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Item 7 of the provisional agenda
Development and transfer of technologies

Report of the Global Environment Facility on the elaboration of a strategic programme to scale up the level of investment in the transfer of environmentally sound technologies

Note by the secretariat*

1. The Conference of the Parties (COP), by its decision 4/CP.13, 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. The COP requested the GEF to report on its findings to the twenty-eighth session of the Subsidiary Body for Implementation (SBI) for consideration by Parties.

2. The SBI, at its twenty-eighth session, noted the report of the GEF on a strategic programme to scale up the level of investment for technology transfer.[1] It encouraged the GEF to take into consideration the discussion on this issue that took place at that session, noting the concerns of Parties, in the elaboration of the options related to the strategic programme. Parties looked forward to considering a further report, to be provided by the GEF to the SBI for consideration at its twenty-ninth session, outlining a programme that fully addresses the elements called for in paragraph 3 of decision 4/CP.13 such as the need for broad and balanced consultation with Parties and how such a strategic programme might be implemented along with its relationship to existing and emerging activities and initiatives.

3. In response, the GEF secretariat has submitted the attached report (see annex); it is reproduced here as submitted, without formal editing, and with the original pagination.

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* This document was received from the Global Environment Facility secretariat on 21 November 2008 and was submitted as soon as it was received.

[1] FCCC/SBI/2008/5.

Annex

Global Environment Facility

GEF/C.34/5.Rev.1
November 13, 2008

GEF Council
November 11-13, 2008

Agenda Item 10

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

Recommended Council Decision

The Council, having reviewed document GEF/C.34/5, *Elaboration of a Strategic Program to Scale up the Level of Investment in the Transfer of Environmentally Sound Technologies*, notes with appreciation that the GEF Secretariat had prepared a progress report on the Elaboration of a Strategic Program to Scale up the Level of Investment in the Transfer of Environmentally Sound Technologies, and, upon Council approval, had forwarded it to the UNFCCC Subsidiary Body for Implementation at its 28th session in Bonn, Germany, in June 2008.

The Council also requests the Secretariat to forward a revised version of document GEF/C.34/5, as presented in GEF/C.34/5.Rev.1, to the UNFCCC Subsidiary Body for Implementation at its 29th session in Poznan, Poland, in December 2008.

The Council further agrees to a target funding level of $35 million pending resource availability for the proposed technology transfer program in the following manner:

(i) $5 million from the climate change global and regional exclusion window of the GEF Trust Fund; and

(ii) $30 million to be realized from:

a. National individual allocations and the group allocation;

b. Resources that might be made available from the planned RAF reallocation, subsequent to a Council decision on this in June 2009.

The Council notes a pending decision to set aside $15 million from *SCCF Program B on technology transfer* for the proposed technology transfer program.

EXECUTIVE SUMMARY

1. At the 13th Session of the Conference of the Parties (COP) to the UN Framework Convention (UNFCCC)on Climate Change held in Bali, Indonesia, in December 2007, the COP reached a decision (4/CP.13) requesting the Global Environment Facility to elaborate a strategic program to scale up the level of investment for technology transfer to help developing countries address their needs for environmentally sound technologies (EST), specifically considering how such a strategic program might be implemented along with the program's relationship to existing and emerging activities and initiatives regarding technology transfer. This paper is a response by the GEF to the COP decision 4/CP.13, based on consultations with interested Parties, international financial institutions (IFIs), the private financial community, and other relevant multilateral institutions. In addition, this paper is a response to the GEF Council's decision (GEF Council 33, April 22-24, 2008, Joint Summary of the Chairs, paragraphs 24-26) requesting the Secretariat to prepare a report comprising a description of its work to date on financing technology transfer and a description of current financing options for technology transfer.

2. This paper adopts the concept of technology transfer as defined by the Intergovernmental Panel on Climate Change (IPCC) and embodied in the UNFCCC technology transfer framework. The paper presents an overview of the GEF experience in financing technology transfer in the climate change focal area, from strategy development to project implementation. The general conclusion is that GEF operations have always focused on the deployment and diffusion of climate-friendly and environmentally sound technologies. Virtually all GEF mitigation and adaptation projects aim to promote climate-friendly technologies and expand the capacity for their utilization and reach in the market. GEF funding has focused on supporting innovative approaches and technologies to benefit the global environment while enhancing development goals. Altogether, the GEF has supported more than 30 technologies related to energy efficiency, renewable energy, low-greenhouse-gas-emitting electricity generation, and sustainable urban transport, as well as technologies for adaptation. Additionally, the GEF has provided funding for the preparation of technology needs assessments (TNAs) and other enabling activities for over 100 developing countries. A number of gaps in the current operations of the GEF have been identified, including: (1) the weak link between GEF project development and TNAs; (2) a lack of adequate reporting and knowledge management on technology transfer activities; (3) an uneven engagement with the private sector; and (4) the limited synergy with the carbon market.

3. In elaborating a GEF strategy on technology transfer, this paper identifies a range of options for promoting the transfer of ESTs, including expanding support for existing and new public-private partnerships, technology needs assessments, cost-effective demonstration projects, development of policy frameworks and institutions, and synergy with the emerging climate investment funds as well as the carbon market.

4. Finally, following comment by UNFCCC Parties, the paper proposes a strategic program for implementation during the remainder of GEF-4 using existing GEF-4 resources from the GEF Trust Fund and the Special Climate Change Fund (SCCF) Program B. The proposed program will consist of three funding windows to support technology transfer activities: (1) technology needs assessments; (2) piloting priority technology projects linked to TNAs; and (3) dissemination of GEF experience and successfully demonstrated ESTs.

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ABBREVIATIONS AND ACRONYMS

CDM	Clean Development Mechanism
CFL	Compact Fluorescent Lamp
CIF	Clean Investment Fund
COP	Conference of the Parties
CSP	Concentrating Solar Power
CTI	Climate Technology Initiative
EBRD	European Bank for Reconstruction and Development
EGTT	Expert Group on Technology Transfer
EST	Environmentally Sound Technology
FCB	Fuel-Cell Bus
FDI	Foreign Direct Investment
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWP	Global Warming Potential
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFI	International Financial Institution
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
LDCF	Least Developed Countries Fund
LULUCF	Land Use, Land-Use Change, and Forestry
NAPA	National Adaptation Program of Action
NGO	Non-Governmental Organization
ODA	Official Development Assistance
OP	Operational Program
PFAN	Private Financing Advisory Network
PV	Photovoltaic
RE	Renewable Energy
REN21	Renewable Energy Network for the 21st Century
S&L	Standards and Labeling
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SEFI	Sustainable Energy Finance Initiative
SHS	Solar Home System
SME	Small and Medium-Sized Enterprise
SPA	Strategic Priority on Adaptation
STRM	Short-Term Response Measure
TNA	Technology Needs Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VC	Venture Capital

I. 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 Conference of the Parties (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 a technology transfer framework through both the GEF Trust Fund in 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 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

[1] Bert Metz, et al., *Methodological and Technological Issues in Technology Transfer*, Cambridge, UK: Cambridge University Press for the IPCC, 2001.
[2] FCCC/CP/2001/13.
[3] FCCC/CP/2001/13/Add.1.

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 five 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 technical reports on a range of topics from the importance of enabling environments to technologies for adaptation as well as analytical work, particularly in terms of innovative financing, including a workshop, technical paper, and project financing guidebook.

II. BACKGROUND TO THIS PAPER

6. At the Thirteenth Meeting of the 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 ESTs. The decision (4/CP.13) reads as follows:

> 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.

7. At its 33rd 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 request from the COP. Given the tight time constraints, the Council reached the following decision:

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

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.[5]

8. In response to the above decision, the GEF Secretariat prepared a Progress Report, which was approved by the Council and submitted it to the 28th session of the SBI.[6] At the 28th session of the SBI, Parties requested the GEF to conduct broad and balanced consultation with interested Parties regarding the elaboration of a strategic program on technology transfer in accordance with decision 4/CP.13. Subsequently, the GEF Secretariat held informal consultations with interested Parties during the UN Climate Change Talks in Accra in August 2008. Further consultations were conducted with international financial institutions (IFIs), the private financial community, and other bodies.

9. The paper presented here is the GEF's response to decision 4/CP.13 based on extensive consultations carried out by the GEF Secretariat and feedback it received from UNFCCC Parties and other stakeholders. It is apparent from the feedback that the Secretariat received that not all Parties share the same interpretation of decision 4/CP.13. As a result, this paper offers a "menu" of options to scale up the level of investment for the transfer of ESTs to developing countries that can be considered by the GEF Council and by the Parties. The paper also elaborates a GEF strategic program on technology transfer for which the implementation can start during the remainder of GEF-4.

10. The following sections of the paper summarize GEF experience with technology transfer, identify some lessons learned as well as gaps, present a range of options for scaling up investment, and finally propose a strategic program for implementation.[7] In offering a GEF strategic program on technology transfer, the Secretariat recognizes that Parties have submitted various proposals to the UNFCCC on technology transfer. The strategic program on technology transfer proposed here is based on the existing financial mechanism of the UNFCCC, and it does not in any way prejudice outcomes and decisions to be taken by the COP on future technology transfer mechanisms.

III. GEF EXPERIENCE WITH TECHNOLOGY TRANSFER

11. As an operating entity of the financial mechanism of the UNFCCC, the GEF has a mandate with significant guidance from the COP related to financing the transfer of ESTs in the context of both mitigation and adaptation. Such 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 least developed countries (LDCs), it can also be applied to meeting technology transfer

[5] GEF Council 33, April 22-24, 2008, Joint Summary of the Chairs, paragraphs 24-26.
[6] UNFCCC/SBI28/5. Based on this progress report, the GEF Secretariat prepared a publication describing GEF experience in financing technology transfer activities and projects.
[7] Current financing options for the transfer of ESTs aside from the GEF are discussed in Annex 4.

needs relating to the urgent and immediate adaptation needs under the Least Developed Countries Fund (LDCF). Annex 1 to this paper summarizes COP decisions that provide the GEF mandate to work on the transfer of ESTs under both the GEF Trust Fund and the Special Climate Change Fund (SCCF).

12. This section reviews the experience of the GEF to date in supporting technology transfer consistent with both the IPCC definition and the UNFCCC's Framework on Technology Transfer. The paper first gives an overview of the GEF's strategies and policies that have evolved in the years of its operation with respect to the transfer of ESTs. It then summarizes GEF-financed activities related to transfer of ESTs relevant to both mitigation and adaptation, with more detailed examples provided in Annex 2. Finally, it identifies a number of gaps in the GEF's current operations.

GEF Policies and Strategies relating to Technology Transfer

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

14. 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."[8] This objective for GEF operations still holds, and was restated in the GEF-4 revised strategy.

15. 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 response measures (STRMs).[9] In contrast, the long-term programs 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. Both programmatic long-term approaches and short-term projects focused primarily on mitigation through the use of commercialized or nearly commercialized technologies that were not yet widely disseminated in developing countries or countries with economies in transition.

16. Operational programs 5 and 6 (OP5 and OP6) focused on energy efficiency and renewable energy technologies, respectively, that were mature, available on the international market, and profitable on paper, but were not disseminating widely because of the existence of institutional, technological, policy, or financial barriers. Projects under OP5 and OP6 sought to remove these barriers and promote accelerated growth in the adoption of the new technologies and practices. In contrast, OP7 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 costly relative to the baseline or conventional alternatives. In these cases, such as concentrating solar power (CSP) plants, stationary fuel-cells, and micro-turbines, significant incremental costs still existed. Finally, approved in 2000, the operational program on sustainable urban transport (OP11)

[8] GEF Secretariat, 1995, *GEF Operational Strategy*, p. 31.

[9] Short-term projects are considered extremely cost-effective, with a unit abatement cost of less than $10/ton of carbon avoided, or roughly $2.7/ton of CO_2 equivalent avoided.

contained a combination of approaches, including a focus not only on technologies and practices that were cost-effective and underutilized, but also on technologies that were not fully developed.

17. According to the second Climate Change Program Study (2004) by the GEF's Office of Monitoring and Evaluation,[10] GEF's operational strategy focusing on barrier removal for energy efficiency and renewable energy technologies had largely been successful, but required some codification of the key barriers. The Third Overall Performance Study also concluded 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."[11] These conclusions have informed the approach embodied in the GEF-4 revised strategy in the climate change focal area.

18. As part of the GEF-4 replenishment process, the climate change strategy for mitigation was revised to focus primarily on six strategic programs to promote energy efficiency in buildings and appliances; industrial energy efficiency; market-based approaches for renewable energy; sustainable energy production from biomass; 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.

19. The GEF's work in the climate change focal area has generally focused on the deployment and diffusion of ESTs. Mitigation projects at the GEF have focused on a technology and the need to expand the capacity for its utilization and reach in the market. The approach adopted has conformed closely to the UNFCCC's technology transfer framework.

GEF Experience in Financing Technology Transfer

20. Since the creation of the GEF in 1991, about $2.5 billion has been allocated to projects in the climate change focal area.[12] Such funding has leveraged an estimated additional $15 billion in co-financing and resulted in the reduction of over one billion tons of GHG emissions. GEF funding has focused on supporting innovative approaches and technologies to benefit the global environment while enhancing national development goals. In the years of its existence, the GEF has supported the transfer, uptake, and deployment of more than 30 climate change mitigation and adaptation ESTs in more than 50 countries; it has also provided funding for TNAs and other enabling activities in over 100 developing countries. Following is a summary of selected technologies for which the GEF has provided support.

Energy Efficiency Technologies

21. GEF experience financing ESTs has been found in each of the programs under the GEF climate change strategies. Among the more than 30 ESTs that the GEF has supported over the years, more than one-third are energy efficiency technologies, ranging from efficient

[10] GEF Office of Monitoring and Evaluation, *GEF Climate Change Program Study*, 2004.
[11] GEF Office of Monitoring and Evaluation, *OPS3: Progressing Toward Environmental Results – Third Overall Performance Study of the Global Environment Facility*, 2005.
[12] Information on GEF-funded projects is available on the GEF website: http://thegef.org/interior.aspx?id=90.

lighting and appliances to chillers, boilers, motors, and brick kilns; from building design and construction materials to district heating systems; and from power generation and distribution to cogeneration and industrial energy efficiency technologies. Total GEF funding to support the deployment, diffusion, and transfer of energy efficiency technologies is close to $1 billion. GEF-financed energy efficiency projects have also leveraged about $6 billion in co-financing, a significant portion of which has come from the private sector in developing countries.

22. In Annex 2, Table 1 lists the countries that have received support for technologies through 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 expanding markets for the particular technologies by the countries listed. In some cases, technology transfer has been successful, and in other cases, additional barriers prevent maturation of the market for the specific technology. Below is a brief summary of the range of technologies for which the GEF has provided support.

Renewable Energy Technologies

23. For renewable energy technologies, from 1991 to 2007 the GEF approved grants totaling more than $800 million for approximately 150 projects that promote the transfer of renewable energy technologies to developing countries and countries with economies in transition. The technologies range from solar energy (PVs, solar homes, and solar water heaters), wind turbines, geothermal, small hydro, methane, and biomass for heat and electricity generation. A sample list of countries that have benefited from GEF support for renewable energy technologies is contained in Annex 2, Table 2.

Low-GHG-Emitting Energy Generating Technologies

24. The GEF has pioneered the support of a number of new, low-GHG-emitting energy technologies under OP7. GEF finance has aimed to provide support for early technology demonstrations in developing countries and thereby to increase experiences with these technologies and accelerate the reduction in cost of subsequent installations. Table 3 of Annex 2 shows seven technologies and the countries that have received GEF support to adopt them. The largest and most significant technology to receive support under this program has been the CSP technology.

Transport Sector Technologies

25. In the transport sector, the GEF program on sustainable urban transport, approved by the Council in 2000, supports a combination of new technologies and the removal of barriers to well established technologies and practices that are not disseminating throughout the market. The most noteworthy new technology is the fuel-cell bus, for which Brazil and China have received significant GEF support; they are the only developing countries where such technology has been made available. Table 4 of Annex 2 lists the technologies and countries where GEF has provided support.

Short-Term Response Measures

26. The window for STRMs in climate change was established to support opportunities considered “too good to refuse.” It set a hurdle rate for eligibility at a unit abatement cost of

$10/ton of CO_2 equivalent. The list of projects supported under STRM is given in Table 5 of Annex 2. Virtually all short-term projects focused on methane reduction and utilization.

Technologies for Adaptation

27. Support for adaptation has been provided by the GEF under the Strategic Priority on Adaptation (SPA) in the GEF Trust Fund, the SCCF, and the LDCF. Total funding allocated by the GEF for adaptation projects has exceeded $130 million.

28. Technology transfer has been a major consideration for most adaptation projects. Because the portfolio of adaptation projects is still in its infancy, there is less experience with successful cases of technology transfer than with the GEF's mitigation programs. Nevertheless, while recognizing key differences between technologies for adaptation and mitigation, technologies for adaptation will require significant efforts for 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 its past work as well as that of others such, as the EGTT and other organizations.

29. GEF support for adaptation activities has covered six different adaptation sectors: ecosystem management, agriculture, water management, disaster risk management, coastal zone management, and health. The approaches taken by GEF projects in supporting technology transfer include transfer of information, infrastructure and hard technology transfer, and capacity building, coordination, and policy. For further discussion and project examples, see Table 6 of Annex 2. In addition to the current work the GEF is doing in adaptation, the GEF intends to finance new and innovative technologies for adaptation that will assist developing countries address the future challenges they face.

30. To a larger degree than for mitigation technologies, technologies for adaptation often have to be customized to suit local conditions and situations. Annex 3 contains some examples of adaptation technologies. Technologies for adaptation can often be soft or hard technologies, and many of them are very innovative. The GEF is exploring a wide range of technologies for adaptation, which, unlike mitigation technologies, are very site-specific and often require the enhancement of existing technologies so as to take into consideration the changing climate. Technologies for adaptation will play an increasingly important role in the overall dynamic of adapting to climate change, and these technologies will need to be used to improve the overall resilience of natural and human systems to climate change.

Gaps in GEF Current Operations

31. Although the GEF has been a key player in providing public financing for the transfer of ESTs to developing countries, its function as a technology transfer mechanism can be improved and strengthened. The GEF has identified four gaps in its support to date, namely, (1) the weak link between GEF project development and TNAs and national communications; (2) a lack of adequate reporting and knowledge management on technology transfer activities; (3) an uneven engagement with the private sector; and (4) the limited synergy with the carbon market. Each of these gaps is briefly elaborated below.

Weak Link between GEF Project Development and TNAs

32. Through the funding of additional capacity building or top-up activities to initial national communications, the GEF has provided funding for TNAs in more than 90 countries. To date about 50 TNAs are available at the UNFCCC website. Only a handful of countries have developed project concepts and proposals based on their TNAs, and hardly any of those proposals have been submitted to the GEF for funding. Many reasons lie behind the weak link between the TNAs and GEF project development. First, enabling activities such as national communications are primarily designed to assist countries in fulfilling their requirements under the UNFCCC; they seldom lead to the development of projects. Further, the guidelines for preparing TNAs also do not cover project development.[13] Second, in many countries the government agencies responsible for enabling activities are different from, and often not well coordinated with, those that develop climate change proposals for funding by the GEF or other sources. Third, the quality of TNAs varies substantially in terms of analytic rigor, often with little effort being devoted to indentifying the cost-effectiveness and market potential of technologies, barriers that prevent the market potential from being realized, and the means of overcoming these barriers. Finally, in the first round of TNAs, technical support and guidelines were provided far too late in the implementation processes to be effective. Lessons need to be drawn from the existing experience of funding and conducting TNAs so that those supported in the future will lead to better results.

Lack of Adequate Reporting and Knowledge Management on Technology Transfer Activities

33. Although technology transfer activities have been promoted by the GEF over the years through various strategies and programs, there has been little reporting by the GEF on its activities on technology transfer, nor have there been systematic efforts to draw on the experiences and lessons learned and to disseminate them. Despite all the financing that the GEF has provided and the results that have been achieved from the completed and ongoing projects, there has been no comprehensive, in-depth analysis of the GEF portfolio from the technology transfer perspective. Even at the project level, where indeed dozens of technologies have been successfully deployed and transferred with GEF support, there is still relatively little understanding of the intricate process of technology transfer in different national contexts and markets, of the various roles of different actors and stakeholders (such as the GEF, national and local governments, domestic and international research, development, and design institutes, and the private sector), and finally, the necessary conditions and prerequisites for the successful transfer of specific technologies under different circumstances. Detailed GEF experience at the project level, including lessons learned, needs to be distilled and disseminated.

Uneven Engagement with the Private Sector

34. Engagement with the private sector by the GEF has been somewhat haphazard. The GEF Council adopted a strategy in June 2006 with guidelines aimed at enhancing engagement with the private sector.[14] Consequently, a public-private-partnership initiative (also known as the Earth Fund) was proposed and approved by the Council in June 2007, for which $50 million of GEF funding has been earmarked.

[13] The UNFCCC and the Climate Technology Initiative (CTI) in collaboration with the EGTT have conducted workshops and training courses to promote good practices of TNAs and on project development arising out of TNAs. CTI's Private Financing Advisory Network (PFAN) has been actively involved in providing advice on project development and financing as well as provision of financing through the PFAN network.

[14] GEF/C.28/14, *GEF Strategy to Enhance the Engagement with the Private Sector*, June 2006.

35. In the climate change focal area, the majority of GEF projects have some aspect of engagement with the private sector. Most engagement with the private sector has been through procurement. In particular, energy efficiency and renewable energy projects often engage small and medium-sized enterprises in the recipient countries, which co-finance the GEF projects and are also beneficiaries of GEF support. Engagement by the GEF with large multinationals, the private financial community, and the capital market has been rather limited or non-existent. In fact, even the GEF portfolio with the International Finance Corporation – the private-sector arm of the World Bank Group – has significantly declined during GEF-4, largely due to the introduction of the Resource Allocation Framework.

Limited Synergy with the Carbon Market

36. As an operating entity of the financial mechanism of the UNFCCC, the GEF has had limited interaction and synergy with the market-based flexibility mechanisms such as the Clean Development Mechanism (CDM) under the Kyoto Protocol. Although the mandate and the modality of the GEF and carbon finance are different, there is tremendous potential for synergy between the two mechanisms that needs to be explored.

37. Even though the GEF does not support activities directly linked to implementation of the Kyoto mechanisms, such as development of CDM methodologies and projects or verification of emission reductions, a number of approaches have been identified whereby GEF funding and carbon finance can be combined in a complementary manner. GEF support can, for instance, create or strengthen enabling environments, demonstrate technical and financial viabilities, and provide risk mitigation facilities, while carbon finance can support specific project investment and replication and participate in project structuring. To date only a very limited number of projects have taken advantage of the potential synergy, notably the India and Philippines Chiller Energy Efficiency Projects, whose financing structure has included the GEF, the Multilateral Fund under the Montreal Protocol, and carbon finance. With the continuing development of the carbon market, the GEF needs to explore the potential of leveraging resources from this growing source of funds.

IV. OPTIONS FOR CONSIDERATION EMERGING FROM THE GEF'S CONSULTATIVE PROCESS

38. Given the ever changing nature of technology transfer processes, it is envisioned that a GEF strategy on technology transfer would be a living document. In recent months the GEF, in cooperation with interested Parties, public and private sector institutions, and representatives of the financial community, has launched an informal consultation process. The options presented in the following section are a product of this effort. These options are intended to be illustrative and not exhaustive. Based on consultations and the consensus-building process, the role of the GEF and other leading institutions will be identified.

39. During the GEF's consultations through October 2008, a number of considerations regarding the scaling up of investment in technology transfer were raised that the Parties may wish to consider, including the following.

40. Using existing GEF-4 resources and the SCCF Program on Technology Transfer, establish a $50 million funding portfolio devoted to scaling up investment in the transfer of EST activities. This element will build on the GEF's mandate, experience, and current network of technology transfer activities. This portfolio will help enable private and public

climate-friendly investments and provide funding for innovative and highly leveraged projects. The portfolio priorities will be activities with multiple local and global benefits that contribute to private sector investment in, and financing of, technology transfer in developing countries.

41. Continue support for existing public-private technology transfer partnerships and identify new and emerging partnerships. A large number of existing partnerships have been highly successful, and they merit continued support. New partnerships aimed at unmet technology transfer needs or geographic regions should be considered. Incentives to engage and leverage the private sector should be explored and cultivated. Risk-sharing instruments that encourage greater private sector financial investment should be encouraged. Public-private partnership tools such as the CDM have been proven to be effective in some countries.

42. Improve and expand support for conducting technology needs assessments (TNAs), preparing technology roadmaps and national action plans, and allied activities. All of these assessment and planning activities, including those for both mitigation and adaptation, will help form a strong foundation for a strategic technology transfer program. TNAs, roadmaps, action plans, and allied activities can be sharpened in order to identify and prioritize national technology transfer activities to attract financial investment. For instance, it has been suggested that TNAs might include sector-specific analysis, and that the assessments could be produced on a regional basis. Better matching projects with potential financial resources to implement the projects would be an immediate benefit of improved TNAs. Appropriate technologies, policies, and financial instruments can be developed to address market challenges and opportunities. In many instances these efforts will be nationally focused, but scope should exist for regional and sectoral approaches where these match existing markets for ESTs or those that can be developed. These activities should build upon existing efforts.

43. Explore the opportunity for, inter alia, public and private-sector venture capital (VC) funds to play a growing role in the transfer of ESTs to developing countries. New VC funds, entirely focused on ESTs, are expanding rapidly throughout the world. While it is recognized that VC funds cannot supply all the ESTs that will be needed by developing countries, these funds utilize a variety of innovative financial instruments that have played an important role in transforming the clean energy technology community over the last decade. New roles for multilateral financial institutions in the VC community should be explored to quickly scale up the level of investment in developing countries. New VC platforms might help overcome recurring barriers to technology transfer and could include establishment of public-private governance structures that could help moderate investment risks and other issues. It is recognized that the VC community is not dependent on GEF funds, but the GEF can look for a niche to facilitate the process of leveraging private capital for the transfer of ESTs. For example, the GEF Earth Fund and its evolving linkages to the VC community is one business model that may merit consideration.

44. Continue and expand support for cooperative research, development, and demonstration programs and activities that reduce the costs and improve the performance of ESTs. The International Energy Agency reports that public and private sector investments in new energy technologies have been inadequate in recent decades, and this trend should be reversed. New business models for technology innovation should be explored and implemented. Public-private technology innovation partnerships that leverage scarce

resources should be encouraged.[15] TNAs and technology roadmaps, inter alia, can be used to guide this work and focus on high priority topics.

45. Support strategic demonstration projects and activities that transfer ESTs. Barriers to widespread commercialization and dissemination of clean technologies can be identified and overcome by demonstration projects. Well-placed demonstration or pilot activities can stimulate interest and build confidence in promising new technologies. Demonstrations also help build human resources and the institutions needed to support wide-scale deployment. Parties may wish to consider if the GEF should play a greater role in funding applied demonstration projects, filling the technology continuum between R&D and prototype projects and commercial-scale investments.

46. Support efforts to improve policy frameworks, institutions, and other dimensions of the enabling environment that are fundamental to the finance of technology transfer. Lack of access to information, market imperfections, absence of skilled human capital, weak institutional frameworks, and legal, social and regulatory constraints are frequently cited as barriers in the enabling environment. The development and adoption of new technologies is a fragile process, and enabling activities are an essential ingredient, particularly in developing countries. Human resources, institutions, policies and regulatory structures, financial and investment instruments all need to be expanded and developed as new technologies are introduced and absorbed by economies large and small.

47. Lessons learned from globalization of the world economy should be used to expand and accelerate the transfer of environmentally sound technologies in both the public and private sector. While considerable emphasis has been placed on North-South and South-South cooperation, the flow of information, technology, and finance across national borders is increasingly fluid and efficient. While globalization is sometimes criticized, the real-time benefits for transfer of cutting-edge technologies and practices are enormous. There are public and private-sector examples of highly effective technology innovators and disseminators in all hemispheres; replicating these successes can be beneficial.

48. Identification and use of endogenous natural resources, financial instruments, human capital and technologies to mitigate and adapt to a changing climate should be encouraged. While exogenous best practices and technologies can be helpful, local resources should not be overlooked or dismissed. Assessing capabilities and limitations of endogenous technologies and their role in mitigation and adaptation should be a priority in TNAs and technology roadmaps. Endogenous practices and technologies are frequently efficient to disseminate and duplicate. There are numerous examples of highly successful endogenous technology transfer efforts, and these models should be replicated.

49. Raise the visibility and encourage technology transfer cooperation among international and regional financial institutions (e.g., the World Bank, the GEF, and regional development banks). The World Bank's evolving family of strategic Climate Investment Funds (CIF) including the Strategic Climate Fund, Clean Technology Fund, Forest Investment Fund, and a Climate Resilience Pilot Program should all be carefully coordinated with efforts at the GEF. Similarly, the Asian Development Bank via the Asia-Pacific Carbon

[15] Historically, the GEF has not financed R&D but has mainly focused on later stages of the technology innovation continuum. The GEF has been most successful when focusing on deployment and diffusion of existing technologies.

Fund and the European Bank for Reconstruction and Development via the Sustainable Energy Initiative and Multilateral Carbon Credit Fund are supporting clean energy technology development and transfer activities. Complementary investment strategies and work programs should be carefully coordinated. The World Bank and the regional development banks are all GEF implementing and executing agencies, and all are striving for close collaboration on these initiatives.

50. Supporting and guiding private sector investment in new infrastructure, technologies and best practices must be a top priority for all Parties, international financial institutions, relevant multilateral institutions, and the private financial community. Private sector investments are the largest component of investment (over 85%) to address climate change and it is estimated that this resource base must triple in the next 30 years to meet energy security, economic growth, and environmental protection needs. Presently, only 25% of these private sector investment flows occur in developing countries. Governments and public institutions should work cooperatively and with efficiency to facilitate the orderly growth of this investment profile.

51. Carbon finance is an increasingly important public and private sector portfolio and the benefits and challenges of these instruments should be explored to scale up the level of investment in ESTs. The Kyoto Protocol mechanisms – CDM, joint implementation, and emissions trading – represent a growing flow of resources into the development and dissemination of ESTs. For example, recent CDM projects will generate investments exceeding $25 billion over their lifetime with almost 90% supporting clean energy technologies. A plethora of new public and private sector carbon finance platforms have been established in the last five years with the goal of investing in clean energy technologies that can be easily transferred and applied in developing countries. The GEF has already proposed several approaches to build synergy between the GEF and carbon finance,[16] and has approved a number of projects that combine GEF grants and carbon finance as well as other funding sources to scale up investment in ESTs in developing countries.

52. Technology transfer finance leaders or "technology finance champions," if not already in place, should be established in public and private sector institutions. While many institutions and organizations proclaim to be leading technology transfer efforts, the investment in properly trained and experienced human capital is inadequate. The GEF and other public-sector institutions should be encouraged to hire and promote technology transfer experts. Public-private partnerships that specifically encourage the training and development of human capital should be a high priority. Technology transfer finance leaders can develop and increase the steady flow of bankable technology projects aided by improved access to private capital markets through vehicles such as CTI's PFAN.

53. Innovative technology transfer finance models such as UNEP's Sustainable Energy Finance Initiative (SEFI) should be examined and replicated to fill gaps. UNEP's Renewable Energy and Finance Unit works with the private sector on new approaches to financing sustainable energy. The network of participating financial institutions is globally significant. The UNEP program aims to help financiers by sharing risks, buying down transaction costs,

[16] See *GEF Strategy to Enhance the Engagement with the Private Sector*, GEF/C.28/14, and *Additional Information to Support the GEF Strategy to Enhance Engagement with the Private Sector*, GEF/C.28/Inf.4, June 2006.

building capacity, and addressing emerging barriers. Both public and private sector financial institutions could play a role in expanding this business model.[17]

54. Strengthen capacities for developing a steady flow of bankable technology projects by bringing project developers and financiers together through such vehicles as CTI's PFAN. Project developers often lament the lack of access to favorable financing, while public and private financial institutions cite the weak flow of financially viable projects. It is important to maintain and facilitate dialogues between the financial and banking community and project proponents and developers. Technical assistance to developing countries from IFIs and other partners is often just as imperative as the financing they provide in pioneering new ideas, financing instruments, and business models. Given its dominant role as the source of investment and financial flows, the private sector is essential in scaling up investments in new technologies.

55. Build and sharpen methodologies and tools to regularly monitor, verify and report accomplishments and performance of technology transfer activities. EGTT and others have invested in performance indicators, and preliminary results will be forthcoming. Additional investment in these tools and methods are needed for both mitigation and adaptation activities. For example, additional investments are needed in sustainable forest management to develop cost-effective and scalable methods for taking national inventories of forests, land use, and land-use change. National reference scenarios and monitoring frameworks are also required for measuring other environmental services.

56. Make concerted efforts to better monitor, verify, and report on the actual spread of ESTs worldwide, as well as on their global environmental benefits, including those of GEF-supported projects.

57. Other options as suggested by Parties, international financial institutions, relevant multilateral entities, and the private financial community all need to be considered.

The Path Forward

58. It is recognized that UNFCCC Parties, taking into account the experiences of IFIs, relevant multilateral entities, and the private financial community, are continuing to consider issues related to scaling up the level of investment in ESTs. Technology transfer is a complex and wide-ranging topic, and there are diverse interests among Parties and relevant entities. The costs and benefits of current efforts and potential new approaches should be addressed and shared.

59. Formal and informal consultations, consensus building, and partnership development are underway as part of the international community's discussion of investment in ESTs. Parties, IFIs, multilateral agencies, and the private sector are engaged in this process. Historically, the IPCC, EGTT, and others have laid the foundation for the consultative process and for thinking about how to structure resources to promote the transfer of ESTs. As others are drawn into the consultation process, appropriate human, technical, and financial resources should be devoted to this effort by participating organizations and institutions. As part of the GEF's continued efforts to evaluate and improve on its own operational effectiveness in the climate change focal area, it is proposed that the GEF Secretariat enhance

[17] Details on UNEP's SEFI are available at http://www.uneptie.org/energy/projects/SEFI/.

its own efforts to participate in and contribute to these formal and informal consultations. Given the GEF's experience in the promotion of ESTs, the Secretariat's involvement can help ensure continuity and effectiveness in these discussions.

V. A PROPOSED GEF STRATEGIC PROGRAM ON TECHNOLOGY TRANSFER

60. Using existing GEF-4 resources, the GEF will establish a strategic program at a target level of $35 million from the GEF Trust Fund and $15 million from the SCCF Program B devoted to scaling up investment in the transfer of EST activities while filling in some of the gaps identified above. This program will build on the GEF's mandates, experience, and current network of technology transfer activities.

61. The timeframe for this program is for the remaining period of GEF-4. The program is intended to complement other ongoing GEF climate change strategic programs, including those under the GEF Trust Fund, as well as those under the SCCF and the LDCF. It will also complement other ongoing GEF initiatives, such as the public-private partnership known as the Earth Fund. GEF's monitoring and evaluation process will apply.

62. Three funding windows are proposed for the program to support: (1) technology needs assessments (TNAs); (2) piloting priority technology projects; and (3) dissemination of GEF experience and successfully demonstrated technologies.

63. The total amount of funding under these three windows would be up to $50 million, with an illustrative range for each window suggested below. The program would become effective upon approval of the current paper by the GEF Council and after comment by the UNFCCC Parties.

64. The amount below for each window is illustrative only. Based on the GEF Council's and the UNFCCC Parties' discussions of the windows under the proposed GEF strategic program, these allocations can be adjusted. Additional technology transfer models and activities could be envisioned.

Window 1: Technology Needs Assessments

65. The GEF has already funded TNAs for over 90 countries, and over 50 TNAs have been identified and posted on the UNFCCC website. These TNAs will provide the basis for expanding GEF support of new and more comprehensive TNAs. Some countries have presented information on technology needs as part of their national communications, bringing the total number of countries for which this information is available to close to 60.

66. Under this funding window, a global program is envisioned. The global program will be open to countries that have prepared their TNAs but need to update them, as well as to those that have not received GEF funding to prepare a TNA. For those that have completed their initial TNAs, GEF support will focus on updating the initial TNAs to reflect the evolving needs and circumstances of the country. Prioritizing the technologies that are considered to be of strategic importance to the country, including the potential to bring global environmental as well as local development benefits; assessing the policy, institutional, and market conditions, such as analysis of the barriers to the deployment and diffusion of the technologies, detailed market assessment, and recommendation of approaches and actions to remove those barriers; and, where feasible, evaluating the technical, economic and financial

viability of the priority technologies that will lead to concrete project proposals. This enhanced TNA process will produce a more detailed and actionable plan for the most important technologies, in accordance with Convention guidance.

67. GEF support for the new round of TNAs will draw on past experience, best practices, and lessons learned.[18] Preparation of the new TNAs will be linked to the revised handbook for TNAs currently being commissioned by the EGTT and UNFCCC, with UNDP, UNEP, and other agencies providing technical support. The goal of GEF support is to make the TNAs a useful tool for policy makers, potential users, intermediaries, financiers of the technologies, and other stakeholders, so that all parties can better understand not only the technology needs but also how to facilitate their implementation in a collective and coordinated manner. The TNAs are one avenue through which eligible countries can propose priority projects for GEF funding.

68. The global TNA program will be implemented by UNEP and UNDP. The illustrative amount of GEF funding for this window would be $9 million, including fees to the GEF implementing agencies.[19] Funding for this program will be drawn from the SCCF Program B. Regular reports will be provided to update the LDCF/SCCF Council on the progress and outcomes of this program.

Window 2: Piloting Priority Technology Projects Linked to TNAs

69. Although the bulk of the GEF funding for climate change activities has been geared toward the deployment and diffusion of ESTs that reduce GHG emissions, the linkage between the TNAs/national communications and GEF project development has been weak. The main purpose of this funding window is to finance pilot projects that will support the deployment, diffusion, and transfer of technologies that have been identified and evaluated in the TNAs or national communications but have not yet been funded by the GEF. Through this funding window, the GEF can strengthen the link between GEF project development and TNAs while gaining practical experience from the pilot program to develop a more comprehensive strategy and focused program on technology transfer in the future.[20]

70. Funding priority will be given to countries that have not received GEF support for a given technology or sector in the past and to projects with multiple local and global benefits that contribute to private sector investment in, and financing of, technology transfer in developing countries. Project proposals must clearly describe the technology, the process with which to facilitate the transfer, deployment, and diffusion of the technology, and the expected tangible results. The program will help enable private and public climate-friendly investments and provide funding for innovative and highly leveraged projects, including using non-grant instruments.

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[18] See, for example, UNFCCC, *Best Practices in Technology Needs Assessments*, FCCC/TP/2007/3, November 2007; UNDP, *Experiences and Lessons Learned from Technology Needs Assessments*, May 2008; and UNEP, *UNEP Assistance to 14 Countries within the Framework of the GEF Expanded Financing for (Interim) Measures for Capacity Building in Priority Areas*, May 2008.

[19] This illustrative amount is based on the estimated needs for preparing or updating TNAs in about 130 countries, at a cost to the GEF of approximately $50,000 to $200,000 per country.

[20] Availability of TNAs is not an eligibility criterion or a prerequisite for accessing funding from this window. The key consideration is that the proposed project is consistent with the priority technology identified by the country.

71. To ensure wide accessibility to the funding under this program, each eligible country can receive funding for no more than one project, and the range of GEF grant for each project will be between $1-$3 million, including project preparation and agency fees.[21] The standard GEF project review procedures and policies will apply. The proposed projects may fall under one of the existing strategic programs identified in the GEF-4 climate change strategy but are not limited to them.[22]

72. Projects can be proposed through one of the ten GEF agencies,[23] as long as the agency has a comparative advantage in the field of the proposed project. The illustrative amount of GEF resources devoted to this window would be approximately $40 million. Funding for this window would be drawn from both the SCCF Program B and the GEF Trust Fund. This program could continue beyond GEF-4 based on guidance from the GEF Council and the COP.

Window 3: Dissemination of GEF Experience and Successfully Demonstrated ESTs

73. Under this window, the GEF proposes to disseminate GEF experience and climate friendly ESTs that have been successfully demonstrated through GEF support. The objective of this activity is two-fold: (1) to gain better, more in-depth understanding of the process of technology transfer and the role of the GEF with specific cases of technologies; and (2) to disseminate the technologies that have been successfully demonstrated through GEF support to a wider range of countries and audiences with a view to facilitating wider adoption of those technologies.

74. Dissemination will apply to five to ten ESTs that have been successfully demonstrated by GEF projects. Consideration will be given to a range of technologies, including those that have adaptation benefits. These technologies should have great potential for wide application in many developing countries that will lead to significant GHG emissions reductions while contributing to the development objectives of the countries. The experience and lessons learned will be drawn and disseminated so as to benefit the design of new projects in the future.

75. Dissemination activities under this window will be managed by the GEF Secretariat, in collaboration with relevant GEF agencies and other interested partners. The amount of funding proposed for this window is $1 million, which would be drawn from SCCF Program B. Further dissemination activities could be planned beyond GEF-4.

[21] Multi-country projects may be envisaged to pool resources for support of a particular sector or technology, provided that they will lead to tangible, on-the-ground results in each country.

[22] Once approved by the GEF Council and endorsed by the Parties, the GEF Secretariat will send a call for proposal to all eligible countries through the GEF Operational Focal Points, along with more details on selection criteria and process.

[23] They are UNDP, UNEP, World Bank, African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank, Food and Agriculture Organization of the UN, International Fund for Agricultural Development, and UN Industrial Development Organization.

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ANNEX 1
COP GUIDANCE TO THE GEF ON THE TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES

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 ESTs.

The first meeting of the COP provided guidance to the operating entity or entities of the financial mechanism that included the following statement (Decision 11/CP.1, paragraph 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 operationalizing the transfer of technology under Article 4.5 of the Convention.

Decision 2/CP.4 (paragraph 1) states that GEF should provide funding to developing country Parties to:

> 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 4/CP.7 which established the technology transfer framework also included the following statement (paragraph 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 5/CP.7 decided that the GEF and other bilateral and multilateral sources should provide support to the transfer of adaptation technologies (paragraph 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 (SCCF) to support adaptation to the adverse effects of climate change; transfer of environmentally sound technologies; mitigation initiatives in different sectors; and economic diversification.

Decision 6/CP.8 (paragraph 1(c)) decided that the GEF should:

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

Decision 5/CP.9 (paragraph 3) included the following statement:

> *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 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.

In decision 3/CP.12 (paragraph 1(d) and (e)), 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, 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.

Finally, in decision 4/CP.13 reached in Bali, Indonesia in 2007, the COP

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.

ANNEX 2
OVERVIEW OF GEF-FINANCED PROJECTS AND TECHNOLOGIES

Mitigation: Energy Efficiency Technologies

Table 1: GEF Support to Energy Efficiency Technologies

Energy Efficiency Technology and Technology Sector	Countries That Have Received GEF Support
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 efficiency 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

Efficient Lighting

Since the 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.

According to the post-project impact assessment commissioned by the World Bank of four projects under its implementation,[24] these projects achieved (1) major market

[24] 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.

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.

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.

Energy-Efficient Appliances

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.

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, a 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 Efficiency Technologies

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.

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.

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

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[25], as well as in China and Mongolia. Most of these projects involve demonstrating technologies and practices to improve 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 with efficiency improvement.

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

A 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 existing 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.

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

Energy-Efficient CFC-Free Chillers

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.

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 ozone-depleting substances and greenhouse gas emissions, while replication and market transformation has taken place rapidly beyond the GEF project.

Mitigation: Renewable Energy Technologies

Table 2: GEF Support to Renewable Energy Technologies

Renewable Energy Technology	Countries That Have Received GEF Support
Off-grid PVs	Bangladesh, Bolivia, Botswana, Burkina Faso, China, 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, Morocco, 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 (mini and micro) 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

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 SHSs; 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.[26] But just because PVs and SHSs are a least-cost option for remote electricity supply does not necessarily make them affordable to those who need them.[27] In such a case, financing arrangements are needed to match both the customers' ability and willingness to pay for the energy services provided.

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

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.

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

[26] International Finance Corporation, *Selling Solar: Lessons from More Than a Decade of IFC's Experience*. Washington, D.C.: IFC, 2007.

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

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.

On-Grid Photovoltaics

The GEF has been less active in supporting PVs 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. Moreover, given the high costs of on-grid PV electricity, it should be a technology handled under OP7 supporting Low-GHG-Emitting Energy Technologies that are still not commercially competitive.

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

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).

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.[28]

Geothermal Energy

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.

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

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

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

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, but GEF support is no 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.

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 use it for energy production. The GEF project supported capacity building at five national R&D laboratories and other institutions that were 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.

While the capacity building activities were very successful and sustainable, and the demonstration units clearly indicated the types of industries that 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

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.

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 CO_2, the establishment of at least 40 community-based micro hydro projects for productive uses each year, and 130 GWh produced and 100 GWh sold, cumulatively in 3 years.

Biomass Co-generation

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.

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 tons of CO_2 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

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.

The project "Latvia: Economic and Cost-Effective Use of Wood Waste for Municipal Heating Systems" ($0.75 million GEF and $2.73 million 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 local 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 tons of CO_2 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 tons of CO_2 being avoided annually.

Biomass Gasification for Electricity

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.

Through UNDP, the GEF supports 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 the last three years.

Mitigation: New, Low-GHG-Emitting Energy Generating Technologies

Table 3: GEF Support to Low-GHG-Emitting Energy Generating Technologies

Low-GHG-Emitting Energy Generating Technology	Countries That Have Received GEF Support
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, Philippines
Stationary fuel-cell power generation	South Africa

Concentrating Solar Power (CSP)

Starting in 1996, the World Bank and the 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.

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.[29]

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 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.

[29] An expert assessment commissioned by the World Bank recommended that despite the many drawbacks, the remaining three CSP projects be allowed to move ahead. See World Bank-GEF, *Assessment of the World Bank Group/GEF Strategy for the Market Development of Concentrating Solar Thermal Power*, Washington, D.C.: World Bank and GEF, 2006.

Mitigation: Sustainable Urban Transport Technologies and Practices

Table 4: GEF Support to Transport Sector Technologies

Sustainable Urban Transport Technology	Countries That Have Received GEF Support
Non-motorized transport	Botswana, Chile, Nicaragua, Peru, Philippines, Poland, Vietnam
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

Fuel-Cell Buses

The original version of GEF OP 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.

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 its buses and they appear to be operating well.[30] 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 reductions in the production cost of hydrogen. In many ways, the issues of relevance to the CSP projects under OP7 are of relevance to these new technologies as well.

Mitigation: Short-Term Response Measures

Table 5: GEF Support to Technologies as Short-Term Response Measures

Technology under STRMs	Countries That Have Received GEF Support
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

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

[30] UNDP-GEF, *UNDP-GEF Fuel-Cell Bus Programme: Update*, New York: UNDP, GEF/C.28/Inf.12, 2006.

reduce emissions of GHGs to atmosphere both in terms of reducing it back to CO_2 and in terms of substituting methane for other fossil fuels.

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.

Adaptation

Transfer of Technology Information

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

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

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 that 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-Supported Adaptation Projects

	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)

ANNEX 3
TECHNOLOGIES FOR ADAPTATION[31]

Sector	Technologies	
	Hard	**Soft**
Water Resources	• Recycling of wastewater and enhanced water treatment • Desalinisation • Early warning systems for floods • Increased efficiency of water Use in industries	• Rain water harvesting • Run off water capture • Changes in water pricing structures
Coastal Resources	• Detached breakwaters • Sea wall, revetments and bulkheads • Dykes and gryones • Salt water intrusion barriers • Tidal barriers • Reef protection	• Beach nourishment and dune restoration • Protect and restore wetlands • Littoral drift replenishment • Improved planning and insurance • Afforestation
Agriculture	• Changing cultivars and varieties • Utilization of drought resistant crops • Drip Irrigation Systems • Improved Water Distribution Networks	• Improving farm operations and cultivation practices • Crop rotation • Bench terracing and contour cropping • Construction of windbreaks
Infrastructure	• Improved technical design and construction • Changes in roofing materials • Improved levee construction	• Establishment of Building Codes • Improved Planning
Human Health	• Early warning systems • Improved water storage and transportation • Systems	• Improved control and surveillance programs • Vector control • Health Education • New panning laws

[31] Data in the table compiled from *Technologies for Adaptation to Climate Change*, UNFCCC, 2006, and Tol Klein Tol (1997), *Adaptation to Climate Change: Options and Technologies: An Overview Paper*, UNFCCC, FCCC/TP/1997/3.

ANNEX 4
CURRENT FINANCING OPTIONS FOR TECHNOLOGY TRANSFER[32]

The definition of technology transfer by IPCC and the Convention's technology framework, cited in the introduction to this paper, is broad enough to encompass both "hard" and "soft" aspects of technology transfer and diffusion, without being so broad as to cover any and all aspects of a climate change mitigation or adaptation intervention in a developing country. The GEF's experience with technology transfer, summarized in this paper, 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.

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 provides 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.

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

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.

This was remarked upon by others, and following others,[33] 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 Annex 2 demonstrates that nearly all GEF projects have addressed some aspect of the deployment, diffusion, and transfer of technologies.

[32] A comprehensive report is being prepared under the auspices of EGTT to identify and analyze existing and potential new financial sources and relevant vehicles in supporting the development, deployment, and diffusion, and transfer of ESTs for mitigation and adaptation to climate change.

[33] 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.

The equivalent of the recent extensive analysis of specific experiences in technology transfer for the protection of the ozone layer[34] does not yet exist for the climate change experience. Yet even that latter book does not specifically and in any detail analyze the financing of such efforts.

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.

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.[35]

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, and 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.

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.

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 (2007).[36] The limit of that analysis in terms of providing aggregated data was recognized by the authors, and the analysis is based on the aggregation in the original data sets, including OECD, UNCTAD, and World Bank databases.

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

[35] See description of a framework for technology transfer framework in COP decision 4/CP.7 cited in the introduction to this paper.

[36] E. Haites, *et al*., *Investment and Financial Flows to Address Climate Change*, UNFCCC, 2007. All statistical data are quoted from this report unless otherwise specified.

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, was 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. Foreign direct investment (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 where it reaches over 6%.

Mitigation

Energy

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 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

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 renewable energy in that period, is an important actor in the public sphere.

Investments in the developing world were concentrated in three countries: China, India, and Brazil.[37] 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.

The authors of the *Global Trends in Sustainable Energy Investment* report[38] 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

[37] Data in this paragraph are from C. Greenwood, *et al*., *Global Trends in Sustainable Energy Investments*, UNEP, 2007. The authors estimate that worldwide investments in sustainable energy reached over $70 billion in 2006.
[38] C. Greenwood, *et al*., *Op. Cit.*

This is an area where quantification is most difficult; in fact it has even been referred to as the "invisible market".[39] The investment and financial flows report estimates that total investments in developing countries amounted to $132 million 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, and for each GEF dollar invested in climate change projects, about six dollars of co-financing has been leveraged. This in any event points to the GEF potentially playing a key role in promoting energy efficiency in developing countries.

Specific Sectors

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.

Transport sector. About 86% of the $248 billion investment flows to the transport, storage and communications sector in non-Annex I countries in 2000 was of domestic origin. The largest share of these investments was 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.

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.

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 international financial institutions (IFIs) prepare to ramp up their efforts in the agriculture sector.[40]

Forestry. Data disaggregated from agriculture and fisheries are difficult to obtain, and difficult to reconcile as well, as noted by the authors of the UNFCCC report on financial flows. 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 GEF Strategic Program on Sustainable Forest Management, GEF contribution was estimated to amount to approximately $150 million through various related operational programs.

[39] C. Greenwood *et al., Op. Cit.*
[40] See, for example, *World Development Report 2008: Agriculture for Development*, Washington, D.C.: World Bank, 2008.

Adaptation

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 in adaptation. For example, two out of the six determinants of adaptive capacity identified by Smit et al. (2001)[41] 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," as covering the gamut of requisite adaptive measures that pertain to technology transfer.

In addition, the information needs for adaptation to climate change will likely demand a longer forward timescale and correspondingly greater demands upon data and skills to support choices of technology, techniques, and practices. New information and skills that will be required for adaptation include, for example, forecast models, risk analysis, options appraisal, policy analysis, uncertainty analysis, and sensivity analysis.

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, 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.

Water supply. Expenditures for water supply in developing countries were estimated at $65 billion in 1999,[42] 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 toward the developing economies of Asia.

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. Health expenditure in non-Annex I and LDCs 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

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[41] 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, ed, *Climate Change 2001: Impacts*, Cambridge University Press, Cambridge, UK, 2001, pp. 877-912.

[42] 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, et al.

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 United Nations Millennium Development Goals. Slightly less than half of that amount is directed to Africa. In this sector, the Global Fund to Fight Aids, Tuberculosis, and Malaria, and private foundations such as the Bill and Melinda Gates Foundation have become major players. This trend is likely to continue.

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-1990s 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.

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 bilateral agencies 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.

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 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 where it reaches over 6%.

Activities of Partner Institutions and Other Initiatives[43]

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.[44] GEF funding made up $128 million of this total. The World Bank also hosts a number of different carbon funds to

[43] The following paragraphs provide a snapshot of some related activities supported by a number of GEF partner agencies, regional, and bilateral initiatives. The description is not intended to be exhaustive.

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

support clean development mechanism (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 (CIFs), expected to include a Clean Technology Fund that would focus on financing clean technologies.

In addition to the initiatives of the World Bank, 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, 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 European Bank for Reconstruction and Development is supporting low-carbon projects through both the Sustainable Energy Initiative and the Multilateral Carbon Credit Fund. The Inter-American Development Bank 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.

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

The role of the CDM in promoting technology transfer for climate mitigation has been analyzed,[45] and can only grow. This growing role has its respondent on the adaptation side through the potential that lies with the Adaptation Fund.

Another important initiative is the Asia-Pacific Partnership (APP) on Clean Development and Climate. The APP is a partnership of seven countries in the region (Australia, Canada, China, India, Japan, Republic of Korea, and the United States) that work together and with the private sector to accelerate the development and deployment of clean energy technologies. The APP has approved eight public-private sector task forces, covering Aluminum, Buildings and Appliances, Cement, Cleaner Use of Fossil Energy, Coal Mining, Power Generation and Transmission, Renewable Energy and Distributed Generation, and Steel. Each task force has developed an action plan and a list of projects. For details about the APP, please visit http://www.asiapacificpartnership.org/.

Many bilateral and multilateral initiatives have also been emerging. For example, in early 2008, Japan announced a new financial mechanism on the scale of $10 billion for the "Cool Earth Partnership" for international environmental cooperation to assist developing countries in reducing GHG emissions and to address the adverse effects of climate change.[46] Japan also works with other donors to create multilateral climate investment funds to finance climate change projects.

[45] E. Haites, M. Duan and S. Seres, "Technology Transfer by CDM Projects," *Climate Policy* 6: 327-344, 2006.
[46] See http://www.mofa.go.jp/mofaj/gaiko/oda/bunya/environment/cool_earth_e.html.

Most recently, on September 27, 2008, the World Bank announced that the representatives from 10 industrialized countries (Australia, France, Germany, Japan, the Netherlands, Norway, Sweden, Switzerland, the U.K., and the U.S.) pledged more than $6.1 billion to support the Clean Investment Funds to scale up funding on climate action.

Conclusion

The above brief overview presented 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 realized 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.

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. The GEF, along with its partner agencies, has extensive past experience in successfully promoting the transfer of ESTs. The GEF is indeed well placed with its mandate for demonstration activities and catalytic role, and is uniquely positioned as a bridge between the UN agencies and the World Bank and other multilateral development banks.

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