to be built in so that manufacturers and patent holders of HFO 1234yf would be held accountable if negative environment impact is experienced.

Option 3: The amendment proposal categorically states that the MLF would not fund HFO 1234yf till the patent expires. This will give clear indications to the manufacturers in developing countries to use HFO 1234yf in the MAC sector when the patents expire.

Option 4: The amendment proposal decides to exclude the MAC sector from the phase-down schedule for 10 years until we get clarity as well as alternative refrigerants for the MAC sector. The MAC sector under the business-as-usual scenario is likely to contribute only 10 per cent of HFCs in developing countries by 2030. So this postponement is unlikely to significantly impact an ambitious phase-down schedule as countries can compensate this by phasing-down HFCs in other sectors.

The provision in the North American HFC phase-down proposal for periodic technology reviews can be institutionalized to take a call on the inclusion of MAC sector in the future. This will allow parties to focus on SAC and commercial refrigeration—the main HFC-emitting and energy-consuming sectors. It will also give time for more long-term environmental impact studies and technological alternatives to develop in the MAC sector.

Whichever option parties decide to choose, they will also have to clearly define the term 'flexibility' being discussed as part of the amendment.

There is ongoing discussion to give 'flexibility' to developing countries to prioritize which sector they want to address and when. In the past, the MLF has 'dictated' sectors based on the cost efficiency; sectors where the cost of phase-down is lowest went first. As the MLF only funded projects that are part of the national phase-down plan, any phase-down out of the national plan is supported. In the HFC phase-down, some changes will have to be made in this. The 'flexibility' provided to developing countries should include flexibility to have a multi-sectoral plan. That is, apart from the sectoral proposal, if companies from other sectors also want to phase-down HFCs during the same time period, there should be 'flexibility' to also include them and provide them agreed support.

If we do not do this, the MAC sector across the developing world would move to HFO 1234yf without the MLF paying a single penny for this transition, putting the burden of transition (however high or low) squarely on the consumers of developing countries, while profiting very few transnational companies.

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