INTERNATIONAL

PATENTS AND THE ROLE OF THE MULTILATERAL FUND*

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EXECUTIVE SUMMARY

Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer are considering actions to phase down hydrofluorocarbons (HFCs) because of their contributions to climate change. One important issue raised by Article 5 Parties[1] is the concern that patents on recently developed low-global warming alternatives could restrict access to or increase the costs of transitioning to these substitutes. This paper looks at how issues related to patents have previously impacted the phase-out of ozone-depleting substances by Article 5 Parties with a focus on the role played by the Protocol's Multilateral Fund. Key conclusions are:

- The funding mandate (Article 10) of the Montreal Protocol establishing the Multilateral Fund includes explicit provisions making clear that the incremental costs of patents and royalty fees associated with shifting to alternatives are eligible for funding.
- Several of the sector specific technology guidelines adopted by the Multilateral Fund's Executive Committee, which are used as the basis for reviewing investment projects, have included the costs associated with licenses and technology transfer fees.
- A review of past investment projects under the Fund shows that only a relatively few cases included the explicit payment for licenses or technology transfer fees, but in other cases such costs are likely to have been incorporated into the costs of the technology itself.
- Because patents are applicable only in the specific countries in which they are filed, projects in most Article 5 Parties are not directly impacted. Other factors which limited the number of past investment projects where payment for licenses or fees was required included: technologies employed were no longer covered by patents (e.g., patents had expired) or the technologies were never covered by patents (e.g., certain not-in-kind alternatives).
- In considering an HFC phasedown, the Multilateral Fund should continue to play a role in paying, both directly and indirectly (as part of the costs of technology), for patents and royalty fees based on future decisions and guidelines, where necessary, as adopted by the Executive Committee. While some of the low global warming alternatives will not be covered by patents, others, particularly those that have only recently been introduced into commerce, are more likely to be subject to patent rights. Any estimates of the funding requirements for replenishing the Multilateral Fund should continue to include the potential need to pay for the costs associated with licensing and technology transfer fees.

INTRODUCTION

The success of the Montreal Protocol to date in phasing out 98 percent of ozone-depleting substances can be attributed to the political will of the parties to protect our planet, but also to the technological innovations that have emerged to make transitions feasible to less harmful alternatives. Faced with another transition to low-global warming potential (low-GWP) alternatives, Article 5 Parties have raised important questions about whether the technologies that will enable compliance with an HFC phasedown will be available to them, whether patents will restrict their access to these alternatives, and whether the Protocol's Multilateral Fund will provide adequate funding for the transfer of these low-GWP technologies.

This paper examines the extent to which patents have played a role in past transitions under the Montreal Protocol with a focus on how the Multilateral Fund has addressed such issues. It also looks to the future at the role that patents associated with the new generation of alternatives are likely to play as Parties to the Protocol shift away from high-GWP hydrofluorocarbons (HFCs) and whether new or different patent-related challenges are likely to arise.

WHAT ARE PATENTS?

Patents are a form of intellectual property protection under which a country (or regional entity) grants an exclusive, time-limited right to a product or process. Patents can be granted for the creation of a new way of doing something or a new technical solution to a defined problem. The patent system seeks to balance the interests in advancing public knowledge about innovative developments with protections aimed at rewarding the inventors of such technologies while also providing economic incentives for continued innovation. In return for the exclusive right to control the use of the patented invention for a specified period of time (typically 20 years from the date of filing for the types of patents relevant here), the applicant must disclose the innovative technical knowledge created by the patent. While publicly available at the time the patent is published, that technology can only be used by others without the approval of the patent holder after the expiration of the patent.[2]

In addition to being limited in duration, patents are only applicable in the jurisdictions (country or regional entity) where they are filed. For example, a patent filed in the United States would only apply to that product's manufacture or sale in the United States. The patent would also need to be filed in other countries, if the applicant wanted to control the product's manufacture or use in any other country.

When a company develops an innovative technology, it must decide in which countries it wants to file a patent. With costs to file and maintain a patent ranging in the thousands to tens of thousands of dollars per country, companies typically are selective where they decide to file. They balance the costs of filing against the business opportunity and the historical security of property rights in countries.

While patents are still required for individual countries or regions, the Patent Cooperation Treaty (PCT)[3], initially signed in 1970, has undertaken actions aimed at making it easier to file patents across multiple jurisdictions. Entities that file patents in a national patent office have a period of 12 months from that filing date to select the other countries where they also intend to file that patent. The patenting entity then has until the end of the 30th month (or 31st month in some countries) from when it filed in the first jurisdiction to file in other national patent offices.[4]

THE MULTILATERAL FUND: PAYING FOR COSTS ASSOCIATED WITH PATENTS

The creation of a financial mechanism under the Montreal Protocol has provided critical support for Article 5 Parties to enable their compliance with the treaty's control measures. Since its start in 1991, the Multilateral Fund has funded a range of activities including institutional strengthening, training, and investment projects totaling approximately US$3.198 billion. These projects have resulted in reductions in ozone-depleting substances estimated to be approximately 458,689 ODP tons (as of December 2014).[5]

As agreed by the Parties to the Montreal Protocol, an Executive Committee, consisting of equal numbers of representatives from Article 5 and non-Article 5 Parties, manages the Multilateral Fund. It adheres to directions provided by the Montreal Protocol Parties, typically in the form of decisions or amendments to the Protocol. While the initial decision creating the Fund and setting out its core operating parameters has remained largely unchanged, the Executive Committee has demonstrated flexibility in implementing its mandate in order to address the evolving needs of Article 5 Parties.[6]

The key guidance setting out the types of costs that are eligible for support from the Multilateral Fund is the "indicative list of categories of agreed incremental costs" that was adopted by the parties at the time the Fund was established.[7] This list first sets out general principles for determining costs including that projects should be based on the "most cost-effective option" and should "take into account the national industrial strategy of the recipient party." The principles also call for avoiding any double counting of costs, mandate that any savings from a project be used to offset costs, that funding should be provided to encourage early action, and that time-scales for supporting incremental costs should be set for each sector.[8]

Beyond these general principles, the guidance specifies a list of categories of agreed incremental costs. In three different categories on the list, the "cost of patents and designs and incremental costs of royalties" is specified. Those categories are:

- cost of conversion of existing facilities;
- costs of establishing new production facilities; and
- for use in manufacturing as an intermediate good (e.g., manufacturing refrigerators, foam, and aerosols that rely on controlled substances).

Thus, the parties explicitly identified that costs associated with patents and associated royalty fees are eligible for funding by the Multilateral Fund. The indicative list was and continues to be the basis upon which the Executive Committee develops policies and guidelines that have shaped actions under the Fund.

COSTS OF PATENTS UNDER PAST MULTILATERAL FUND ACTIVITIES

While a comprehensive examination of the more than a thousand individual investment projects approved to date was beyond the scope of this project, based on a review of the sector-specific technology guidance approved by the Executive Committee and on consultations with staff at the Multilateral Fund and the two of its implementing agencies involved in the greatest number of investment projects(the World Bank and the United Nations Development Program), only a small number of projects were identified where the Multilateral Fund explicitly has paid for licenses and technology transfer fees.[9] Following a description of those projects where the Multilateral Fund directly paid for patents, this paper then looks at the question of why the costs of patents were not incurred in a greater number of projects and whether that is likely to change in the context of a phase-down of high-GWP alternatives.

PROJECTS WHERE PATENTS OR ROYALTIES WERE EXPLICITLY PAID BY THE MULTILATERAL FUND

In order to facilitate project preparation and review for individual investment projects, the Executive Committee has approved specific technology guidelines for a number of sectors. Box 1 below discusses three examples where funds for patents were explicitly included in these guidelines.

In terms of individual investment projects, the following examples illustrate where the Multilateral Fund has explicitly paid for patents or technology license fees.[10] While these examples are not exhaustive, they provide insights into the types of technologies and the circumstances under which licenses or fees of an agreed amount were paid by the Fund.

Refrigerator Manufacturers Conversions in Thailand:[11] A series of projects in the early 1990s in Thailand supported the conversion of refrigerator models, lines

and compressors from chlorofluorocarbons (CFC-11) to a hydrochlorofluorocarbon, HCFC-141b (insulating foam), and from CFC-12 to HFC-134a (refrigerant). In all of these cases, Thai manufacturers had developed their refrigerator product lines working with partners in Japan or the United States under existing technology agreements. The project proposals generally called for the partners to assist the Thai companies in redesigning their refrigerators to shift out of CFCs. While the projects generally included funding for technology assistance in making this transition, only in two cases were licensing fees explicitly paid. Sanyo Universal Electronics paid a technology transfer fee for the new CFC-free refrigerator designs to Sanyo Japan and KKC was paid a licensing fee for new technology it had developed for HFC-134a compressors. In all other cases, the licensing fees were not altered from the existing contracts (thus no incremental costs were incurred) or they were rolled into the costs paid for technology assistance in making the transition. The majority of costs for the projects involved purchasing new equipment to blow foam and charge refrigerators, for test chambers to insure the quality of newly designed products, and for technical support to ensure designs were suitable for Thai conditions (power characteristics and high temperatures and humidity).

***Aqueous systems to make chlorinated rubber*:**[12] Rishiroop is a company in India that wanted to convert from using ozone-depleting carbon tetrachloride to an aqueous-based system in the manufacture of chlorinated rubber. This transition involved a new process that was covered by a patent recently filed by another Indian company. The project approved by the Executive Committee included a technology transfer fee of US$238,000. To insure that the fee was legitimately required, its approval was made contingent on the provisional patent being finalized by the Indian government.

Tobacco expansion projects: The largest single end-user of ozone-depleting substances in the Philippines was Fortune Tobacco, which used CFC-11 to "fluff" tobacco leaves to expand the volume of the commodity per unit of weight.[13] The company wanted to switch to a CFC-free, Dry Ice Expanded Tobacco (DIET) process, that was covered by patents in the Philippines. While publicly available technologies including steam and a nitrogen processes could also be used for tobacco leaf expansion, neither was considered by the company to be as effective as the DIET process. This project was approved by the Executive Committee and included funds for paying the patent holder of the DIET process a royalty of 9-12 cents per pound (depending on total quantity) for several years until the patent expired. Due to delays in implementation of the project, Executive Committee documents show that the actual project start-up occurred after the expiration of the patent, so while approved for payment, no royalties were ever paid.

Tobacco expansion projects were also proposed using the same technology in Indonesia and in a number of facilities in China as part of its proposal to phase out CFC-11 use in this sector. China requested US$100,000 to US$120,000 per machine to pay for the costs for licenses, and funds were approved as part of a sector-wide plan for China to phase out CFC-11 in tobacco fluffing.[14]

Supercritical carbon dioxide for sprayed polyurethane foam: A company in Colombia wanted to switch out of using HCFC-141b in spray foam applications. Instead of moving to a high-GWP HFC alternative, the company proposed a demonstration project using a relatively new carbon dioxide-based process.[15] This technology had been developed recently by a Japanese company and was covered by a patent. While the Multilateral Fund tends to avoid new, relatively untested technologies, this project offered the avoidance of using a high-GWP alternative and lower, long-term operating costs. During project negotiations, the patent-holding company agreed that any information developed during the project implementation using money from the Multilateral Fund would be in the public domain (i.e., detailed experimental protocols used to test the technology; the complete results obtained during the validation including dimensional stability of the foam; and the cost analysis of the technology based on standard prices). The Executive Committee approved the demonstration project to validate the use of supercritical carbon dioxide in the manufacture of sprayed polyurethane (PU) rigid foam on the understanding that this would be the only validation project for this technology in this use sector.

Liquid Carbon dioxide (LCD) technology for polyurethane foams: To shift out of CFC-11 in flexible polyurethane slabstock foams, projects in a number of countries were approved based on a liquid carbon dioxide blowing agent which had been patented by a German manufacturing company. This technology was attractive because it was believed capable of achieving the high density foam cells required for these applications, while avoiding the use of

BOX 1: Sector-Specific Guidelines under the Multilateral Fund

In the following three sector technology guidelines, the costs of licenses or transfer fees were explicitly identified:

- **Liquid carbon dioxide systems**[18] were considered a potentially attractive alternative to CFC-11 in a number of polyurethane foam blowing applications. Because this technology was patented, the guidelines for this subsector included US$50,000 per unit for a technology license fee. These guidelines were initially approved for a one-year trial period and were subsequently modified when the Secretariat determined that the technology was not meeting its performance specifications and as a result some projects had shifted from carbon dioxide to methylene chloride.
- **Tobacco expansion**[19] had used CFC-11 to expand the size of dried tobacco leaves and thereby reduce the quantity (and tar and nicotine content per cigarette) required for use in products. A patented technology (Dry Ice Expanded Tobacco) used carbon dioxide to achieve the same expansion. The guidelines specified that projects could include a royalty fee of US10 cents/pound.
- **Metered-Dose inhalers:**[20] The replacement of CFCs used in metered dose inhalers requires extensive testing, a high standard of quality control, and regulatory approval by medical authorities. The Multilateral Fund's guidelines suggest as one option that Article 5 countries explore licensing arrangements with pharmaceutical companies that already produce these products and mentions examples of existing cross-licensing arrangements – agreements between MDI manufacturers and drug suppliers that allow for use of patented products or technologies under specified conditions. The guidelines state "that small royalty payments (typically upfront payments on signing the agreement (US$2-US $4 million) or payments of a few cents per canister) would be made where such technology is covered by patents."

methylene chloride, a widely available but toxic alternative blowing agent to CFC-11. These projects generally included a US$50,000 licensing fee per machine allowed under the Multilateral Funds guidelines. However following a review of projects implemented under these guidelines, the Executive Committee determined that a large percentage had fallen back on the use of methylene chloride because of technical issues associated with the LCD process and the Committee suspended approval of any future projects relying on this technology pending additional review and guidance.[16]

HFC-134a in Metered-Dose Inhalers (MDIs): MDI projects for a number of Article 5 Parties included payment of a technology transfer fee or license. The first and most challenging of these projects involved Cuba, where restrictions on participation by companies and experts from the United States made obtaining direct technical support problematic. Initial efforts to identify technologies that could be licensed resulted in cost estimates well in excess of what the Executive Committee had determined to be appropriate for this sector. After extended research into less costly options, the project budget included US$1 million for a technology transfer fee and that money was used to hire experts that worked with local industry to convert their MDIs to HFC-134.[17] Similar approaches were used for the MDI sectors in Bangladesh and Pakistan.

PRODUCTION SECTOR PROJECTS

Patents and royalties are specified as qualifying as incremental costs in the phase out of chemical production facilities under the Fund's guidelines. However, to achieve the most cost-effective approach, the Executive Committee has approved funding for production sector phase out projects based primarily on the lost revenue from premature retirement of these facilities and not on the costs of paying for patents. For example, based largely on the lost revenue from early retirement, the Executive Committee approved US$150 million for China to phase out its CFC production facilities and US$82 million for India.[21] Once the amount of the sector project has been calculated, countries then have flexibility in determining how best to use these resources to achieve the project's objective. China used some of the money it received from the Multilateral Fund to support the development of an HFC-134a plant.

CONCLUSIONS

An overview of past activity by the Multilateral Fund illustrates that, consistent with the language in the indicative list of categories of incremental costs, licenses or technology transfer fees were identified as an acceptable cost in several of the Fund's sector technology guidelines. The review also shows that patent-related fees, as agreed to by the Fund's Executive Committee, were also paid in investment projects across several different sectors, but only in a relatively small number of cases. Like other cost items covered by the Fund, the amount of the licensing or technology transfer fees paid in these cases was negotiated with technology suppliers and reviewed by the Executive Committee in the context of cost-effectiveness thresholds for the sector. In looking at whether the same situation is likely for a phase-down of HFCs, it is important to understand why license and technology transfer fees were paid in so few cases.

WHY SO FEW TECHNOLOGY TRANSFER PAYMENTS?

A number of factors may have contributed to the apparently minor role that patents and related licensing fees have played in the transfer of technologies under the Multilateral Fund.

ALTERNATIVE TECHNOLOGIES IN THE PUBLIC DOMAIN

One reason that paying for patents would not be necessary is that the technology being employed in the project was in the public domain – not subject to restrictions created by a patent. This could occur for several different reasons: the technology may never have been patented; the relevant patents for the technology may have expired; or patents were never filed in the specific country where the technology is being produced or sold.

In transitioning out of ozone-depleting substances, companies have relied upon a wide array of technologies. Some technologies, like hydrocarbon propellants for aerosols, have been in use for a very long time. Basic aspects of the process are well established and in the public domain.[22] In contrast, other alternatives (e.g., HFC-134a, HCFC-123) have been developed more recently in response to controls on ozone-depleting substances. Depending on when patents were first filed, the production or use of these may still be subject to restrictions.

Based on the technologies deployed in past projects funded by the Multilateral Fund, it appears a large percentage were no longer subject to patent restrictions. Because the start of controls for Article 5 Parties typically has lagged controls for non-Article 5 Parties by ten years, many patents on substitutes had expired before Article 5 Parties needed to begin their transitions. For example, many of the patents on the production process for HFC-134a date back to the 1980s and early 1990s, and would have expired before Article 5 Parties were required to make substantial reductions in their use of CFCs.

Given that 147 Article 5 Parties are recipients of support from the Multilateral Fund, patents specific to the technologies relevant under the Multilateral Fund have not have been filed in many of these countries. As discussed in the introductory section of this paper, patents are specific to the country in which they are filed. This may explain, in some cases, why patents were paid for in projects in some countries, but not in others.

Overall, the general principles under which the Fund operates tend to result in the use of widely available, proven technologies and typically to avoid newer, less-well proven technologies that are more likely to be covered by patents.[23] The Fund's focus on using the "most cost-effective option" may also limit the adoption of newer, more expensive and recently patented technologies that may not yet have benefited from economies of scale and price competition. Moreover, the Multilateral Fund seeks to maintain to the extent possible the same level of technology pre- and post-project conversion. In avoiding technological upgrades, the Fund may also have limited the number of projects where recently patented technologies have been involved.[24]

One additional reason for the absence of fees and licenses is that in a few cases, companies and organizations owning patented technologies useful to protecting the stratospheric ozone layer have made these available without charge for public use. Examples include technologies critical to recycling refrigerants, aqueous cleaning, no-clean soldering, and most recently the use of HFC-32 in room air conditioners.[25]

TECHNOLOGY TRANSFER FEES INCORPORATED INTO PRODUCT COSTS

While licenses and technology transfer fees have been explicitly identified in only a small number of investment projects that does not necessarily mean that the costs of patents have not been incorporated into other items paid for by the Multilateral Fund.

In many cases a company holding the patent is also selling the product made with that patent. For example, a chiller manufacturer with a patent on its equipment design may simply incorporate the cost of the patent into the price of the product that it sells. Similarly, a firm holding a patent on blends for specific foams, may include the costs of a patent into the price it charges for the blends it sells to manufacturers or system houses. Blends of fluorocarbons (sometimes mixed with other compounds) are increasingly being considered as alternatives and many are patented. Here too, the cost of the patent would generally be reflected in the price of the substitute with the Multilateral Fund covering the incremental operating costs for a specific period of time (typically one year).

Patent restrictions and the payment of explicit fees are more likely to come into play when third parties are involved and where the project entails the conversion of a user who is manufacturing a product. The is illustrated in the example described above of the refrigerator company in Thailand paying a license fee for the design of a refrigerator that used alternatives to CFCs.

Patent payments may also arise where companies have overlapping patents, both of which are necessary to produce a product, where a company holds an application patent restricting the use of its product by others, or where a company holds a composition patent on a specific blend. In these cases, companies oftentimes seek to market their products using cross-licensing agreements. As commercial agreements, the terms are typically not public information, but the costs of the patents may be reflected in the price of the products covered by the agreement.

CONCLUSIONS

There are a number of reasons why the Multilateral Fund has explicitly paid licenses or technology transfer fees in only a limited number of cases. Where no fee was paid, either patents were not in effect or their costs were embedded in some other category of costs (e.g., technical assistance, the costs of the alternative chemicals, or the costs of the technology itself). Cross licensing and other commercial arrangements between patents holders and users may also result in patent-related costs being embedded in the purchase price of affected products. Given the Fund's tendency to favor proven technologies and the time lag before Article 5 Parties are required to make reductions, patents may have expired before the relevant technologies are transferred. It is also possible that patents may never have been filed in the specific countries where products were located. In cases where licenses and technology transfer fees are assessed on a one-time basis, the Multilateral Fund pays the full costs of such transfers. In contrast, where licenses or transfer fees are incorporated into operating costs, the guidelines of the Fund limit such payments to a specified period of time (typically one year).

PATENT ISSUES RELATED TO AN HFC PHASE-DOWN

In considering an HFC phase down, Article 5 Parties have raised concerns that patents could play a more significant role than in the phase down of CFCs and could adversely affect the costs, timing, and even the ability of Article 5 Parties to comply with reduction requirements.

In order to get a better sense of current patent filings on low-GWP alternatives, databases developed by the World Intellectual Property Organization (WIPO) and the government of India were searched for patents filed on HFO-1234yf.[26] The search results include patents filed in 41 countries and regional entities and show both patents that have been granted and those that have been filed, but are pending review[27]. The search conducted for this paper included any patents on record in the WIPO database with the chemical name 2,3,3,3-tetrafluoropropene (HFO-1234yf) listed on the front page. For India, a similar search was conducted of the Indian Patent Advanced Search System for the same chemical name included in the abstract section of filed patents. Because these searches produce results that include patents that are not directly relevant to the use of HFO-1234yf specif-

TABLE 1: HFO-1234yf Patents by Country and Applicant

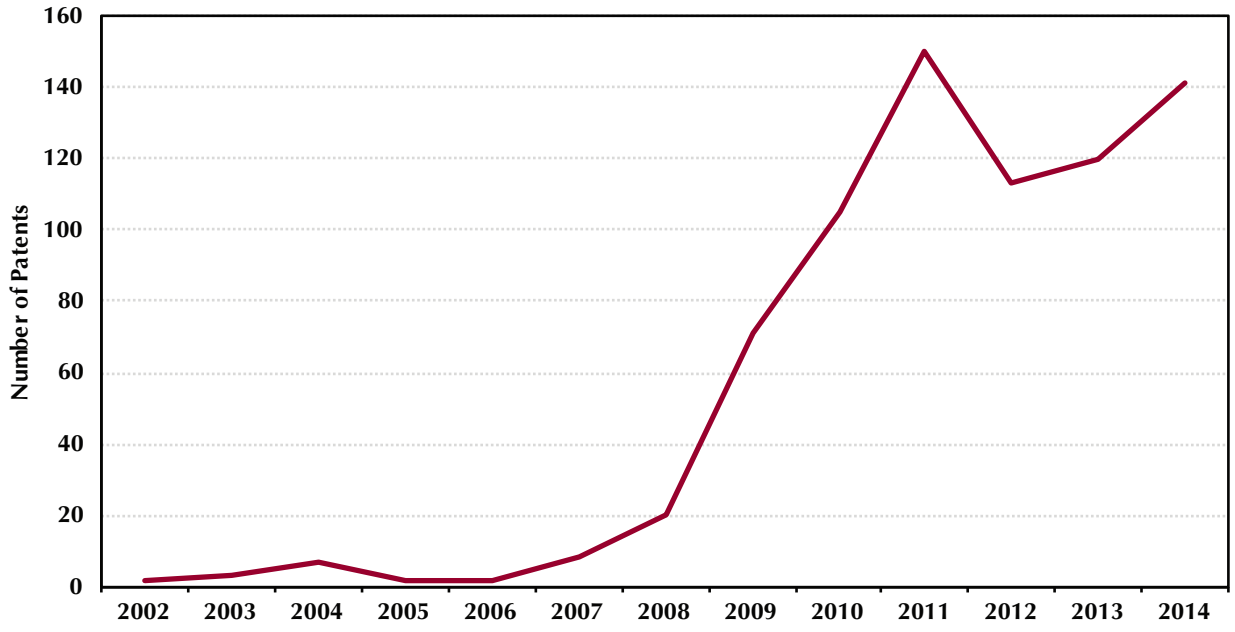
COUNTRY	NO. PATENTS
United States	207
PCT	173
European Patent Office	147
China	125
Mexico	42
India	30
Canada	24
Japan	17
Republic of Korea	17
Russian Federation	16
Singapore	6
United Kingdom	5
Portugal	2

APPLICANT	NO. PATENTS
Honeywell	163
Arkema	146
Du Pont	87
Daikin Industries, LTD.	49
ASAHI GLASS COMPANY, LTD	46
MEXICHEM AMANCO HOLDING S.A. DE C.V.	10
Xi'an Modern Chemistry Research Institute	7

C2ES analysis of patents published from January 1, 2002 to September 10, 2015.

Source: Patents compiled using World Intellectual Property Organization (WIPO) Patent Scope and the Indian Patent Advanced Search System (inPass).

FIGURE 1: Number and Year of Publication of Patents Filed for HFO-1234yf, 2002–2014



C2ES analysis of patents published from January 1, 2002 to September 10, 2015.

Source: Patents compiled using WIPO Patent Scope and the Indian Patent Advanced Search System (inPass).

ic to the Montreal Protocol, the results presented provide useful insights but should not be viewed as definitive.[28]

Table 1 shows that over 800 patents related to HFO-1234yf have been filed to date in a relatively small number of nations (only 13 of the 41 nations covered in the combined WIPO and Indian government databases). The largest number of patents has been filed in the United States and the European Union, but a significant number has also been filed in China, Mexico and India.

Table 1 also shows the seven companies that have filed the largest number of patents. It documents that, as was the case with alternatives to CFCs, a few large transnational corporations are by far the largest filers of patents. However, a number of patents have also been filed by national entities in China that are not part of transnational corporations.[29]

Figure 1 lays out the timing of when patents for HFO-1234yf were filed. While the earliest patents date as far back as 2002,[30] the largest number of patents have been filed more recently, over the past five years.

PRODUCTION PROCESS PATENTS

A closer look at patents specifically focused on the production process for making HFO-1234yf shows that the earliest filings were by Honeywell (2005)[31] and DuPont (2007).[32]

Consistent with past experience with production of HFC-134a,[33] other companies and research entities in both non-Article 5 and Article 5 Parties have also filed patents with their own unique production processes. This includes large transnational companies such as Arkema and Mexichem, but also several national entities in China (e.g., Xi'an Modern Chemical Research Institute (5), Juhua Group Technology (2), Zhejiang University (2), Sinochem Lantian (1)). If past experience holds true, the number and geographic distribution of producers is likely to expand over time.

APPLICATION PATENTS AND PATENTS ON BLENDS

While production process patents focus on how to make a particular compound, application patents are patents on the specific use of a specified compound. Regardless of the company that produces the compound, this type of patent would allow the patent holder to exercise control over its use in specified applications (refrigerators, foams, mobile air conditioning, etc.) covered by the patent. The use of patents on blends (e.g., composition-based patents) also appears to be growing. While a specific compound itself cannot be patented, the use of such compounds in specified blends can be and a growing number of such patents have been filed.

Both application patents and patents on blends have existed in the past and are not unique to sectors of interest to the Montreal Protocol. Typically, cross-licensing and other commercial arrangements are commonly used by patent holders and users to facilitate the marketing of these technologies. To date, neither has proven to be an impediment in the transfer of technology under the Montreal Protocol.

One example of an application patent was filed by Honeywell in the United States in 2009 and covers the use of HFO-1234yf across a wide range of sectors, including in mobile air conditioning, heating and cooling equipment, foams, and solvent applications.[34] This patent has also been filed in Australia, Canada, China, the European Union, India, Israel, Japan, Korea, Mexico, Russia and South Africa.[35]

Honeywell's application patent covering the use of HFO-1234yf in mobile air conditioning has been legally challenged by several other companies holding HFO-1234yf production patents and by auto manufacturers in Europe. While the European Patent Commission has issued an invalidation ruling on this particular application patent, it is currently under appeal and remains in effect.[36] Despite the existence of this application patent, several transnational corporations have announced plans to build HFO-1234yf production plants, and approximately 7 million cars will be on the road worldwide by the end of 2015 with HFO-1234yf as their coolant.[37]

Other potentially significant application patents are held by Daikin, covering the use of HFC-32 in air conditioning systems. In 2011, the Indonesian Ministry of Environment and Ministry of Industry and the Japan Ministry of Economy Trade and Industry (METI) plus Daikin, Panasonic, Fujitsu, Hitachi and Toshiba—with the support of the United Nations Development Program and the Institute for Governance & Sustainable Development formed a partnership to commercialize HFC-32 room air conditioners to avoid shifting to a high-GWP HFC.[38] In September 2015, expanding on a previous commitment, Daikin announced that it would make 93 patents on HFC-32 use in cooling and heating technologies freely available to all manufacturers.[39] Thus, through this voluntary commitment, patent issues associated with the use of this alternative in this important application are likely to be reduced.

At this early stage in the transition to low-GWP alternatives, it is unclear the extent to which patents on applications and blends will impact the costs or timing of shifting to low-GWP alternatives. The initial experience in those countries with national regulations limiting high-GWP HFCs is that a range of alternatives are available for many sectors. The role of not-in-kind alternatives and substitutes has and is likely to continue to play an important role in providing price competition.[40] Some low-GWP alternatives are widely available (e.g., hydrocarbon-based technologies in foams and refrigeration) and relatively low cost. The new generation of chemical alternatives varies widely in costs, with some many times more expensive than the HFCs they are substitutes for, while others are only marginally more expensive. Over time, the costs of these substitutes are likely to come down in price as worldwide production capacity increases. Moreover, to the extent that cross-licensing and other commercial arrangements continue to make these products widely available globally, issues of concern about availability are less likely to materialize.

The Protocol's Multilateral Fund can also help address these concerns by continuing to fund the costs of licenses and transfer fees when necessary to enable the conversion to low-GWP technologies. Moreover, the Fund can help facilitate increased use of voluntary patent contributions as was recently initiated by Daikin. In cases where license fees are required, the Fund may also investigate the feasibility and desirability of arranging a patent pool whereby the license fee would be negotiated by the Fund and then made available for multiple use in those investment projects where it is selected as the appropriate technology.

CONCLUSIONS

The widespread existence of patents is not new or unique to sectors involving the Montreal Protocol. Nor is it surprising, given the innovation required for a transition out of high-GWP alternatives. As was true with HFC-134a, the initial chemical production process patents were filed by transnational companies who continue to hold the largest portfolios. But technological innovation is not limited to companies in any one country or region. A number of entities in China have also recently filed their own unique processes and commercial-scale production has already begun in cooperation with transnational companies in China.

Patents on the use of these alternatives in specific sectors and on the use of blends have raised considerable concerns about their impact on restricting access to or the costs of alternatives. As was true in past transitions, cross licensing among and between patent holders and users is likely to be an important mechanism for making patented products more widely available. The Multilateral Fund can also play a role by continuing to include licenses and technology transfer fees as a relevant cost in investment projects, by supporting efforts by companies to voluntarily make patents available free of charge for use by Article 5 Parties, and by arranging patents pools for cost effective payment of licenses where such payments are required.

ENDNOTES

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1 As defined by the Protocol, Article 5 Parties are essentially developing countries, while non-Article 5 Parties are developed countries. See "List of Parties categorized as operating under Article 5 paragraph 1 of the Montreal Protocol," United Nations Environment Programme (UNEP) Ozone Secretariat, accessed July 20, 2015, http://ozone.unep.org/new_site/en/parties_under_article5_para1.php.

2 "Frequently Asked Questions: Patents," World Intellectual Property Organization accessed October 1, 2015, http://www.wipo.int/patents/en/faq_patents.html.

3 The Patent Cooperation Treaty is administered through the World International Property Rights Organization (WIPO).

4 "PCT – The International Patent System," World Intellectual Property Organization, accessed October 1, 2015, http://www.wipo.int/pct/en.

5 "Multilateral Fund for the Implementation of the Montreal Protocol," Secretariat of the Multilateral Fund for the Implementation of the Montreal Protocol, accessed October 1, 2015, http://www.multilateralfund.org.

6 For example, the Executive Committee has provided extensive support for institutional strengthening and country capacity building, categories of costs that were not specifically identified in the original terms of reference.

7 "Decisions on establishment of interim financial mechanism," Ozone Secretariat, accessed October 1, 2015, http://ozone.unep.org/en/handbook-montreal-protocol-substances-deplete-ozone-layer/1815.

8 Ibid.

9 A comprehensive review completed in 2007 of projects under the Multilateral Fund (with a small percent completed by the Global Environmental facility) did not focus on the number of cases where licenses or technology fees were paid, but did identify two projects (both in India) where patents had been a constraint: one where producers were constrained by the high price and market restrictions placed on access to a production process patent on HFC-134a and one where a firm marketing halon substitutes had difficulties in obtaining a license to distribute HFC-227a. See Andersen, Stephen O., K. Madhava Sarma, and Kristen N. Taddonio, *Technology transfer for the ozone layer: lessons for climate change* (London: Earthscan, 2007), p. 262-265.

10 These projects were identified through consultations with current and former staff at the Multilateral Fund Secretariat and several of the implementing agencies that support the Fund's operations.

11 Based on information contained in Project Summary Reports for Thailand for the refrigeration sector. Prepared by the World Bank for the Secretariat to the Multilateral Fund (May 1993).

12 Multilateral Fund Project Completion Report for Investment Project Number IND/PAG/34/INV/320. Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Project Proposals: India*, UNEP/OzL.Pro/ExCom/34/30 (Montreal, Canada: Multilateral Fund, 2001), http://www.multilateralfund.org/sites/34/Document%20Library2/1/3430.pdf.

13 Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Project Proposals: The Philippines,*, UNEP/OzL.Pro/ExCom/9/17 (Montreal, Canada: Multilateral Fund, 1996).

14 Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Project Proposals: China*, UNEP/OzL.Pro/ExCom/36/26 (Montreal, Canada: Multilateral Fund, 2002), http://www.multilateralfund.org/sites/36/Document%20Library2/1/3626.pdf.

15 Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Project Proposals: Columbia*, UNEP/OzL.Pro/ExCom/60/25 (Montreal, Canada: Multilateral Fund, 2010), http://www.multilateralfund.org/sites/60/Document%20Library2/1/6025.pdf.

16 Decision 39/52. Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Report of the 39th Meeting of the Executive Committee of the Multilateral Fund for the implementation of the Montreal Protocol. An update for the period 2011/12,* UNEP/OzL.Pro/ExCom/39/43 (Montreal, Canada: Multilateral Fund, 2003), http://www.multilateralfund.org/sites/39th/Document%20Library2/1/3943.pdf.

17 Multilateral Fund investment project number CUB/ARS/41/INV/23. Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *2015 Consolidated Project Completion Report*, UNEP/OzL.Pro/ExCom/74/7 (Montreal, Canada: Multilateral Fund, 2015), http://multilateralfund.org/74/English/1/7407.pdf.

18 "Annex IX.14: Guidelines for liquid carbon dioxide projects," Multilateral Fund Secretariat, accessed October 1, 2015, http://www.multilateralfund.org/Our%20Work/webhelp/index.html#!anneIxGuidForLiquCarbDioxProj.

19 Annex IX.24: Guidelines for Calculation of incremental cost in tobacco expansion projects," Multilateral Fund Secretariat, http://www.multilateralfund.org/Our%20Work/policy/Shared%20Documents/Policy73-ChapterIX.pdf.

20 Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Draft guidelines for Metered Dose Inhaler (MDI) projects,* UNEP/OzL.Pro/ExCom/37/58 (Montreal, Canada: Multilateral Fund, 2002), http://www.multilateralfund.org/sites/37/Document%20Library2/1/3758.pdf.

21 Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Report on the intermediate evaluation of CFC production phase-out agreements*, UNEP/OzL.Pro/ExCom/42/12 (Montreal, Canada: Multilateral Fund, 2004), p. 10, http://www.multilateralfund.org/sites/42/Document%20Library2/1/4212.pdf.

22 However, even for longstanding technologies, product enhancements and innovations can still be patented. For example, advancements in aerosol valve designs could be the subject of patents.

23 There are exceptions, as described above in the cases of the super-critical carbon dioxide and liquid carbon dioxide projects for foams. Under certain circumstances, the Fund has supported demonstration projects utilizing less proven technologies particularly those that substitute for high-GWP alternatives.

24 See Agenda Item 18: Technology Upgrades in Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, *Report of the 18th meeting of the Executive Committee,* UNEP/OzL.Pro/ExCom/18/75 (Montreal, Canada: Multilateral Fund, 2002), http://www.multilateralfund.org/MeetingsandDocuments/meetingsarchive/reports/English/1/1875.pdf.

25 Stephen O. Andersen, K. Madhava Sarma, and Kristen N. Taddonio, *Technology Transfer for the Ozone Layer,* (Earthscan 2007) and "Technical Assistance to Thailand for Next Generation Refrigerant HFC32," Daiken Industries, last modified April 27, 2015, http://www.daikin.com/press/2015/150427/index.html.

26 The World Intellectual Property Organization maintains PatentScope, a searchable database containing 48 million patent records from 40 national or regional offices. Since patents for India are not currently included in the PatentScope data base, a separate search was conducted of patents in India using a data base maintained by the government.

27 Patents that are published, but are pending review, may be challenged by others, not granted by the patenting authority, or may be allowed to lapse by the patent holder.

28 A detailed review of individual patents would be required to identify only those relevant to the issues addressed by this paper, but that level of analysis was beyond the scope of this research. It is also important to note that different

searches would have resulted in substantially different output. For example, if the full text of the document was searched rather than the front page, almost three times the number of entries would have been identified.

29 For a more detailed discussion of the shift over time of production of CFCs and HFCs from developed to developing countries, see Stephen Seidel and Jason Ye, *Technological Change in the Production Sector Under the Montreal Protocol* (Arlington, VA: Center for Climate and Energy Solutions, 2015), http://www.c2es.org/publications/technological-change-production-sector-under-montreal-protocol.

30 The initial patents published for HFY-1234yf in 2002 were for its use as a fluoroelastomer. The first patent for a production process to manufacture HFO-1234yf was published in 2005.

31 Hsueh S. Tung, Haridasan K. Nair, Sundip S.M. Mukhopadhyay, Der Puy Michael Van (Honeywell). Processes for synthesis of 1,3,3,3-tetrafluoropropene and 2,3,3,3-tetrafluoropropene. PCT/US2005/015125, published on November 17, 2005.

32 For example, two patents from DuPont published in 2007 were: Velliyur Nott Mallikarjuna Rao, H. David Rosenfeld, Allen Capron Sievert, Shekhar Subramoney (DuPont). Process for the preparation of 1,3,3,3-tetrafluoropropene and/or 2,3,3,3-tetrafluoropropene. PCT/US2006/030531, filed August 4, 2006, and issued March 16, 2010. See also Ralph Newton Miller, Mario Joseph Nappa, Velliyur Nott Mallikarjuna Rao, Allen Capron Sievert (DuPont). *Process for the preparation of 1,3,3,3-tetrafluoropropene and/or 2,3,3,3-tetrafluoropropene*. PCT/US2006/042771, filed November 1, 2006, and issued August 2, 2007.

33 While the first patents were filed for HFC-134a by DuPont, ICI and other transnational corporations and production began in non-Article 5 Parties, over time many other companies began production and currently roughly half of production occurs in China and India. See Stephen Seidel and Jason Ye, *Technological Change in the Production Sector Under the Montreal Protocol* (Arlington, VA: Center for Climate and Energy Solutions, 2015), http://www.c2es.org/publications/technological-change-production-sector-under-montreal-protocol.

34 Rajiv R. Singh, Hang T. Pham, Ian Shankland, Raynond H. Thomas, David P. Wilson (Honeywell). Compositions containing fluorine substituted olefins. US Patent 8065882, issued November 29, 2011.

35 "(WO2005105947) Compositions containing fluorine substituted olefins," WIPO PatentScope, accessed October 1, 2015, https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2005105947.

36 "Honeywell appeals decision to revoke 1234yf patent," ACR News, last modified May 11, 2012, http://www.acr-news.com/honeywell-appeals-decision-to-revoke-1234yf-patent.

37 Estimated by DuPont. "DuPont Statement: Extensive Distribution Network in Place to Support Accelerating Adoption of HFO-1234yf Refrigerant, which is Expected to be in 7 Million Cars by End of 2015," DuPont, last modified October 6, 2014, http://www.dupont.com/corporate-functions/media-center/press-releases/dupont-statement--extensive-distribution-network-in-place-to-sup.html.

38 Sadatani, Satoshi, "Tipping the Balance Towards Climate Protection Through the HCFC Phaseout," special issue, *OzonAction* (2011).

39 "Daikin Offers Worldwide Free Access to Patents for equipment Using Next-Generation Refrigerant," Daiken Industries, last modified April 27, 2015, http://www.daikin.com/press/2015/150910/index.html.

40 One recent study estimated that only about 15 percent of ozone-depleting substances were replaced by chemicals alternatives. Not-in-kind substitutes and alternatives, recovery and recycling, and reductions in emissions accounted for the remainder of past uses. Stephen O. Andersen, Duncan Brack, and Joanna Depledge, *A Global Response to HFCs through Fair and Effective Ozone and Climate Policies* (London: Chatham House, 2014), http://www.chathamhouse.org/publication/global-response-hfcs.

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