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Item 6 of the provisional agenda
Development and transfer of technologies

Report of the Global Environment Facility on a strategic programme to scale up the level of investment for technology transfer

Note by the secretariat[*]

1. The Conference of the Parties, by its decision 4/CP.13, paragraph 3, requested the Global Environment Facility (GEF), as an operational entity of the financial mechanism under the Convention, in consultation with interested Parties, international financial institutions, other relevant multilateral institutions and representatives of the private financial community, to elaborate a strategic programme to scale up the level of investment for technology transfer to help developing countries address their needs for environmentally sound technologies, specifically considering how such a strategic programme might be implemented along with its relationship to existing and emerging activities and initiatives regarding technology transfer and to report on its findings to the twenty-eighth session of the Subsidiary Body for Implementation for consideration by Parties.

2. In response to this request, the GEF secretariat has submitted the attached report (see annex) dated 8 May 2008; it is reproduced here as submitted, without formal editing, and with the original pagination.

[*] This document was received from the Global Environment Facility Secretariat on 23 May 2008 and was submitted as soon as it was received.

Annex

Global Environment Facility

May 8, 2008

THE ELABORATION OF A STRATEGIC PROGRAM TO SCALE-UP THE LEVEL OF INVESTMENT IN THE TRANSFER OF ENVIRONMENTALLY-SOUND TECHNOLOGIES: A PROGRESS REPORT

EXECUTIVE SUMMARY

1. This paper presents a response by the GEF to the request embodied in COP Decision 4/CP.13, which requested the GEF to report to the 28th Session of the SBI on its findings with respect to the elaboration of a strategic program on technology transfer. In keeping with a decision reached by the Thirty-third Meeting of the GEF Council, this report contains two parts. Part I describes the GEF's work to date on the financing of technology transfer in the areas of both mitigation and adaptation to climate change. Part II describes current financing options for technology transfer.

2. These two parts could provide useful background for any future discussion of the transfer of EST's in the context of the climate change convention.

ABBREVIATIONS AND ACRONYMS

CDM	Clean Development Mechanism
CFL	Compact Fluorescent
COP	Conference of the Parties
CSP	Concentrating Solar Power
EBRD	European Bank for Reconstruction and Development
EGTT	Expert Group on Technology Transfer
EST	Environmentally Sound Technology
FCB	Fuel-cell Bus
GEF	Global Environment Facility
GHG	Greenhouse Gases
GWP	Global Warming Potential
IDB	Inter-American Development Bank.
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
MP	Montreal Protocol
NAPA	National Adaptation Program of Action
NGO	Non-governmental Organization
ODA	Official Development Assistance
ODS	Ozone Depleting Substance
PV	Photovoltaic
RE	Renewable Energy
REN21	Renewable Energy Network for the 21st Century
S&L	Standards and Labeling
SBI	Subsidiary Body on Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SHS	Solar Home System
SME	Small and Medium Enterprises
TNA	Technology Needs Assessment
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change

INTRODUCTION

1. Technology transfer is seen to play a critical role in the global response to the challenge of climate change. In the Special Report of the Intergovernmental Panel on Climate Change (IPCC) Working Group III, "Methodological and Technical Issues in Technology Transfer", the IPCC defined the term "technology transfer" as:

> … a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions. Therefore, the treatment of technology transfer in this Report is much broader than that in the UNFCCC or of any particular Article of that Convention. The broad and inclusive term "transfer" encompasses diffusion of technologies and technology cooperation across and within countries. It covers technology transfer processes between developed countries, developing countries and countries with economies in transition, amongst developed countries, amongst developing countries, and amongst countries with economies in transition. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies.[1]

2. This definition includes a wide range of activities and extends to a broad range of institutions. It also provides the basis for much of the current understanding of technology transfer. Technology flows are frequently traced through investment flows, as the latter serves as a surrogate indicator for technology transfer in general. Foreign direct investment, official development assistance (ODA), commercial lending and equity investment are all important channels through which technology transfer is financed. However, financial flows alone are insufficient to ensure adequate transfer of climate-friendly technology. The IPCC describes three major dimensions necessary to ensure the effectiveness of technology transfer: capacity building; enabling environments; and mechanisms for technology transfer. Barriers to the smooth working of the market for a specific technology—either in the form of limited capacity; an unsuitable policy environment; or a lack of financing mechanism—will limit the diffusion of the technology.

3. The COP established the Expert Group on Technology Transfer (EGTT) under the Subsidiary Body for Scientific and Technological Advice (SBSTA) through Decision 4/CP.7.[2] Decision 4/CP.7 also requested the GEF to provide financial support for the technology transfer framework through both the climate change focal area and the Special Climate Change Fund (SCCF).

4. The Annex to Decision 4/CP.7 defined a framework for meaningful and effective actions to increase and improve the transfer of and access to ESTs and know-how.[3] The framework

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[1] Metz, Bert; O. Davidson; J.W. Martens; S. N. M. Van Rooijen; and L. V. W. McGrory. 2001. Methodological and Technological Issues in Technology Transfer. Cambridge, UK: Cambridge University Press for the IPCC.

[2] FCCC/CP/2001/13.

[3] FCCC/CP/2001/13/Add.1.

defined five key elements for meaningful and effective actions to transfer technology. The first element is the area of technology needs and needs assessments, defined as a set of country-driven activities to determine technology priorities through a widespread stakeholder consultation process. The second element is that of technology information. The third element is that of enabling environments, defined as government actions, including the removal of technical, legal and administrative barriers to technology transfer, sound economic policy and regulatory frameworks to create a conducive environment for private and public sector investment in technology transfer. The fourth element of the framework is capacity building, which is considered to be a process seeking to build, develop, strengthen, enhance and improve existing scientific and technical skills, capabilities and institutions in developing country Parties to enable them to assess, adapt, manage and develop ESTs. The fifth element is that of mechanisms to facilitate the support of financial, institutional and methodological activities to enhance coordination among stakeholders; to engage stakeholders in cooperative efforts to accelerate the development and diffusion of ESTs; and to facilitate the development of projects and programs to support these ends.

5. The COP most recently reconstituted the EGTT for a period of 5 years (Decision 3/CP.13), with the "objectives of enhancing the implementation of Article 4, paragraph 5, of the Convention and advancing the development and transfer of technology activities under the Convention" and with the objectives "of enhancing the implementation of the Convention provisions relevant to advancing the development, deployment, adoption, diffusion and transfer of environmentally sound technologies to developing countries, taking into consideration differences in accessing and applying technologies for mitigation and adaptation"[4]. EGTT activities have included analytical work, particularly in terms of innovative financing, including a workshop, technical paper, and project financing guidebook.

BACKGROUND TO THIS PAPER

6. At the Thirteenth Meeting of the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) held in Bali, Indonesia in December 2007, the COP reached a decision on the development and transfer of environmentally-sound technologies. The decision reads as follows:

> 3. Requests the Global Environmental Facility, as an operational entity of the financial mechanism under the Convention, in consultation with interested Parties, international financial institutions, other relevant multilateral institutions and representatives of the private financial community, to elaborate a strategic programme to scale up the level of investment for technology transfer to help developing countries address their needs for environmentally sound technologies, specifically considering how such a strategic programme might be implemented along with its relationship to existing and emerging activities and initiatives regarding technology transfer and to report on its findings to the twenty-eighth session of the Subsidiary Body for Implementation for consideration by Parties" (Decision 4/CP.13).

[4] FCCC/CP/2007/6/Add.1.

7. At its Thirty-third Meeting held from April 22- 24, 2008, the GEF Council reviewed a draft paper prepared by the Secretariat. There was no consensus as to whether it responded appropriately to the guidance from the COP. Given the tight time constraints, the Council reached the following decision with regard to Agenda Item 13, Strategic Program to Scale-Up the Level of Investment in the Transfer of Environmentally-Friendly Technologies:

> Council agreed that the Secretariat should prepare a report comprising:
>
> (i) a description of its work to date on financing technology transfer, and
> (ii) a description of current financing options for technology transfer.
>
> Council noted that further guidance would be needed regarding its mandate in respect of decision 4/CP.13. Pending further guidance, Council will continue to work on this issue in light of views expressed at the Subsidiary Body on Implementation (SBI) of the UNFCCC.
>
> The report will be circulated to Council for approval to forward to the SBI.
>
> *(GEF Council 33, April 22-24, 2008, Joint Summary of the Chairs, para 24-26).*

8. This paper was prepared by the GEF Secretariat in response to the above-cited decision. It contains two parts. The first part represents a brief summary of its work to date on financing technology transfer. The second part presents a brief description of current financing options for technology transfer.

PART I: GEF'S WORK TO DATE ON FINANCING TECHNOLOGY TRANSFER

9. Part I of this paper focuses on the experience of the GEF to date in supporting technology transfer consistent with both the IPCC definition and the Convention's Framework on Technology Transfer. It first summarizes the COP decision texts providing the GEF's mandate to work on the transfer of environmentally-sound technologies (EST's) under both the GEF Trust Fund and the Special Climate Change Fund (SCCF). Although some decisions focus on technology transfer for mitigation and others on technology transfer for adaptation, the bulk of the guidance provided to the GEF does not distinguish between mitigation and adaptation, simply addressing the need to support technology transfer. The paper then summarizes the GEF's strategies and policies that have evolved in the years of its operation with respect to the transfer of EST's and provides examples of the EST's relevant to both mitigation and adaptation to which the GEF has provided support together with a brief summary of the results and findings. Finally, it discusses some of the elements relating to the transfer of EST's from COP Decision 4/CP.13 and how GEF has been able to provide that support in the past.

GEF's Mandate on the Transfer of EST's: COP Guidance

10. The transfer of EST's is embodied in the very fabric of the UNFCCC. Article 4.5 of the Convention states that

> "developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention." *(UNFCCC, Article 4.5)*

11. In order to pursue these goals, the Convention proposed the creation of a Financial Mechanism. Article 11 of the Convention reads

> "A mechanism for the provision of financial resources on a grant or concessional basis, including for the transfer of technology, is hereby defined. It shall function under the guidance of and be accountable to the Conference of the Parties, which shall decide on its policies, program priorities and eligibility criteria related to this Convention. Its operation shall be entrusted to one or more existing international entities". *(UNFCCC Article 11)*.

12. Since the time of the First Meeting of the Conference of Parties, the GEF has served as an entity operating the financial mechanism of the Convention. It has responded to guidance given to it by the COP on policies, program priorities, and has reported to the COP on an annual basis. The COP regularly provides guidance to the GEF, and much of this guidance has addressed the financing of EST's.

13. The first meeting of the COP provided guidance to the operating entity or entities of the financial mechanism that included the following statement:

2 (b) On transfer of technology, the Committee took note of document A/AC.237/88 prepared by the interim secretariat. The Committee recognized the importance of this subject under the relevant articles of the Convention and concluded that discussions should continue at the Conference of the Parties and its subsidiary bodies with a view to identify ways and means of operationalize the transfer of technology under Article 4.5 of the Convention.

(Decision 11/CP.1 paragraph 2 (b)).

14. Decision 2/CP.4 states that GEF should provide funding to developing country Parties to:

1(g) Support capacity-building for:

(i) The assessment of technology needs to fulfill the commitments of developing countries under the Convention, the identification of sources and suppliers of these technologies, and the determination of modalities for the acquisition and absorption thereof;

(ii) Country-driven activities and projects to enable Parties not included in Annex I to the Convention (non-Annex I Parties) to design, evaluate and manage these projects;

(iii) Strengthening the capacity of non-Annex I Parties to host projects, including from project formulation and development to their implementation;

(iv) Facilitating national/regional access to the information provided by international centres and networks, and for working with those centres for the dissemination of information, information services, and transfer of environmentally sound technologies and know-how in support of the Convention;

(Decision 2/CP.4, paragraph 1)

15. Decision 4/CP.7 which established the technology transfer framework also included the following statement:

3. *Requests* the Global Environment Facility, as an operating entity of the financial mechanism of the Convention, to provide financial support for the implementation of the annexed framework through its climate change focal area and the special climate change fund established under decision 7/CP.7;

(Decision 4/CP.7, paragraph 3).

16. Decision 5/CP.7 decided that the GEF and other sources of bilateral and multilateral sources should provide support to the transfer of adaptation technologies (para. 7b(iv)). Decision 6/CP.7 specified that the GEF should provide support to the least developed and the small island developing states in support of Articles 4.3; 4.5 and 11.1 of the Convention. Decision 7/CP.7 established the Special Climate Change Fund to support adaptation to the adverse effects of climate change; transfer of environmentally-sound technologies; mitigation initiatives in different sectors; and economic diversification.

17. Decision 6/CP.8 decided that the GEF should:

> (c) On matters relating to transfer of technologies: provide financial resources to non-Annex I Parties, in particular the least developed country Parties and the small island developing States among them, in accordance with decision 4/CP.7, through its climate change focal area and the Special Climate Change Fund established under decision 7/CP.7, for the implementation of the framework for meaningful and effective actions to enhance the implementation of Article 4, paragraph 5, of the Convention, contained in the annex to decision 4/CP.7;
>
> *(Decision 6/CP.8 para. 1(c)).*

18. Decision 4/CP.9 decided that the GEF should continue to support enabling activities related to technology needs assessments (Decision 4/CP.9 para. 1(c)).

19. Decision 5/CP.9 included the following statement:

> 3. *Decides further* that resources from the Special Climate Change Fund shall be used to fund technology transfer activities, programmes and measures that are complementary to those currently funded by the Global Environment Facility taking into account national communications or any other relevant documents in accordance with decision 4/CP.7 and its annex containing the framework for meaningful and effective actions to enhance the implementation of Article 4, paragraph 5, of the Convention, in the following priority areas:
>
> (a) Implementation of the results of technology needs assessments;
> (b) Technology information;
> (c) Capacity-building for technology transfer;
> (d) Enabling environments;
>
> *(Decision 5/CP.9 para. 3.)*

20. Decision 1/CP.12 decides that the funds of the SCCF shall be used in a manner complementary to those of the GEF Trust Fund to support activities related to the following priority areas:

> (a) Energy efficiency, energy savings, renewable energy and less-greenhouse-gas-emitting advanced fossil-fuel technologies;
> (b) Innovation including through research and development relating to energy efficiency and savings in the transport and industry sectors;
> (c) Climate-friendly agricultural technologies and practices, including traditional agricultural methods;
> (d) Afforestation, reforestation and use of marginal land;
> (e) Solid and liquid waste management for the recovery of methane;
>
> *(Decision 1/CP.12)*

21. In Decision 3/CP.12, the COP requested the GEF, as an operating entity of the financial mechanism:

(d) To continue to provide financial support for the implementation of the technology transfer contained in the annex to decision 4/CP.7, including new sub-themes,1 through its climate change focal area and the Special Climate Change Fund established under decision 7/CP.7;
(e) To provide financing to Parties not included in Annex I to the Convention that received the top-up fund but did not conduct their technology needs assessments, to enable these Parties to conduct their technology needs assessments as part of their second national communications, and to provide these funds to Parties not included in Annex I to the Convention that have conducted their technology needs assessments but need to update them, also as part of their second national communications, in addition to the amount approved for the preparation of their second national communication.

(Decision 3/CP.12, para. 1 (d) and (e)).

22. In summary, the COP has provided the GEF, as an operating entity of the financial mechanism of the Convention, with significant guidance related to financing activities relating to the transfer of EST's in the context of both mitigation and adaptation. This guidance refers to activities to be funded under both the GEF and the SCCF, and because it also includes mention of the special needs of the LDCs, it can also be applied to meeting technology transfer needs relating to the response to urgent and immediate adaptation needs under the Least Developed Countries Fund (LDCF).

GEF Policies and Strategies relating to Technology Transfer

23. During the GEF's Pilot Phase (1991-1994), projects focused largely on demonstrating as wide a range as possible of technologies that would be useful in stabilizing the level of GHG concentrations in the atmosphere.

24. After the restructuring of the GEF in 1994, the GEF Council approved the Operational Strategy which stated the GEF's goal in the climate change focal area as being to "support sustainable measures that minimize climate change damage by reducing the risk, or the adverse effects, of climate change. The GEF will finance agreed and eligible enabling, mitigation, and adaptation activities in eligible recipient countries."[5] This objective for GEF operations still holds, and was restated in the GEF-4 Revised Strategy.

25. The First Meeting of COP of the UNFCCC approved of the proposed GEF strategy in the climate change focal area, which was described as:

> "a mixed strategy wherein projects will be selected with a double set of programme priorities as described in paragraph 9(c) of the [GEF] report, that is, if they meet either one of the long-term programme priorities or one of the short-term programme priorities,"
>
> *(Decision FCCC/CP/1995/7/Add. 1 or Decision 12/CP.1, Appendix 3B.)*

[5] GEF Secretariat, 1995, GEF Operational Strategy, p 31.

26. The operational strategy approved by the Council in 1995 identified three long-term operational programs to support climate change mitigation and a window for short-term projects. Short-term projects were defined as options that were "too good to refuse" because of their extreme cost-effectiveness, in this case, they were required to demonstrate a unit-abatement cost (UAC) of less than $10/ tonne of carbon avoided.[6] In contrast, the long-term programmes were designed to support less cost-effective interventions and to allow for a distinction between technologies on the basis of their maturity and commercial availability. All of the approaches—both programmatic long-term approaches and short-term projects—focused primarily on mitigation through the use of newly commercialized or nearly-commercialized technologies that were not yet widely disseminated in developing countries or countries with economies in transition..

27. Operational Programs (OP) 5 focused on energy efficiency and OP 6 focused on renewable energy technologies that were mature, available on the international market and profitable on paper but were not disseminating because of the existence of a number of barriers of a human, institutional, technological, policy, of financial nature. Projects under these OP's were termed "barrier removal" projects, as they sought to remove these barriers and promote accelerated growth in the adoption of the new technologies and practices. In contrast, OP 7 focused on reducing the long-term costs of low-GHG emitting electricity generating technologies. By definition, the technologies included under this program were not-yet commercially available and very expensive relative to the baseline or conventional alternatives. In these cases, such as concentrating solar power (CSP) plants, fuel-cell buses (FCB's), biomass-integrated-combined-cycle generation (BIG/GT), stationary fuel-cells, and micro-turbines, significant incremental costs still existed. In other words, the technology and its costs formed the barrier to greater dissemination of the technology. When the operational program on sustainable transport (OP 11) was approved in 2000, it contained a combination of approaches, including a focus not only on technologies and practices that were cost-effective but underutilized but also on technologies that were not fully developed.

28. In 2004, the GEF's Office of Monitoring and Evaluation completed the second Climate Change Program Study.[7] It concluded that the GEF's operational strategy focusing on barrier removal renewable and energy efficient technologies had largely been successful, but required some codification. The five key barriers to be addressed in moving toward more efficient dissemination of technologies through markets in developing countries were:

(a) Policy frameworks: Government plays an essential role in setting the ground-rules that are favorable to the adoption of ESTs.

(b) Technology: The technology itself needs to be robust and operational. The more mature a technology is, the easier it will be to transfer.

[6] The UAC for short-term projects was set at $10/tone of Carbon avoided, or roughly $2.7/tonne of CO2 equivalent avoided.

[7] GEF Office of Monitoring and Evaluation. 2004. *GEF Climate Change Program Study*. (September) Washington D.C.: World Bank.

(c) Awareness and information: National stakeholders, especially market participants, need to be aware of the technology and have information on its costs, uses, and niches.

(d) Business and delivery models: As technology transfer occurs through markets, businesses and institutions need to be in place to deliver and service the markets.

(e) Availability of financing: Financing needs to be available for the technology, but financing itself is insufficient to ensure the uptake of the EST.

29. The main conclusions of the Climate Change Program Study were endorsed by the Third Overall Performance Study that noted that "the GEF has played an important catalytic role in developing and transforming the markets for energy and mobility in developing countries, particularly through its energy efficiency portfolio" and that "OPS3 also found good examples of market transformation in renewable energy".[8] These principles or lessons have informed the approach embodied in the GEF-4 Revised Programming Strategy in the climate change focal area.

30. As part of the GEF-4 replenishment process, the Operational Strategy for mitigation in the GEF was revised to focus primarily on six Strategic Programs in the mitigation area: Promoting Energy Efficiency in the Built Environment; Promoting Energy Efficiency in the Industrial Sector; Promoting Market-based Approaches for Renewable Energy; Promoting Sustainable Energy Production from Biomass; Promoting Sustainable Innovative Systems for Urban Transport; and Management of Land-use, Land-Use Change and Forestry (LULUCF) as a Means to Protect Carbon Stocks and Reduce GHG Emissions.

31. As a result of the GEF's strategy and development, the GEF's work in the climate change focal area has always focused on technology. Virtually all GEF mitigation projects have focused on a technology and the need to expand the capacity for its utilization and reach in the market. As explained above, the approach adopted has conformed closely to the UNFCCC's technology transfer framework. Based upon experiences with the GEF portfolio, a number of conclusions with respect to technology transfer can be drawn for future operations, but three of these deserve highlighting in particular. First, technology is transferred primarily through markets: barriers to the efficient operation of those markets need to be removed systematically. Second, technology transfer is not a single activity, but a long-term engagement. Partnerships and cooperation are mandatory for successful development, transfer and dissemination of new technologies and they often require time to develop and mature. Third, technology transfer requires a comprehensive approach incorporating capacity building at all relevant levels.

GEF Experience with Technology Transfer: Mitigation

32. Since the creation of the GEF, about $2.4 billion has been allocated to projects in the climate change focal area, funding which has leveraged an estimated additional $14 billion in financing,

[8] OPS3: Progressing Toward Environmental Results – Third Overall Performance Study of the Global Environment Facility, GEF Office of Monitoring and Evaluation, 2005

and resulted in the reduction of over one billion tons of GHG emissions avoided. GEF funding has focused on supporting innovative approaches and technologies to benefit the global environment. Altogether, GEF has supported more than 30 technologies in the years of its existence. The following sections summarize the range of technologies to which the GEF has provided support in the time of its existence as well as a brief summary of some of the lessons learned from these experience. As the bulk of the GEF support to date has focused on mitigation activities, the discussion focuses more on mitigation. However, some examples from the nascent adaptation portfolio are included as well in order to provide whatever insight is available.

Mitigation: GEF Experience with Energy Efficient Technologies (OP5)

33. Table 1 summarizes the various technologies, and in some cases, technological sectors in which the GEF has provided support to energy efficiency initiatives. It also lists the countries that have availed themselves of support to this technology through the various GEF-funded projects. This is not to claim that all of these technologies have been successfully transferred, but rather that the GEF portfolio provides an indication that there has been a need expressed in growing the markets for the particular technologies by the countries listed. In some cases, technology transfer has been successful, and in other cases, more barriers remain to the maturation of the market for the specific technology.

34. The following paragraphs highlight experience with each of the technologies listed above and provide a brief indication of lessons learned through GEF support.

Efficient Lighting

35. Since mid-1990s, the GEF has supported the dissemination of efficient lighting technologies in more than two dozen countries throughout the world. The type of intervention includes sector-specific lighting initiatives, utility demand-side management (DSM) programs, energy standards and labeling programs, and build codes and standards programs.

36. According to the post-project impact assessment commissioned by the World Bank of four projects under its implementation,[9] these projects achieved (1) major market transformation of efficient lighting in the residential sector, (2) significant project replication and extension, both in the countries themselves and in surrounding countries, (3) significant benefits for consumers in terms of cost savings and improved product quality, and (4) development of capacity for DSM and energy efficiency within government institutions.

37. Approved by the Council in 2007, the GEF has launched a global initiative to accelerate the phase-out of inefficient lighting through UNEP and UNDP, and is extending support to more countries and more programs at the national level.

[9] See *World Bank GEF Energy Efficiency Projects: Synthesis Report*, 2006; *Poland Efficient Lighting Project*, 2006; *Mexico High Efficiency Lighting Project*, 2006; *Thailand Promotion of Electrical Energy Efficiency Project*, 2006; and *Jamaica Demand-Side Management Demonstration Project*, 2006.

Table 1 GEF Support to Energy Efficient Technologies

Energy Efficient Technology	Countries with GEF Support to Transfer the Technology
Efficient lighting (compact fluorescent lamps, efficient street lighting, light-emitting diodes, etc.)	Argentina, Bangladesh, Brazil, China, Czech Republic, Egypt, Ghana, Hungary, Indonesia, Jamaica, Kenya, Latvia, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia Slovakia, South Africa, Thailand, Uruguay, Vietnam
Energy efficient appliances (refrigerators, air-conditioners, washers, dryers, cookers, stoves, etc.)	Argentina, Bangladesh, Brazil, China, Cuba, India, Indonesia, Kenya, Mongolia, Pakistan, Russia, Thailand, Tunisia, Vietnam
Energy efficient building design	Belarus, Bosnia-Herzegovina, Brazil, Bulgaria, China, Cote d'Ivoire, Czech Republic, Kyrgyzstan, Lebanon, Mauritius, Morocco, Senegal, Tunisia
Energy efficient building materials (windows, doors, perforated bricks, straw bales, etc.)	Bangladesh, Bosnia-Herzegovina, China, Mongolia, Pakistan, Poland
Industrial energy efficient technologies (steel, brickmaking, cement, ceramics, textile, foundry, rubber, wood, cokemaking, tea processing, food processing, pulp and paper, charcoal production, etc.)	Bangladesh, Belarus, Bulgaria, China, Costa Rica, Cote d'Ivoire, El Salvador, Honduras, Hungary, India, Iran, Macedonia, Malaysia, Morocco, Nicaragua, Panama, Philippines, Poland, Tunisia, Vietnam
District heating systems	Armenia, Belarus, Bulgaria, China, Croatia, Czech Republic, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Moldova, Mongolia, Slovenia, Slovak Republic, Ukraine, Poland, Turkmenistan, Romania, Russia, Uzbekistan
Power generation (rehabilitation) and distribution	Brazil, China, Ecuador, Guinea, India, Philippines, Sri Lanka, Syria
Cogeneration (including heat recovery for power generation from industrial processes)	China, Czech Republic, Ethiopia, Kenya, Malawi, Swaziland, Tanzania, Uganda, Sudan, Russia
Energy efficient motors	Bangladesh, China, India, Indonesia, Poland, Thailand, Pakistan, Vietnam
Energy efficient boilers	China, Poland, Russia
Energy efficient CFC-free chillers	Brazil, Colombia, India, Thailand

Energy Efficient Appliances

38. The GEF has built a strong, evolving portfolio in promoting energy efficient appliances and technologies in developing countries. GEF-supported interventions typically focus on instituting energy efficiency standards and labels, consumer education, and testing and certification of appliances. In countries where there is substantive manufacturing capacity, GEF support has also extended to the manufacturers for developing new, energy efficient appliance models and acquiring technical information and knowledge from more advanced countries.

39. In Tunisia, as a result of the GEF project implemented by UNDP, 10 out of 12 local appliance manufacturers are offering more energy efficiency models to the market. In China, GEF project to promote energy efficient refrigerators adopted a two-pronged approach of technology-push and market-pull. Technology push is achieved through technical assistance to the refrigerator and compressor manufacturers, upgrading of technologies, training of designers, and promulgation of energy-efficiency standards. Participating refrigerator manufacturers improved their average energy efficiency by 23 percent between 1999 and 2003, and production and sale of top-rated energy-efficient refrigerators increased from 360,000 to 4.8 million units during this period.

Industrial Energy Efficient Technologies

40. The GEF has funded more than 30 projects to promote technology upgrading and adoption and diffusion of energy efficient technologies in the industrial sector. The GEF industrial energy efficiency portfolio implemented by the World Bank and the International Finance Corporation (IFC) generally do not focus on specific technologies or industries; instead, they support the development of market mechanisms, such as the Energy Service Companies, and the creation of dedicated financing instruments as well as technical assistance to stimulate investments in energy efficient technologies.

41. The GEF industrial energy efficiency projects implemented by UNDP typically identify one or multiple sub-sectors and specific technologies to promote. The range of industries includes construction materials (brick, cement, and glass), steel, coke-making, foundry, paper, ceramics, textile, food and beverage, tea, rubber, and wood. A number of projects also aim at promoting industrial energy efficient equipment, such as boilers, motors, pumps, as well as cogeneration.

42. In some projects, the GEF has also promoted South-South technology transfer. A case in point in the transfer of energy efficient brick kiln technology from China to Bangladesh. The technology has been developed, adopted, and disseminated in China with support from the GEF through UNDP, and it is being transferred to Bangladesh through another GEF-funded project.

District Heating Systems

43. The GEF has financed projects to promote energy efficiency in district heating in more than 20 countries, mostly in Eastern Europe and the former Soviet Union[10], as well as in China and Mongolia. Most of these projects involve demonstrating technologies and practices to improve

[10] For a review of the UNDP-implemented portfolio, see *Heating in Transition*, UNDP-GEF, May 2005.

the technical and operating efficiency of heat and hot water supply, creating enabling policies and regulations, and facilitating access to financing and investments. Some of the projects in Eastern Europe have also featured fuel switching from coal to biomass in combination of efficiency improvement.

44. Although some heating technologies promoted by the GEF projects may be new to a given country and their applications may need to be adapted to the local conditions, the technologies in general are well-known. The barriers to technology transfer tend to be largely institutional in nature and include the lack of conducive policy and regulatory framework which lead to limited access to financing.

High Efficiency Boilers

45. The quintessential example of technology transfer supported by the GEF is the China Efficient Industrial Boilers Project, supported through the World Bank. The project received a $32.8 million GEF grant to (1) upgrade exiting Chinese boilers models through the introduction of advanced combustion systems and auxiliary equipment from developed countries, (2) adopt new high efficiency boiler models through the introduction of modern manufacturing techniques and boiler designs, and (3) undertake technical assistance and training for boiler producers and consumers. Completed in 2004, the project successfully supported international technology transfer of boiler technologies that benefited nine boiler manufacturers and nine boiler auxiliary equipment makers in China. Under the GEF support, the Chinese manufacturers acquired the advanced efficient boiler technologies, built prototypes, and went on to commercial production. Through technical assistance, the project also led to the revision and formulation of national and sector standards and strengthened the technical capacity of the Chinese boiler sector.

Energy Efficient CFC-Free Chillers

46. The GEF has supported energy efficient, CFC-free building chiller technologies in several countries, including Thailand, Brazil, and India. GEF support has aimed to accelerate the replacement of old CFC-based chillers with CFC-free, energy-efficient ones. Such projects have also leveraged synergy and resources between the GEF and the Multilateral Fund under the Montreal Protocol on Substances that Deplete the Ozone Substances (ODS).

47. In Thailand, the GEF project, which was implemented by the World Bank and completed in 2006, has successfully demonstrated the technical feasibility and financial viability and attractiveness of chiller replacement. Results of the project have exceeded expectation in terms of both financial return from energy savings and reduction of ODS and greenhouse gas emissions, while replication and market transformation has taken place rapidly beyond the GEF project.

Mitigation: Experience with Renewable Energy Technologies (OP6)

48. From 1991 to 2007 the GEF approved grants totaling more than $800m for approximately 150 projects that promote the transfer of renewable energy technologies in developing countries

and industrialized nations transitioning to market economies. An indicative list of countries that have been benefited from GEF support to renewable energy technologies is contained in Table 2.

Table 2 GEF Support to Renewable Energy Technologies (OP6)

Renewable Technology	Countries with GEF Support to Transfer the Technology
Off-grid PVs	**Bangladesh, Bolivia, Botswana, Burkina Faso, Costa Rica, Ethiopia, Eritrea, Ghana, India, Kenya, Lesotho, Morocco, Malawi, Namibia, Nepal, Peru, South Africa, Sri Lanka, Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe**
On-grid PVs	**India, Mexico, Philippines, *(also considered as OP7)***
Solar Water Heating	**Albania, Algeria, Chile, India, Lebanon, Mexico, Morrocco, South Africa, Tunisia**
Wind turbines	**Azerbaijan, Bangladesh, Brazil, China, Costa Rica, Cuba, El Salvador, Eritrea, Ethiopia, Ghana, Guatemala, Honduras, Iran, Jordan, Kazakhstan, Kenya, Korea DPR, Madagascar, Mauritania, Mexico, Nepal, Nicaragua, Pakistan, Russian Federation, South Africa, Sri Lanka, Tunisia, Uruguay**
Geothermal	**Armenia, Bulgaria, Djibouti, Eritrea, Ethiopia, Indonesia, Hungary, Kenya, Lithuania, Philippines, Poland, Romania, Russian Federation, Tajikistan, Turkey, Ukraine, Tanzania, Uganda**
Methane from Waste (mixed municipal and/or liquid biological)	**China, Czech Republic, Jordan, Latvia, Mexico, Uruguay *(some also qualified under STRM, see below)***
Small Hydro	**Benin, Bhutan, Burundi, Cameroon, Central African Republic, Congo, Congo DR, Gabon, Haiti, Hungary, Indonesia, Macedonia, Mali, Montenegro, Nicaragua, Rwanda, Togo**
Biomass co-generation	**Hungary, Malaysia, Thailand**
Biomass boilers (heat production)	**Belarus, China, Egypt, India, Kenya, Latvia, Poland, Slovak Republic, Slovenia, Sri Lanka**
Biomass gasification for electricity	**Chile, India, Uruguay**

Off-grid Photovoltaics

49. Since its inception, the GEF has been confronted with the question of new renewable technologies for the provision of energy services to the 1.6 billion people without access to electricity. Since these people often live in remote areas experts expect that power grid expansion is not cost effective and affordable to the governments, and their limited energy consumption patterns contribute GHG emissions due to their use of kerosene for lighting and woodfuel for cooking. In response to this need, the GEF funded a number of projects with all

agencies that provided access to electricity through the use of Solar Home Systems (SHS). A number of lessons has emerged from this cluster of projects, including the importance of the technical quality of the SHS's; the need to raise awareness of the technology; the importance of system maintenance and business infrastructure; and perhaps most importantly, the need for sustainable financing in appropriate instruments.[11] But just because PV's and SHS's are a least-cost option for remote electricity supply does not necessarily make them affordable to those who need them. [12] In such a case, financing arrangements are needed to match both the customers' ability and willingness to pay for the energy services provided.

50. The Transformation of the Rural Photovoltaic market in Tanzania project is implemented by UNDP and was designed to incorporate the earlier lessons from these rural PV projects. Ongoing progress reports indicate that the Project has contributed to the removal of taxes and VAT on all PV components. Standards and a code of practice have been approved and are in place. A Rural Energy Agency has been put in place and a Rural Energy Master Plan has been developed. PV awareness among key government decision makers at district level has been raised through a series of seminars. Most importantly, the private sector has been responsive to the project and a PV curriculum has been adopted by the Vocational Education and Training Authority of Tanzania. Technicians have been trained in sizing, installation, repair and maintenance of the systems and 60% of them are active. Financial models for supply-chain and consumer financing are being developed to boost the number of consumers and dealers/companies in PV business requesting financing.

Solar Water Heaters

51. Although solar water heaters are sometimes considered to be a simple technology, experience around the world has shown that perception to be somewhat deceptive. The quality of the fittings, the collectors, and the installation determines to a great extent how satisfactory their operation is. Frequently, inexpensive materials, poor workmanship, or shoddy installation have resulted in non-functional units and with installations being abandoned. GEF's experience has shown that the observance of high standards and knowledgeable staff are critical to the successful dissemination of this technology.

52. In Morocco, early solar water heaters tended to be of a low quality. As a result, they fell into disuse and the market languished. Through a UNDP-implemented GEF project, the older non-functioning installations were repaired; new, higher quality standards were adopted; and technicians and staff were trained to be able to ensure the quality of future installations. In addition, in order to incentivize the production and sale of the higher quality units, a limited subsidy for the early adopters of solar water heaters meeting the new standard was adopted with the effect of jump-starting the market for high quality solar water heaters. The Moroccan market and industry are now growing rapidly.

[11] International Finance Corporation. 2007. Selling Solar: Lessons from More Than a Decade of IFC's Experience. Washington DC: IFC.

[12] Martin Krause and S. Nordstroem, ed. 2004. Solar Photovoltaics in Africa: Experiences with Financing and Delivery Models. UNDP Lessons for the Future. Monitoring and Evaluation Report Series Issue 2. New York: UNDP.

On-grid photovoltaics

53. The GEF has been less active in supporting PV's installed in an on-grid configuration, due largely to the high cost of PV-based electricity when compared to normal grid-based electrical generation options. In fact, this technology has only been supported in a handful of cases to date, and has been included in this discussion under OP6. In fact, given the high costs of PV electricity, it should be a technology handled under OP7 supporting Low-GHG Emitting Energy Technologies that are not still not commercially competitive.

54. An interesting case of on-grid PV support from the GEF is the CEPALCO Distributed Generation PV Plant in Philippines project (implemented by IFC), which aimed to demonstrate PV's effectiveness in addressing distribution system capacity issues. A 1 MW distributed generation PV power plant was built and integrated into the 80 MW distribution network of the Cagayan de Oro Power & Light Company (CEPALCO), a private utility operation on the island of Mindanao in the Philippines. The PV system is operated in conjunction with an existing 7 MW hydroelectric plant with dynamic load control, thereby enabling the joint PV/hydro resource to reduce distribution level and system level demand, effectively providing "firm" generating capacity. The PV plant also assisted in postponing the need for additional substation installations in the CEPALCO distribution system for a period of up to three years. The project thus reduced the need of CEPALCO to purchase additional quantities of thermal plant-based power, thereby reducing its emissions of greenhouse gases. However, more importantly, this plant provides the first, full-scale demonstration of the environmental and, ultimately, also economic benefits of the conjunctive use of hydro and PV-based power, as well as the first significant use of grid-connected PV in a developing country. This project is a significant step in trying to solve the issue of "storage" which is a major issue for many renewables. If conjunctive use can allow for the use of existing hydro facilities for "storage," many renewable technologies such as PV and wind power can be viewed in combination as a "firm hybrid," completely renewable source of power.

Wind Power

54. The GEF has supported a number of wind energy projects around the world. Experience has shown that in addition to questions of resources availability and familiarity with the technology, the most important barrier preventing the successful growth of the wind market are the regulations concerning the access of renewable generators to the grid and the ability of the distributors to pay the incremental costs of the electricity generated through wind turbines. Worldwide experience has shown several successful approaches to this problem, including the creation of a renewable portfolio standard or a guaranteed renewable "feed-in" tariff. GEF has continued helping countries to understand and adopt these regulations. In Mexico, all three Implementing Agencies provided support to assist in improved wind-speed measurements; to provide training and capacity building (UNDP); and to assist in regulatory changes and provide a "green energy" fund to assist in paying the incremental costs of renewable generation (World Bank).

55. One of the most visible and successful of the GEF's projects to support the fledgling market for wind energy in developing countries is the "China: Renewable Energy Scale Up Program (CRESP), being implemented by the World Bank. It adopted a programmatic approach to secure long-term structural change and provided support to the creation of the Chinese Renewable Energy Law in 2007, which included an important renewable portfolio provision. The main global benefits of the project are (a) the removal of multiple barriers to the introduction of cost-effective renewables, especially wind energy, in China; (b) the reduction in cost and improvement in performance of small hydro, wind and selected biomass technologies; and (c) an increased market penetration of renewables in China and consequent reduction in greenhouse gas emissions from power generation. It is estimated that by 2010, the scale up will result in an incremental annual production of electricity from renewable sources of 38 TWh, equivalent to about 7.9 GW of installed capacity. The carbon savings of the project are estimated at 187 MtC. According to the REN21, China now hosts the world's sixth largest wind energy market in the world with an estimated installed capacity of 2.6 GW, a figure which doubled during 2006.[13]

Geothermal Energy

56. The GEF has supported a number of projects to help countries exploit their geothermal energy potential. Through this experience, it has been discovered that in addition to the barrier posed by access of renewable energy generators to the grid, a barrier that is especially difficult in the case of geothermal energy is the confirmation of the location and existence of an exploitable geothermal resources. Traditionally, each site has to be confirmed as being exploitable through a drilling process, with the costs of resource confirmation running as high as several million dollars. To deal with this barrier, the GEF has established several contingent funding mechanisms to reimburse the costs of drilling wells that do not produce geothermal energy.

57. A more recent approach to this barrier is found in the Joint Geophysical Imaging for Geothermal Reservoir Assessment project, implemented by UNEP in Kenya. In this project, advanced geophysical imaging techniques have been used to locate commercially exploitable geothermal power in Kenya and East Africa. Micro-seismic sensing of events and electromagnetic sensing of lighting strikes and earth's magnetic field are used to locate steam trapped in fractures underground. Results to date indicate wells targeted using this approach combined with directional drilling yield 4 to 6 MW per well as opposed to the previous 2 MW per well. The success rate for test wells has also improved and they are better able to target re-injection wells for the spent geothermal fluid thus sustaining geothermal field output over time. This will result in substantial savings for the planned development of 512 MWe from geothermal resources in Kenya. The project has helped establish sustainable, world class capacity in these advanced techniques at KenGen's Olkaria facility and KenGen is now capable of providing these services to other countries in the region.

Waste to Energy

[13] REN21. 2008. Renewables 2007: Global Status Report. Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute.

58. A number of projects have supported the utilization of methane from municipal wastes, either from solid wastes in landfills or liquid biological wastes. Many of these projects have qualified for GEF support both as renewable energy projects and as short-term response measures because of their extreme cost-effectiveness. The GEF played a role in helping increase the uptake of these technologies, GEF support is not longer needed as these projects are eligible and very profitable when implemented under the CDM. The same cost-effectiveness linked to the GWP of methane that made them attractive as STRM projects also makes them very attractive and profitable as CDM projects.

59. The India Biomethanation project is an interesting example of the transfer of this technology from the early GEF portfolio. When this project was proposed in the early 1990's, there was limited endogenous capacity in India for adapting and replicating biogas technology for industrial wastes. The result was that large amounts of biological wastes from agro-processing and related industries emitted large amounts of methane and other pollutants to the water. The idea of the project was to produce the methane in a controlled environment, capture it, and used for energy production. The GEF project supported capacity building at five national R&D laboratories and other institutions that were been actively involved in the project as a network. In addition, the GEF co-financed more than a dozen demonstration units, in a wide variety of industries, including agro-processing, pulp and paper, tanneries, slaughterhouses, rice mills, and commercial dairies.

60. While the capacity building activities were very successful and sustainable, and the demonstration units clearly indicated which industries could reach the highest levels of GHG abatement, the project also demonstrated very clearly that it is important not to stop after the development of technologies, or their adaptation to the local conditions. Once suitable technologies have been identified and tested, it is very important to move on to the dissemination stage, and to a systematic integration into national technology policy and the build-up of a national industry to provide the equipment and services needed for a lasting dissemination of the demonstrated successes. Replication is now facilitated through the CDM.

Mini and Micro-hydro power

61. Small hydro is an old technology, but one that is not well disseminated around the world. GEF has supported small hydro installations around the world since its early days. The barriers to the adoption of mini- and micro-hydro can be information about the technology and about the resource; institutional frameworks; regulatory obstacles or financing.

62. The Integrated Microhydro Development and Application Program (IMIDAP) in Indonesia being implemented by UNDP aims to reduce GHG emission from fossil-based power generation in Indonesia. This will be achieved with the objective of accelerating the development of microhydro resources and optimization of their utilization by removing barriers. The four main outcomes of the project are expected to include the enhanced private sector interest and involvement in the microhydro business; the increased use of microhydro in small communities as a result of effective institutional capacity building; the improved availability, and local knowledge, of microhydro technology applications; and increased implementation of microhydro projects for electricity and productive use purposes. The project targets a cumulative amount of GHG reduction equal to 304 kilotons of CO2, the establishment of at least 40

community-based microhydro projects for productive uses each year, and 130 GWh produced and 100 GWh sold, cumulatively in 3 years.

Biomass Co-generation

63. Biomass wastes from agricultural and forestry production can provide significant energy for heat and electricity generation. This waste biomass—typically either crop residues or sawmill waste—can provide significant opportunities for carbon-neutral energy production, as the carbon dioxide released through combustion of the biomass was sustainably grown and fixed as part of a closed cycle. If this energy can be used to substitute for fossil-fuel-based energy, the benefits are even greater. In these cases, common barriers are the regulatory framework's acceptance of small-scale renewable generators; financings; technology and information. GEF has supported a number of projects that have contributed to the co-generation of heat and electricity using biomass residues.

64. The GEF/UNDP project "Removal of Barriers to Biomass Power Generation and Cogeneration in Thailand" aims to assist local commercial partners in their efforts to reduce annual GHG emissions in the order of up to 4 million tons of carbon equivalent annually over the medium term by accelerating the growth of biomass co-generation and power generation technologies to replace current fossil fuel consumption in Thailand. The objectives of the project are to a) build capacity to provide information and services to potential biomass power project investors; b) improve the regulatory framework to provide financial incentives to biomass co-generation and power projects; c) create easy access to commercial financing for biomass co-generation and power projects; and d) facilitate the implementation of two initial biomass power pilot plants through support for commercial guarantees. To date, the results of the project have been the generation of 65,520 MWh annual electricity production from RE sources installed under influence of the project; approximately 855,000 tonnes of CO2 avoided; 97 MW of installed renewable energy capacity, and an increased investment flow of $35.5m linked to biomass projects and $105m linked to total renewable investment projects since the project's inception.

Heat from Biomass

65. Similar to biomass co-generation is the use of agricultural and forestry wastes to generate heat. In these cases, regulatory changes to the regulations governing the heating networks are needed in the same way as regulatory changes are required for electricity co-generation. But these projects can improve overall resource-use efficiency and reduce GHG emissions in the same way as biomass co-generation can.

66. The project "Latvia: Economic and Cost-effective Use of Wood Waste for Municipal Heating Systems" (0.75 M$ GEF and 2.73 M$ co-financing) aims to (i) promote the use of wood waste by removing/reducing barriers that currently hamper the substitution of imported heavy fuel oil (mazut) with locally sustainably produced wood waste for municipality heating systems; (ii) promote the development and implementation of an economic and commercially run municipal heating system that includes generation, transmission and distribution in the municipality of Ludza; and (iii) assist in removing/reducing technical, legislative, institutional/organizational, economic, information and financial barriers related to the replication of a pilot project in the municipality of Ludza. Since the project's inception, 11,200 tonnes of CO2 emissions have been

avoided annually from the Ludza municipality, accounting for about 80% of the emissions from the use of heating oil. The project and the financial scheme developed through the project have encouraged more than 12 other municipalities to make use of forest wastes as part of their district heating networks, resulting in over 100,000 tonnes of CO2 being avoided annually.

Biomass Gasification for Electricity

67. Biomass gasification is a process that has been known for many years. However, in many cases, the technology itself has faced an engineering challenge due to the need to clean the gases to prevent clogging in the system. New gasifiers are becoming more effective at solving this issue. Especially in rural areas where biomass residues are plentiful, this provides a new opportunity for generating electricity for use in rural areas.

68. Through UNDP, the GEF support the Biomass for Rural India project. This project aims to develop and implement a bioenergy technology package that will meet village energy needs, reduce GHG emissions and promote a sustainable and participatory approach to meeting rural energy needs. The project is implemented mainly in two panchayats (a cluster of about 24 villages), of Tumkur district in Karnataka. The project goals are being achieved through (i) demonstrating the technical feasibility and financial viability of bioenergy technologies (including using biomass gasification for power generation) on a significant scale, (ii) building capacity and developing appropriate mechanisms for implementation, management and monitoring of the project, (iii) developing financial, institutional and market strategies to overcome the identified barriers for large-scale replication of the bioenergy package for decentralized applications, and (iv) disseminating the bioenergy technology and information package on a large scale. The project has resulted in stimulating significant out-growing of trees in energy plantations (1200 ha), forest regeneration (850 ha); and tree-based farming (about 1000 ha) by villagers. The wood from this farm forestry is then purchased and used to generate electricity using locally manufactured gasifiers and is sold to the regional electrical distribution company to supply the local population. The project has also succeeded in replacing fuel wood with biogas by 171 families that has resulted in emission reduction of 256 tons/year for last 3 years.

Mitigation: Experience with New, Low-GHG Emitting Energy Technologies (OP7)

69. The objective of the GEF's support to this field was to provide support for early technology demonstrations in developing countries and thereby increase experiences with these technologies and accelerate the reduction in the cost of subsequent installations. The data in Table 3 show that seven technologies have received support, but in a limited number of countries. The largest and most significant technology to receive support under this program has been the Concentrating Solar Power (CSP) technology. At present, the GEF is no longer providing support to projects of this nature as the lessons from the CSP portfolio indicate that greater resources are needed if the GEF is to make any progress in these areas.

Table 3 GEF Support to Low-GHG Emitting Energy Generating Technologies (OP7)

Low-GHG Emitting Energy Technology	Countries with GEF Support to Transfer the Technology
Biomass Integrated Gasification Combined Cycle Generation	Brazil
Building-integrated Photovoltaic Power Production	Malaysia
Concentrating Solar Power Production	Egypt, Morocco, Mexico
Externally-fired combined cycle generation	Brazil
Micro-turbine co-generation	Indonesia
On-grid PV power production	Mexico, Phillipines
Stationary Fuel-cell power generation	South Africa

Concentrating Solar Power (CSP)

70. Starting in 1996, the WB and GEF, together with India, Mexico, Morocco, and Egypt, developed a portfolio of 4 demonstration CSP plants in developing countries. The projects were intended to build a solar field, typically of 30 MW, as part of a hybrid gas-turbine plant. The hybridization of the gas turbine and the solar power plant would enable the projects to be able to dispatch power at will, making it more economically attractive. After nearly eight years of working on this portfolio, the India project was cancelled. The other projects progressed very slowly indicating that the technology did not meet with the enthusiastic uptake originally anticipated.

71. Not only did the technology not make any progress in developing countries, but it also languished in developed countries during this time period. Until 2004, no other CSP plants have been completed in developed countries, although the pilot plant in California has continuously operated under commercial conditions. Only recently have new plants been planned and constructed in developed countries, most notably Spain where they were given generous incentives through a high feed-in tariff for solar energy. Now, together with an increased momentum in spurred by these activities in developed countries, the projects in Egypt, Mexico and Morocco are moving forward.[14]

72. One lesson from this experience is that it is not easy for developing countries to adopt technologies from developed countries that are not yet fully commercialized. The lack of follow-up to the technology in the developed countries damaged its reputation in developing countries. The costs did not fall as anticipated, and in fact, the costs increased while the projects were under development. Not only have the projects imposed additional costs on the countries, but they have also imposed additional risks regarding the likelihood of the projects producing the rated power on a firm basis. In fact, in two of the cases under way, the incremental costs of the project have exceeded those which the GEF has provided leaving both countries to provide

[14] An expert assessment commissioned by the World Bank recommended that despite the many drawbacks, the remaining 3 CSP projects be allowed to move ahead. World Bank GEF. Assessment of the World Bank Group/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Washington DC: World Bank and GEF.

significant cash subsidies to the plants to enable them to move forward. In future, projects of this character would benefit from being involved in multi-country partnerships for information and experience sharing.

Mitigation: Experience with Transport Sector Technologies (OP11)

73. The GEF program on sustainable transport was approved by the Council in 2000 and it is comprised of a combination of support to new technologies and the removal of barriers to well-established technologies that are not disseminating throughout the market because of the existence of certain market barriers. The technologies and countries where GEF has supported activities are listed below in Table 4.

Fuel-Cell Buses

74. The original version of GEF Operational Program 7 included fuel-cell buses as a potential avenue for GEF support to new technologies. When the operational program on sustainable transport was approved in 2000, the fuel-cell buses were included as eligible under that program. UNDP had originally developed a portfolio of five fuel-cell bus projects including projects in Brazil, China, Egypt, India and Mexico. All five projects were approved by the GEF Council, but three of them faced limited interests on the part of industry in the form of limited or not response to the "expressions of interest" stage of the fuel-cell bus procurement process. In the end, three of the projects were cancelled: Egypt, India, and Mexico.

Table 4 GEF Support to Transport Sector Technologies (OP11)

Transport Technology	Countries with GEF Support to Transfer the Technology
Bicycle Paths, Non-motorized transit	Botswana, Chile, Nicaragua, Peru, Philippines, Poland, Viet Nam
Bus-rapid transit systems	Argentina, Brazil, Ghana, Senegal, South Africa, Tanzania,
Dedicated bus lanes	Argentina, Brazil, Chile, China, Ghana, India, Indonesia, Iran, Mexico, Peru, South Africa
Electric Three-wheelers	India
Hybrid Buses	Egypt
Hydrogen-based Fuel-cell buses	Brazil, China
Traffic Demand Management	Argentina, Brazil, Ghana, Mexico

75. Of the two projects that have run through implementation, China was the first to receive buses and they have been in operation since 2004. Brazil has received received its buses and they appear to be operating well.[15] However, it is not clear that either project will lead to a sustainable fuel-cell bus industry, without further rapid advances in the technology and

[15] UNDP-GEF. 2006 (June). *UNDP-GEF Fuel-Cell Bus Programme*: Update. New York: UNDP. GEF/C.28/Inf.12.

reductions in the production cost of hydrogen. In many ways, the issues of relevance to the CSP projects under OP7 are or relevance to these new technologies as well.

Mitigation: Experience with Projects Approved under the Short-Term Window (STRM)

76. The Short-term Window in climate change was established to support opportunities that were considered "too good to refuse". As such, it set a hurdle rate for eligibility at a UAC of $10/tonne of CO2 equivalent. The projects that were supported under this window are included in Table 5 below.

Table 5 GEF Support to Technologies as Short-Term Response Measures (STRM)

Short-Term Response (cost-effective) Technology	Countries with GEF Support to Transfer the Technology
Coal-bed methane/coal-mine methane	China, India, Russia
Coal-to-gas conversion	Poland
Landfill Gas utilization	China, India, Jordan, Latvia, Uruguay *(also included above in OP6 Table)*
LPG Substitution	Yemen
Natural Gas System Leakage Repair	China, Venezuela

Coal-Bed and Coal-Mine Methane

77. Coal deposits contain a significant amount of methane, which can leach out into the mine or can be tapped by drilling before a mine is even opened. Because methane (CH_4) is a GHG with a GWP that is more than 20 times as potent as carbon dioxide, its utilization helps reduce emissions of GHG's to atmosphere both in terms of reducing it back to CO2 and in terms of substituting methane for other fossil fuels.

78. The GEF has supported coal-bed and coal-mine methane projects in China, Russia, and India. In China, the UNDP-GEF project led to the creation of the National Coal-Bed Mining Authority, which has fostered methane-tapping and utilizing joint-venture investments in several large coal-deposit areas. The process is similar to that of tapping and utilizing natural gas, and it holds promise for improving China's useable gas reserves.

GEF Experience with Technology Transfer: Adaptation

79. Since the creation of the Strategic Pilot on Adaptation (SPA) in the GEF Trust Fund in 2004, and the establishment of the LDCF and the SCCF, total GEF funding for adaptation has totaled about $130 million. Technology transfer has been a major component in most adaptation projects funded under the SPA, SCCF and LDCF, all of which are operated by the GEF under guidance from the COP.

80. Because the portfolio of adaptation projects is still in its relative infancy, there is inevitably less experience with successful cases of technology transfer than in the GEF's mitigation programs described above. Nevertheless, and recognising that there are key differences in

considerations for technologies for adaptation and mitigation, adaptation will require significant attention to technology deployment as well. As the adaption portfolio evolves and matures, it will be important for the GEF to assess experiences and lessons learned, drawing upon past work as well as that of others such as the EGTT and other organizations.

81. The majority of GEF administered funding for adaptation technology transfers has gone towards "soft" technology transfers such as: technical assistance for pilot demonstration activities, institutional support for knowledge transfer to decision makers on how to mainstream adaptation concerns in sector development planning. Only rarely is "hard" technology transfer seen in the current project portfolio of the LDCF, SCCF and SPA, such as the physical transferring of, for example, high tech electronics for data logging and alert systems. Projects seek to rely on and enhance local capacity to enhance local participation and ownership, and ultimately therefore the sustainability of the intervention. Many adaptation pilot activities are also centered around improved management of pre-existing local and/or traditional technologies and knowledge, and/or improved access to adaptation-relevant information to increase the efficiency of existing management.

82. Because of these differences in the nature of mitigation and adaptation, and also because the link between "hard" technologies and "soft" technologies differs between the two, the following discussion is organized not by technology per se, but more by the activities pursued in the projects. These three approaches used to organize this discussion are consistent with the elements of the UNFCCC's technology transfer framework contained in the annex of decision 4/CP.7. Table 6 below draws out key examples of technology transfer activities experienced in six different adaptation sectors: ecosystem management, agriculture, water management, disaster risk management, coastal zone management and health.

Technology information transfer

83. Through the GEF Trust Fund's Strategic Priority for Adaptation (SPA), the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), GEF has supported numerous adaptation activities related to technology information transfer. An example is a SPA funded project in Colombia. Here, the SPA is funding development of advanced climate and statistical models, which will allow the continuous evaluation of the local risk of dengue and malaria transmission in the face of global climate change and the determination of the most appropriate actions in order to prevent epidemics before they begin. In Cape Verde, the LDCF will fund pilot demonstration activities for climate resilient techniques for harvesting, storing, conserving and distributing water in a country projected to experience severe water stress as a consequence of climate change. These demonstration activities will include several innovative technologies such as wind traps, underground screens to prevent groundwater seepage and water treatment technologies. Pilot activities, as these, will generate the awareness and experience necessary to successful up-scale activities at the national level.

Infrastructure and hard technology transfer

84. Another group of activities supported through the SPA, SCCF and LDCF involves direct investments in modern physical infrastructure specifically targeting climate change

vulnerabilities. An instructive example in this group of technology transfers is found in a regional SPA project covering five countries in West Africa. Here, the SPA is funding dissemination of alternative energy technology to local communities who previously collected firewood from sensitive mangrove forests along the coastline. By providing neighboring communities with alternative energy sources, the human pressure on these important coastal forests, which acts as a natural buffer to the effects of climate change induced sea level rise and storm surges, is significantly reduced. In Bhutan, the LDCF is funding measures to reduce the risks of Glacial Lake Outburst Floods (GLOFs) from massive melt lakes created by receding glaciers. The intervention is both directly reducing the risk of GLOFs by installing pumps to artificially lower the water levels of lakes below dangerous thresholds, and reducing the impact of GLOFs if they happen, by installing an automated monitoring and alarm system based on novel technologies never before deployed in the country.

Capacity building, coordination and policy

85. Many technology transfer activities funded under the SPA, SCCF and LDCF can be categorized in a "capacity building, coordination and policy" category. Such activities do not involve the targeted transfer of specific information or physical investments, but rather a generation of general knowledge, experience and capacity which provide the necessary foundation for policy mainstreaming, project implementation, and eventual up scaling of pilot activities. In Eritrea, e.g., LDCF funds will be utilized to train agricultural extension staff in climate resilient rangeland management techniques. The successful implementation of this activity will provide Eritrea with a sustainable and flexible pool of knowledge and staff, which can advice local pastoral communities on sustainable livestock and rangeland management under changing climates for decades to come.

Table 6 Elements of technology transfer in GEF adaptation – Including SPA, SCCF and LDCF						
	Ecosystems	**Agriculture**	**Water Management**	**Coastal Zone Management**	**Disaster Risk Management**	**Health**
Technology information transfer.	Pest management technologies introduced into sustainable forest management facing severe pest problems caused by decreasing rainfall (Armenia – SPA)	Improved seasonal forecasts and improved access to seasonal climate information for farmers through extension services (Niger – LDCF)	Demonstration of small scale innovative techniques for climate resilient harvest, storage, conservation and distribution of water (Cape Verde – LDCF)	Planting /conservation of protective mangroves (Sri Lanka – SPA)	Improvement of Early Warning Systems for drought and coordination of food and forage banks (Burkina Faso – LDCF)	Climate and statistical models developed to monitor and track the effects of climate on Malaria and Dengue. (Colombia – SPA)
Infrastructure and hard technologies.	Dissemination of alternative energy technology reduces human stresses on important mangrove ecosystems, previously used for firewood collection (West Africa – SPA)	Promotion and dissemination of drought tolerant crop varieties and technology & knowledge for improved dry land farming (such as 'dry seeding', minimum tillage, etc) (China – SCCF)	Upgrade irrigation facilities to promote efficient usage of available water resources (Malawi – LDCF)	Installation of breakwater/sea walls at key vulnerable coastal locations (Pacific Islands – SCCF)	Reducing risks of Glacial Lake Outburst Floods (GLOFs) through artificial lowering of lake levels and automated monitoring/warning system (Bhutan– LDCF)	
Capacity building, coordination and policy	Updating coastal zoning and fisheries management based on detailed analysis of saline front changes induced by CC (Uruguay – SPA)	Training of adaptation experts for agricultural extension services (Eritrea – LDCF)	Developing and implementing integrated water management frameworks for rational prioritization of limited resources (Ecuador – SCCF)	Improving human and technical capacity (such as GIS technology) for monitoring and responding to coastal erosion (West Africa – SPA)	Increase coverage of existing early warning system and improve the flow of early warning information to vulnerable coastal communities (Bangladesh – LDCF)	Build capacity and understanding of local health professionals through pilot implementation of preventive and responsive public health programs specifically targeting climate change induced illnesses. (Samoa – LDCF)

PART II: CURRENT FINANCING OPTIONS FOR TECHNOLOGY TRANSFER

Introduction

86. The IPCC definition of technology transfer cited in the introduction to this report is broad enough to encompass both "hard" and "soft" aspects of technology transfer and diffusion, without being so broad as to covering any and all aspects of a climate change mitigation or climate change adaptation intervention in a developing country. The Convention's technology transfer framework also includes both the "hard" and the "soft" aspects of technology transfer. The GEF's experience with technology transfer, summarized in Part I of this report, also places emphasis on both the "hard" and the "soft" elements of technology transfer. As a result, any assessment of financial flows relating to technology transfer in the context of climate change will have to be appropriately broad, extending to a wide range of technology-related activities.

87. In order to be in a position to assess where the potential lies to facilitate the growth in investment in environmentally-sound technologies (ESTs), this section of the paper will provide an overview of current investments and financial flows as they relate to climate change mitigation and adaptation. This information could help inform future discussions on technology transfer under the Convention.

88. Assessing the state of current investment and financial flows to address climate change in developing countries can help in the discussion of how to facilitate and enhance technology transfer by pointing out both which are the flows with greatest potential for leveraging (the strategy most likely to succeed), as well possibly as highlighting those flows that should ideally be strengthened to provide the necessary support to technology transfer in the developing world.

Overview

89. A first observation is that there is limited information in the literature regarding financing of "technology transfer", as framed in Article 4.5 of the Convention and as relates to the transfer and diffusion of ESTs in developing countries. At best, one can find information relative to investments and financial flows to developing countries in a specific sector, or investments in more specific technologies but with no or limited desegregation between industrialized and developing countries.

90. This was remarked upon by others, and following others[16] we propose to use investments and financial flows as a proxy for technology transfer, because such investments typically have a strong linkage with technologies. This is evidenced in fact in the GEF's portfolio, where the analysis presented in the first part of this paper demonstrates that nearly all GEF projects have addressed some aspect of the transfer and diffusion of technologies. (The example provided by the GEF portfolio is likely an upper limit since the GEF by mandate is concerned with innovation.)

91. The equivalent of the recent extensive analysis of specific experiences in technology transfer for the protection of the ozone layer[17] (Andersen *et al*., 2007) does not yet exist for the climate

[16] See for example D. Violetti, *Trends in Financial Flows and Technology Transfer*, Presentation at the UNFCCC Workshop on Innovative Options for Financing the Development and Transfer of Technologies, Montreal, September 2004.

[17] S.O. Andersen, K. M. Sarma, and K.N. Taddonio, *Technology Transfer for the Ozone Layer – Lessons for Climate Change*, 418p., Earthscan 2007.

change experience. Yet even that latter book does not specifically and in any detail analyze the financing of such efforts.

92. Another consideration worth making is that there are large differences between countries and regions in terms of the current intensity of financial flows and investments. There is also an enormous difference between countries at various extremes, with some developing countries at the forefront of innovation and technology diffusion in a particular sector. In that latter case, it is likely that market-driven investments will continue to facilitate technology development and transfer.

93. These considerations point to the heterogeneity of "developing countries" taken as a group when it comes to facing technology transfer and diffusion, and therefore necessarily of different responses required to facilitate technology transfer. What remains common to all cases is the desirability of a supportive regulatory framework, and enabling environment more generally, together with circulation of knowledge and capabilities with individuals and institutions in host countries. (See the description of a framework for technology transfer from UNFCCC Decision 4/CP.7 cited earlier in this paper.)

94. Another overwhelming aspect of the analysis of investment and financial flows to address climate change is the overarching importance of domestic investments to meet these needs. This points to the direction of a sustained effort to be made on access to, sharing, and diffusion, of knowledge. For example, in 2000, globally domestic funds, including households, represented 60% of total investments. In developing countries (non Annex I countries) and LDCs, domestic investments including households amounted to over 80% of the total.

95. Finally, investments and financial flows from corporations (domestic plus foreign) are deemed to constitute 60% of the total investment and financial flows worldwide in 2000. This number is relatively constant across regions, being the lowest for Africa at 55% and highest in Asia at 73%. The number is likely comparable if considering specifically technology transfer. This supports the many analyses that point to the central importance of the private sector, and of activities that can facilitate private sector investments in leveraging resources for technology transfer for climate mitigation and adaptation.

96. The following provides some specific data drawn from a number of sources, chief amongst them the recent "Investment and financial flows to address climate change" report of the UNFCCC[18] (2007). All statistical data is quoted from that report unless otherwise specified. The limit of that analysis in terms of providing aggregated data was recognized by the authors, and is based on the aggregation in the original data sets, including OECD, UNCTAD, and World Bank databases.

97. The authors of the report estimate that, overall, total investments in physical assets in 2000 stood at $7.8 trillion dollars, of which 21%, or $1.7 trillion were directed to non-Annex I countries, and only 0.5% to LDCs ($40 billion). Domestic, private and public, investments in non-Annex I countries and LDCs stand at 85% and 88% of the total respectively. FDI is slightly over 10% for non-Annex I countries and over 4% for LDCs. It varies considerably from 3.3% in Africa to 21% in Latin America. ODA is mostly negligible, 1% on average, except for LDCs were it reaches over 6%.

[18] E. Haites and J. Smith *et al*., *Investment and Financial Flows to Address Climate Change*, 270p., UNFCCC 2007.

Mitigation

Energy

98. In 2000, total yearly investment flows for electricity, gas distribution, and power supply amounted to $67 billion in developing countries (non Annex I), and a further $3 billion in Least Developed Countries (LDCs). There the most striking difference is perhaps not so much the share of FDI: 6.3% for LDCs and 12.6% for other developing countries, but rather the share of bilateral and multilateral Official Development Assistance (ODA): less than 4% of the total for non Annex I countries, but more than 30% of the total for LDCs.

Renewable Energy

99. Investments in developing countries represented approximately a fifth of investments in OECD countries in 2005 (total of $4.6 billion versus $23.2 billion). In developing countries, more than three quarters of these investments are private sector investments. The GEF, expending on average approximately $75 million a year on renewables in that period, is an important actor in the public sphere.

100. Investments in the developing world were concentrated in three countries, China, India, and Brazil[19]. They represented 9% of the world total in China, 5% in India, and 3.7% in Latin America (with the majority in Brazil). Investments have grown in all regions during the 2004 to 2006 period, and are projected to continue to do so. A notable exception is Africa which saw 0.3% of the total investments in sustainable energy worldwide in 2006, and where annual investments have actually decreased during the period.

101. The authors of the *Global trends in sustainable energy investment* report[20] make two observations that are particularly relevant to the discussion at hand: that whilst renewable energy accounts for only 2% of installed capacity, it accounts for a significant 18% share of power generation investments; and that "investment in renewable energy remains more policy than purely commercially driven".

Energy Efficiency

102. This is an area where quantification is most difficult; in fact it has even been referred to as the "invisible market[21]". The investment and financial flows report estimates that total investments in developing countries amounted to $132m in 2005, and 1.4 billion in OECD countries. The former might well be underestimated as GEF commitments to projects supporting energy efficiency in recipient countries amounted to around $75 million per year on average during the GEF-3 replenishment period. This in any event points to the GEF potentially playing a key role in promoting energy efficiency in developing countries.

Specific sectors

[19] Data in this paragraph from C. Greenwood *et al*., *Global trends in sustainable energy investments*, 52p., UNEP, 2007 – the authors estimate that worldwide investments in "sustainable energy" reached over $70 billion in 2006.
[20] C. Greenwood *et al*., *Op. Cit.*
[21] C. Greenwood *et al*., *Op. Cit.*

103.Manufacturing sector. Most of the $447 billion investment flows to the manufacturing sector in non-Annex I and LDCs in 2000 were of domestic origin. ODA was negligible. FDI represented 12 to 18% of the total. The majority of these investments were in the developing economies of Asia. LDCs accounted for less than 1% of the total.

104.Transport sector. 86% of the $248 billion investment flows to the transport, storage and communications sector in non-Annex I countries in 2000 were of domestic origin. The largest share of these investments were in the developing economies of Asia. LDCs accounted for 1.5% of the total to developing countries, with a significant share of ODA at 23% of the total. FDI was very variable, up to 41% in Latin America.

105.Construction sector. The overwhelming majority of investment flows of the total $213 billion to Annex I countries and LDCs was of domestic sources (99%) – with the exception of the Middle East. Investments in LDCs represented only 2% of the total.

106.Agriculture. The situation is somewhat comparable in the Agriculture, Forestry and Fisheries sector where investment flows from domestic sources represent 97% of the total for non Annex I countries and 92% for LDCs. Total investments stand at $72 billion for these two categories. In LDCs, ODA is significant at 6% of the total. These numbers are likely to increase as the World Bank and other IFIs prepare to ramp up[22] their efforts in the Agriculture sector.

107.Forestry. Data disaggregated from Agriculture and Fisheries is difficult to obtain, and difficult to reconcile as well as noted by the authors of the financial flows report. These authors estimate that the vast majority of investments are private investments totaling some $15 billion a year, of which over 90% would be of a domestic nature. ODA in 2000 amounted to $330 million. Significant in relation to total ODA is the GEF contribution: even before the launch of the strategic program on sustainable forest management, it was estimated to amount to approximately $150 million through various related operational programs.

Adaptation

108.The challenge in attempting to assess the funding options for technology transfer for adaptation to climate change lies with the nature of adaptation itself: climate change adaptation activities are difficult to identify as being unique from other development activities, as adaptation itself is inextricably linked to development. Nevertheless, it is also clear that "technology transfer" as defined above clearly will play an important role. For example two out of the six determinants of adaptive capacity identified by Smit et al (2001)[23] are directly linked to technology transfer: "technology" and "information and skills". In fact, one could consider "technology, techniques and practices" – supported by "information and skills" that would then cover the gamut of requisite adaptive measures that pertain to technology transfer.

[22] See for example *World Development Report 2008: Agriculture for Development*, World Bank, 2008

[23] B. Smit, O. Pilifosova, I. Burton, B. Challenger, S. Huq, R.J.T. Klein, G. Yohe, *et al.*, Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Adaptation to climate change in the context of sustainable development and equity. In: J.J. McCarthy, O.F. Canziano and N. Leary, Editors, *Climate Change 2001—Impacts*, Cambridge University Press, Cambridge, UK (2001), pp. 877–912.

109.Agriculture. It remains to be seen how much of the adaptations required in the agriculture sectors will be purely technology-driven, but what is clear is that many forms of adaptation will be concerned with transfer and diffusion of management practices and related knowledge. Agricultural extension services have traditionally been a vehicle of choice for the diffusion of knowledge and good practices in the agriculture sector. In 2000, funding for extension in developing countries was estimated at a little over $3 billion dollars, of which only $86 million was provided through ODA. Research was estimated at $15 billion in developing countries, including $53 million from ODA. The latter had tripled by 2005 to $145 million.

110.Water supply expenditures in developing countries were estimated at $65 billion in 1999[24], of which approximately 90% comes from domestic, mostly public, sources. These figures are somewhat dated and in the meanwhile there have been mixed experiences with private sector investments in the water sector in developing countries. It is likely however that public sources are still preponderant today. ODA for water infrastructure was estimated at close to $6 billion in 2005, with nearly half of that directed towards the developing economies of Asia.

111.Health. The first improvement in capacity to adapt will come from general improvements and capacity strengthening in the health sector. Nevertheless, there too the transfer of environmentally sound and socially acceptable techniques and practices will be important, in countering the likely expansion of vectors of diseases such as malaria for example. Health expenditure in non-Annex I and least developed countries in 2000 was $364 billion – only slightly over 10% of the world total. This is shared in roughly equal parts between government and private expenditures; with the government share overall lower in LDCs. ODA was a total of $3.3 billion in 2000 increasing to over $5.5 billion in 2005; no doubt a reflection of the importance given by the international community to the health-related MDGs. Slightly less than half that amount is directed to Africa. In this sector, the Global Fund to fight Aids, Tuberculosis, and Malaria, but also private foundations such as the Bill and Melinda Gates Foundation have become major players; this trend is likely to continue.

112.Ecosystems. Generally, measures to increase ecosystems resilience in the face of climate change deal with improving ecosystem conservation in general, including reducing other stress on these ecosystems, and generally increasing the size, latitudinal reach, and connectivity of protected areas. Supporting this effort will require increased exchange and diffusion of knowledge and good practices regarding biodiversity conservation, and regarding the combined effects of multiple stressors on ecosystems. It is estimated that in the mid 90s some $800 million were spent annually on protected areas in developing countries. At present, GEF's commitment to biodiversity conservation amounts to approximately $250 million yearly.

113.Coastal zone management. This is a domain where, with rare exceptions, little in terms of infrastructure development specifically targeting sea-level rise has been accomplished in developing countries. It is also a domain where central and local government interventions will be crucial, supported in this by the increasing realization of the importance of the issue in the World Bank and other IFIs. It is also a domain where partnerships with bilaterals as well as South-South exchange of experience will be crucial, particularly with those countries that have had to adapt to climate variability and contain sea level for centuries.

[24] J. Briscoe, The Financing of Hydropower, Irrigation and Water Supply Infrastructure in Developing Countries, *International Journal of Water Resources Development*, Volume 15:4, pp. 459-491, 1999; cited by Haites and Smith.

114.Infrastructure. Here too is a sector where the issue would appear to concern not so much specific technologies in the narrow sense of the word, but rather a number of techniques and good practices which will have to be shared, including with other countries that have faced related issues historically. It is a domain where transfer of technologies and techniques, such as building codes for example, is likely to be promoted by the investors themselves, encouraged and pushed by the insurance industry. The sector is approximated by total investments in physical assets, which we have seen were estimated at $1.7 trillion in non-Annex I countries and 40 billion in LDCs. Domestic, private and public, investments in assets represented more than 85% in developing countries, with ODA significant in number only for LDCs were it reaches over 6%.

Activities of partner institutions and agencies

115.The following section provides a snapshot of some related activities supported by a number of GEF partner agencies. An exhaustive description of the initiatives under way under the aegis of various multilateral, bilateral, and other institutions, partnerships, agencies, etc, whilst could provide useful information, would require further analysis beyond the scope of this paper.

116.The World Bank is the strongest implementing partner of the GEF. Over the years of GEF's existence, nearly $1.6 billion or 64% of the GEF's funding in the climate change focal area has flowed via projects being implemented by the World Bank. The World Bank's initiatives in the energy efficiency and renewable energy portfolios have continued to grow, with the total funding committed to renewable energy, hydro-electricity, and energy efficiency comprising $1.4 billion, or 40% of total energy sector commitments[25]. GEF funding made up $128 million of this total. The World Bank also hosts a number of different carbon funds to support CDM projects. During 2007, nearly 10% of the Bank's clean energy portfolio ($140 million) was made up of carbon finance operations. The World Bank is placing renewed emphasis on climate change and is seeking to establish a portfolio of strategic Climate Investment Funds (CIF), expected to include a Clean Technology Fund that would focus on financing clean technologies.

117.In addition to the initiatives of the World Bank, the other multilateral development banks have established specialized funding instruments to address climate change. The Asian Development Bank is supporting clean energy projects through the Asia-Pacific Carbon Fund (APCF), and has just announced the establishment of a new Climate Change Fund to "address the causes and consequences of global warming" in Asia and the Pacific. The EBRD is supporting low-carbon projects through both the Sustainable Energy Initiative and the Multilateral Carbon Credit Fund. The IDB is utilizing its own capital to support both sustainable infrastructure projects through its Infra-fund and sustainable energy projects through its Sustainable Energy and Climate Change Initiative.

118.Other initiatives and activities include FAO's role with regards agriculture technologies and support to extension services; activities of UNIDO's cleaner production centres and investment and technology promotion offices; activities of UNEP's cleaner production centres and collaborating centres; as well as the role played by the Private Financing Advisory Network (PFAN) of the Climate Technology Initiative (CTI) in providing assistance to project developers in the structuring of projects and the preparation of financing proposals to facilitate access to financing.

[25] World Bank. 2007. *Catalyzing Private Investment for a Low-Carbon Economy: World Bank Group Progress on Renewable energy and Energy Efficiency in Fiscal 2007*. Washington, DC: World Bank

119.The role of the CDM in promoting technology transfer for climate mitigation has been analysed[26], and can only grow; this growing role has its respondent on the adaptation side through the potential that lies with the Adaptation Fund.

Conclusion

120.The brief overview presented in part II of this paper provides a broad characterization of investments and financial flows in relevant sectors, as a proxy for potential for technology transfer in the climate mitigation as well as in the climate adaptation spheres. Implicit in this analysis is that the greatest benefits in terms of promotion of technology transfer and diffusion are likely to be realised when working to influence some of the largest of these fluxes, be they domestic or foreign, public or private. Although the public sector is supporting a range of activities contributing to technology transfer, based upon the numbers presented above it is clear that the domestic private sector will continue to play an important role.

121.Whilst in purely quantitative terms the importance of international technical and financial assistance is limited, the GEF and its agencies and partners can play a crucial role in serving as repositories and conduit for knowledge and good practices related to environmentally sound technologies, techniques, and practices. Part I of this paper describes the extensive past experience of the GEF and partners in successfully promoting technology transfer. The GEF is indeed well placed with its mandate for demonstration activities and catalytic role, and unique position as a bridge between the UN Agencies and the World Bank and other Regional Development Banks.

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[26] *E. HAITES, M. DUAN AND S SERES, "TECHNOLOGY TRANSFER BY CDM PROJECTS",* CLIMATE POLICY *6 : 327–344, 2006*