

Results from the GEF Climate Change Program



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Global Environment Facility
Monitoring and Evaluation Unit

Foreword

The GEF Council, at its meetings in December 1999 and May 2000, requested a review of GEF operations prior to discussions on the next trust fund replenishment, which began in 2001.¹ This review, the Second Study of GEF's Overall Performance (OPS2), was carried out by a fully independent team in 2001. The OPS2 is the third major GEF-wide review to take place since the GEF was created.² Among the broad topics the OPS2 team assessed were:

- Program Results and Initial Impacts
- GEF Overall Strategies and Programmatic Impacts
- Achievement of the Objectives of GEF's Operational Policies and Programs
- Review of Modalities of GEF Support
- Follow-up of OPS1

To facilitate the work of the OPS2 team, GEF's Monitoring and Evaluation team, in cooperation with the implementing agencies, undertook program studies in three GEF focal areas—biodiversity, climate change, and international waters. These program studies provided portfolio information and substantive inputs for the OPS2 team's consideration.

This report summarizes the findings of the Climate Change Program Study. That study was undertaken in 2000-2001 by an interagency team comprised of staff from the GEF Secretariat, the three GEF implementing agencies, and the GEF Scientific and Technical Advisory Panel, with additional support from consultants. The team worked under the guidance of an interagency steering committee.

Jarle Harstad
Senior Monitoring and Evaluation Coordinator

¹ Joint Summary of the Chairs, GEF Council Meeting, December 8-9, 1999, and GEF/C.15/11.

² The first two studies, respectively, were *Global Environment Facility: Independent Evaluation of the Pilot Phase*, UNDP, UNEP, and World Bank (1994) and Porter, G., R. Cléménçon, W. Ofofu-Amaah, and Michael Philips, *Study of GEF's Overall Performance*, Global Environment Facility (1998).

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Several individuals and organizations within and outside the GEF family of institutions supported and contributed to the Climate Change Program Study. In particular, an interagency Steering Committee guided the study. Members of the committee included Dennis Anderson, GEF Scientific and Technical Advisory Panel; Jarle Harstad, GEF Monitoring and Evaluation Team; Richard Hosier, United Nations Development Programme; Eric Martinot, GEF Secretariat; Alan Miller, GEF Secretariat; Ramesh Ramankutty, GEF Monitoring and Evaluation Team (task manager); Mahesh Sharma, World Bank; and Ravi Sharma, United Nations Environment Programme.

The exercise was carried out by a team consisting of staff from the GEF Secretariat, the GEF implementing agencies, and the GEF Scientific and Technical Advisory Panel (STAP), along with several consultants working under the guidance of the Steering Committee. Individuals involved in the specific components of the study were as follows:

- Portfolio Coverage Analysis: Dilip Ahuja, Indian Institute for Advanced Studies, Bangalore, India
- Solar Thermal Cluster Review: Dennis Anderson and Jason Mariyappan, Imperial College of Science, Technology and Medicine, London, UK
- Energy Service Companies Cluster Review: Tony Wilson and Andy Gilchrist, AEA Technology Environment, Oxfordshire, UK
- Energy Efficient Products Manufacturing and Marketing Cluster Review: Sabrina Birner, June Consulting, Paris, France; Eric Martinot, GEF Secretariat
- Solar PV Cluster Review: Eric Martinot, Ramesh Ramankutty, and Frank Rittner, GEF Secretariat
- Grid-connected Renewable Energy Cluster Review: Eric Martinot, GEF Secretariat
- China Country Review: Eric Martinot, GEF Secretariat; Nandita Mongia, United Nations Development Programme, New York; Li Junfeng, Consultant, Center for Renewable Energy, Beijing, China
- Mexico Country Review: Martin Krause, United Nations Development Programme, New York; Yasemin Biro, GEF Secretariat; Walter Vergara, World Bank; Sergio Sanchez, Consultant

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Ramesh Ramankutty
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Executive Summary

Background

During the last decade, the Global Environment Facility (GEF) has provided more than US\$1 billion for more than 270 climate change-related projects in 120 countries. Not counting enabling activities and some short-term measures, 120 of those projects in 60 countries demonstrate an impressive range of approaches to promoting energy efficiency, renewable energy, and (to a lesser extent) sustainable transport. The Climate Change Program Study, initiated in June 2000, set out to answer four questions about that subset of 120 projects:

1. Are activities relevant to country needs and global objectives?
2. What are the most significant implementation issues and lessons?
3. What are the impacts/likely impacts of GEF projects?
4. What are the factors influencing sustainability and replication?

The study resulted in seven new reports and incorporated one previously completed report:

1. Energy-efficient products manufacturing and marketing cluster review.
2. Grid-connected renewable energy cluster review.
3. Energy service company cluster review.
4. Solar thermal power plant cluster review.

5. Rural solar photovoltaic (PV) cluster review (previously published August 2000).
6. Assessment of GEF climate change portfolio coverage.
7. Two country reviews, for China and Mexico, that assess how GEF projects are collectively addressing country and global environment objectives.

The present report provides a brief synthesis of the results from these reports, organized by the four basic questions.

Scope of the Climate Change Portfolio

The initial direction of the climate change portfolio was established by the Ad-hoc Working Group on Global Warming and Energy (AWGGWE), set up by the GEF Scientific and Technical Advisory Panel (STAP). Based on a list of technical interventions that reduce or limit emissions of greenhouse gases developed by the STAP, early GEF projects often focused on demonstrations of a variety of technologies. More recent projects have gone beyond technology demonstrations to focus on sustainable market-oriented approaches that pilot new business models, financing mechanisms, demand-side incentives, and means of public involvement. Over time, the portfolio has become dominated by a smaller number of technology applications and strategies that are not necessarily related first and foremost to short-term greenhouse-gas reduction, but rather reflect a complex balance of needs, interests, and interactions among governments and GEF implementing agencies.

Due to the confines of time and resources available for the program study, it was not possible to arrive at a definitive assessment of the degree to which country needs have been met through GEF-financed projects. Such an assessment would require a comparison of needs existing before initiation of the projects with those existing now. Such data are often lacking or difficult to obtain. In addition, national communications under the United Nations Framework Convention on Climate Change (UNFCCC) do not always fully reflect national development priorities.

Detailed reviews of the GEF-financed climate change portfolios in two countries—Mexico and China—indicate that GEF projects are consistent with national priorities in those countries. Furthermore, the technology applications promoted in GEF projects are broadly relevant to at least some national objectives in virtually all countries. For example, the GEF has clearly helped with a number of core country priorities, such as promoting renewable-energy-based rural development and electrification programs and reducing electric power demand. Still, it is fair to say that most GEF projects do not result from coherent, integrated approaches to development and environment at the country level, but are rather conceived on an ad-hoc basis.

As the portfolio evolved, the need to support rural energy enterprises, provide financial intermediation, and attract private sector financing became apparent. To respond to these needs and demonstrate how the GEF can leverage private sector resources to achieve global benefits, the International Finance Corporation (IFC) of the World Bank Group developed five projects that feature new forms of enterprise support, financial intermediation, and private sector co-financing. These projects have used GEF funding commitments to mobilize more than \$200 million of private sector co-financing to date. Impacts from two of these projects are described in the cluster reviews, while the other three have just started. All five will warrant a separate cluster review in the future.

Replication of successful outcomes and models has gained increased attention in more recent projects. Because GEF projects are small relative to the scale of the climate change problem, recognition has grown that achieving global environmental objectives depends greatly on replication and indirect impacts through demonstration of project benefits. Measuring achievement of global environmental objectives is challenging because replication of GEF projects is difficult to monitor. Some projects—such as those for efficient lighting, efficient refrigerators, rural solar PV, coal-bed methane, and electric power demand-side management—have clearly been replicated. Replication of other projects has so far been minimal or remains undocumented.

Emerging Lessons

Eight significant lessons emerging from the climate change program study are highlighted in this synthesis:

1. *Lessons and good practices are emerging but need to be better incorporated into project designs to promote learning.* One of the key advantages of supporting projects through GEF Operational Programs is to facilitate the dissemination of lessons among all participants in the GEF programs. This study finds that such dissemination is slow and only recently has become more efficient. Although the annual project implementation reviews provide a forum for learning, the first concerted effort to pass on lessons from the climate change program was the solar PV cluster review, which was completed in 2000.
2. *Indirect influences and impacts are key GEF results.* Some of the key impacts of GEF-financed projects are indirect in the sense that those impacts were not explicit objectives of the projects. In many cases, significant impacts from projects have been recorded during project preparation (PDF) phases or early in project implementation.

3. *Replication of project results is not well planned or monitored.* In general, GEF projects have not been operational long enough to gauge how well their replication is providing global environmental benefits. Still, most projects contain few provisions or plans for achieving or monitoring replication.
4. *Project risk assessment and management need to be strengthened.* Implementation of projects is often hindered by project managers' inability to adjust to changes in markets, policies, macroeconomic conditions, co-financing, and government commitments.
5. *Transfer of technological know-how is more difficult than project proponents anticipate.* Such transfer appears impeded by problems with technology acquisition and application to domestic conditions.
6. *Long-term programmatic approaches require sufficient GEF "credibility" and experience in a country.* Country stakeholders need time to accumulate experience with GEF-financed projects before they are willing and able to develop long-term programmatic approaches that apply the principles of GEF Operational Programs over longer time frames with more comprehensive results.
7. *The GEF's potential for influencing policy needs to be better utilized.* The influence of GEF projects is evident in three policy areas—national codes and standards, electric power sector policies, and rural electrification policies. But that influence has so far been modest, and additional policy areas could be addressed.
8. *The contribution of GEF-financed projects to social benefits and poverty alleviation needs to be assessed.* The social and development benefits of GEF projects, especially those that cater to rural energy development needs, need to be better documented. An assessment of these benefits is key to helping countries improve sustainable development programs. Many projects do promote strong beneficiary participation, but fail to document benefits or impacts occurring in local communities.

Impacts

Eleven projects in the portfolio were completed as of early 2001. Another 25-30 projects have been operational long enough for their impacts to begin to become evident. The impacts of these 35-40 projects have been analyzed by project application (cluster):

Energy-efficient products. GEF-financed projects have demonstrated important and effective approaches for facilitating and accelerating greater demand for and supply of energy-efficient manufactured products, particularly lights (nearly 5 million of which have been installed through GEF projects), but also refrigerators, motors, and building materials. Some project approaches have resulted in sustained reductions in the price of the products and in highly cost-effective abatement of carbon emissions. Market gains for efficient lights in particular are being sustained and replicated.

Grid-connected renewable energy. The GEF has facilitated implementation of important regulatory frameworks supportive of grid-connected renewable energy, but has done so in only two countries so far (Mauritius and Sri Lanka). Other impacts have been limited to one-time technology demonstrations, research, and increased skills and awareness. The GEF's largest market impact has been in India, where direct and indirect influences on private sector power project development and financing have resulted in nearly 1000 MW of new renewable-energy generating capacity.

Off-grid solar PV. Rural applications of solar photovoltaics (PV) constitute the largest single group of projects in the climate change portfolio. However, most of these projects have little or no implementation experience yet. Of roughly 600,000 solar home systems expected from approved projects, only 18,000 have been installed thus far. Several business models and schemes to extend credit to businesses and consumers show promise of being sustainable and further replicated. Awareness of solar home systems is increasing in several countries and technical standards are improving. The impact of

projects on rural electrification planning and policies has been small, but more recent projects are emphasizing these issues.

Energy service companies. Viable energy service companies (ESCOs) have been established in two countries (Tunisia and China) as a result of GEF projects. Financing for existing ESCOs has been facilitated in the Hungary project. Other projects with ESCO components provide technical assistance, training, and audits, but are not expected to lead to full-service (i.e., “performance-contracting”) ESCOs. With the exceptions of China and Hungary, no other countries have documented replication or energy-savings impacts of ESCOs from GEF projects. Prospects for the emergence and sustainability of ESCOs appear strongest as a result of the China project, which is also pioneering the resolution of key policy and legal issues to allow growth of the ESCO industry. Several GEF projects appear to be increasing awareness and acceptance of ESCOs among industrial clients, policy-makers, and financiers.

Other applications. Projects for coal-bed methane, gas-pipeline leakage repair, fuel switching, decentralized wind power, utility demand-side management, village-scale mini-grids, and district heating-efficiency improvements have all shown significant impacts and could all be replicated on larger scales and used as models for ongoing and future GEF projects. So far, three projects—coal-bed methane in China, decentralized wind in Mauritania, and demand-side management in Thailand—are being replicated.

Sustainability

The Climate Change Program Study found that projects have promoted sustainability by:

- Demonstrating models for sustainable businesses, both public and private
- Promoting “market transformation” approaches that expand markets for energy-efficient products
- Negotiating voluntary agreements with the private sector to take energy-inefficient products off the market
- Creating new legal frameworks and precedents for energy service companies.

The study also revealed factors that can negatively influence sustainability:

- Privatization of power utilities without consideration of the future existence and role of demand-side management units
- Short-term power-purchase tariffs for grid-based renewable energy that hold such tariffs hostage to fluctuations in conventional fuel prices
- Dependence of consumer finance and rural businesses on the resources of GEF projects without creating viable and sustainable commercial sources
- Project implementation arrangements that fall into an “equipment installation and demonstration” role and fail to demonstrate business models.

1. Scope and Approach of Study

The overall objective of the Climate Change Program Study was to assess the achievements of GEF-financed climate change operational programs. To assess those achievements, the study attempted to answer four key questions:

1. Collectively, are the program activities both relevant to client country needs (as articulated by national communications or other national strategies/plans) and effective in meeting global environmental objectives?
2. What are the most significant implementation issues and lessons? Are these issues and lessons country-specific?
3. What are the impacts/likely impacts of GEF projects?
4. What are the primary factors influencing sustainability and replication prospects of clean energy alternatives promoted by the GEF—within projects, within countries, regionally, and internationally?

In answering these questions, the study considered the applications and markets targeted by the GEF portfolio of projects, the results of reviews of individual groups of projects (cluster reviews), and the results of reviews of portfolios in selected countries.

Portfolio Coverage

The study assessed the relevance of the portfolio's technology applications and target markets in meeting global environmental objectives and supporting client countries' development priorities. Are GEF programs targeting the

most effective technologies? Are technology applications really “win-win?” Do key barriers to adoption of technology applications remain unaddressed in particular markets? The analysis was conducted as a desk study, supplemented, as appropriate, with material from the other components of the program study.

Cluster Reviews

Work on GEF climate program indicators suggested that clusters of projects with similar technology applications or approaches to barrier removal can be effectively and collectively assessed with one set of indicators. Clustering facilitates aggregation of project-level results to the program level and highlights program-level lessons about relevance, sustainability, replication, and impact. Four new reviews of project clusters were undertaken. A review of a fifth cluster, off-grid solar PV, was completed in May 2000. The four clusters covered under the reviews are as follows:

- Grid-connected wind, biomass, and small-hydro power (14 projects)
- Solar thermal power plans (4 projects)
- Energy service company models and performance (10 projects)
- Energy-efficient product manufacturing and markets—lights and boilers (8 projects).

Many of the projects in three of these clusters have significant amounts of implementation experience and evaluation information, and many of them contain lessons relevant to recently

approved projects, including pipeline projects. The solar thermal cluster review can aid strategic considerations of Operational Program #7 and may reveal important indirect influences on renewable energy technology markets. The four clusters, together with the projects in the off-grid solar PV cluster, account for 59 projects—nearly two-thirds of the GEF projects being implemented.

In keeping with the study's objectives, the cluster reviews addressed the following topics:

- (a) **Broad Trends.** With respect to what national and international policy, investment, technology, business development, and cost trends should projects be evaluated? What issues do the relevant trends suggest are most deserving of further attention or of intervention?
- (b) **GEF Program Results.** What are the specific results being achieved under projects, and how do these results aggregate to the program level, making use of the seven program indicators?
- (c) **Influence of GEF Projects on Trends.** Are the GEF project results, or the very process of developing those projects, influencing policy, investment, technology, business development, and cost trends? Are the lessons of those projects being utilized in projects not financed by the GEF?

The solar thermal cluster review was conducted as a technology assessment/strategic review without country visits. That review considered the role and influence of the GEF in promoting these technologies in a primarily international context. None of the solar thermal projects have been implemented to date.

Country Reviews

Country-level programmatic approaches have not been implemented in practice in GEF client countries. However, China, India,³ and Mexico have two or more GEF projects. Reviews of how those projects, collectively, are addressing each of the three countries' development goals and global environment objectives are proving useful in establishing principles and frameworks for the development and implementation of country-wide GEF-financed programs.

Each review attempts to answer the four questions noted above on the basis of project reports and evaluations, cluster reviews with relevance to the given country, and field information.

Program Indicators

The GEF has developed seven project-performance indicators for the climate change operational programs.⁴ The Climate Change Program Study has attempted to test the application and appropriateness of these indicators in assessing the success of (a) the entire GEF project portfolio, (b) individual clusters of projects, and (c) country-wide programs.

The seven performance indicators are

1. Energy production or savings and installed capacities
2. Technology cost trends
3. Businesses and supporting services development
4. Financing availability and mechanisms
5. Policy development

³ The review of the India portfolio could not be carried out due to the earthquake in Gujarat, a province in India, during early 2001.

⁴ See *Measuring Results from Climate Change Programs: Performance Indicators for GEF*, GEF Monitoring and Evaluation Working Paper 4, September 2000 (Washington, DC: GEF).

6. Awareness and understanding of technologies

7. Energy-consumption and fuel-use patterns and shares.

The data for these indicators have come from published literature, project documentation and evaluation reports, phone and e-mail communications and interviews with project personnel and other stakeholders, and country visits by members of the study team or by local or international consultants.

2. The GEF Climate Change Portfolio

The strategy of GEF-financed climate change programs is to “support sustainable measures that minimize climate change damage by reducing the risk, or the adverse effects of climate change.”⁵ The strategy is implemented through four operational programs, enabling activities, and some short-term measures projects.

Operational programs support measures designed to achieve long-term impacts:

- (a) Operation Program #5, *Removal of Barriers to Energy Efficiency and Energy Conservation*, seeks to remove barriers to large-scale application, implementation, and dissemination of least-economic-cost, energy-efficient technologies.
- (b) Operational Program #6, *Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs*, is focused on (1) removing barriers to commercial or near-commercial renewable energy technologies and (2) reducing any additional implementation costs for renewable energy technologies that result from a lack of practical experience, initially low-volume markets, or scattered applications, so that economically profitable “win-win” transactions and activities will increase the deployment of renewable energy technologies.
- (c) Operational Program #7, *Reducing the Long-term Costs of Low Greenhouse Gas-Emitting Energy Technologies*, aims to reduce greenhouse gas emissions from anthropogenic sources by increasing the market share of low

greenhouse gas-emitting technologies that have not yet become widespread, least-cost alternatives in recipient countries for specified applications.

- (d) Operational Program #11, *Promoting Environmentally Sustainable Transport*, supports a long-term shift toward low-emission forms of transport. Program #11 is a new program, introduced in 1999, and therefore is not examined by the Climate Change Program Study.

Enabling activities provide support for planning and endogenous capacity building, including institutional strengthening, training, research, and education, that will facilitate implementation of effective climate change response measures in accordance with the United Nations Framework Convention on Climate Change.

Short-term measures are projects that reduce greenhouse gases in the short term. Such projects may not be part of an operational program. They are funded if they are priorities of a country, cost-effective in the short term, and likely to succeed.

Approved GEF Projects

As of June 30, 2000, the Global Environment Facility had approved 272 climate change-related projects. The total GEF allocation to those projects amounts to \$1.08 billion, and the total cost of those projects is \$7.1 billion. The portfolio is made up of full-size projects, medium-sized projects, and enabling activities, as shown in Table 1.

⁵ GEF Operational Strategy, pp. 31.

Table 1. GEF Portfolio
(approved for work program entry as of June 30, 2000)

Type of Project	Number of Projects	GEF Allocation (US\$ millions)	Total Project Cost (US\$ millions)
Full-size Projects	108	982.43	6,967.99
Medium-size Projects	22	15.68	45.36
Enabling Activities	142	82.45	88.61
Total	272	1,080.56	7,101.97

In terms of GEF allocation, regular projects account for about 90 percent of the portfolio. The portfolio distribution across the Implementing Agencies is shown in Table 2. While the UNDP

accounts for the largest share of projects (64%), the World Bank accounts for the largest share of the GEF allocation (70%).

Table 2. GEF Climate Change Portfolio Across Implementing Agencies
(approved for work program entry as of June 30, 2000)

Agency	Number of Projects	GEF Allocation (US\$ millions)	Total Project Cost (US\$ millions)
UNDP	174	298.98	675.91
UNDP/UNEP	1	2.16	3.26
UNEP	29	20.7	25.21
World Bank	68	758.53	6,397.6
Total	272	1,080.56	7,101.97

Support for operational programs is indicated in Table 3. Among those programs, Operational

Program #6 has the largest number of projects and the largest allocation of GEF resources.

Table 3. Operational Programs in the GEF Climate Change Portfolio
(approved for work program entry as of June 30, 2000)

	Short-term Measures	Enabling Activities	OP #5	OP #6	OP #7	OP #11	Total
Number of Projects	25	142	40	52	10	3	272
GEF Allocation (US\$ million)	137.25	82.45	250.69	394.64	200.29	15.22	1,080.56
Total Project Cost	628.31	88.61	1,727.18	3,948.26	684.08	25.55	7,101.97

Completed Projects and Projects in Progress

The major focus of the Climate Change Program Study is full-size projects. Medium-sized projects are relatively new. Enabling activities were subjected to an extensive review⁶ and the findings from that review are incorporated into this study.

As of June 30, 2000, 30 climate change-related

projects had been completed. Those projects were allocated about \$150 million of GEF resources. As of that same date, 58 projects accounting for about \$400 million of GEF resources had been in the implementation stage for at least a year.

⁶ Samir Amous, et al., Review of Climate Change Enabling Activities, October 2000 (Washington, DC: GEF).

3. Overall Findings

Relevance of GEF-Financed Projects to Country Needs and Global Objectives

Assessment of the relevance of the GEF project portfolio to client countries' needs is hindered by the lack of data and difficulty of obtaining data on the needs existing before initiation of the projects and those existing now. To determine the extent to which the portfolio has met needs, the Climate Change Program Study relied on reviews of country-wide GEF programs in China and Mexico.

Portfolio coverage has evolved and expanded but not necessarily in a directed, strategic manner. After the GEF was restructured and became a financial mechanism of the UNFCCC, the facility's operational strategy and programs were developed to respond to guidance from the convention. As a result, the scope of appropriate activities expanded. Because the GEF rarely rejects sensible proposals for renewable energy or energy savings projects, the GEF project portfolio reflects diverse technologies, applications, and sectors. Making a judgment about the merits of proposals that were never presented to the GEF because of decisions made by governments or GEF implementing agencies is, of course, difficult.

The GEF project portfolio addresses two key priorities of developing countries: technology transfer and capacity building. Most climate change projects are directed, at least in part, toward increasing the understanding, awareness, diffusion, and adaptation of environmentally friendly technology and toward promoting domestic manufacturing appropriate to client

countries. In some cases, as in projects to introduce CFLs, the technology has been locally adapted, and manufacturing capacities have been established or given additional support. In other cases, such as rural solar PV, local manufacturers may produce items such as charge controllers, batteries, and lamps, even if the solar panels continue to be imported. Most projects appear to have enhanced local capacity through training of local technicians, development of financing and institutional capacity, or support of regulatory or legal development, all activities that set the stage for project replication.

Unlike other climate change operational programs, which involve a comparatively large number of technologies, Operational Program #6 (Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs), emphasizes only a few technologies, primarily home systems for off-grid solar-energy applications. The projects under this program have demonstrated the viability of using renewable energy sources in meeting rural electrification objectives. Challenges for these projects are (a) addressing issues of affordability and sustainability; (b) systematically incorporating in project design linkages between rural electrification strategies and rural development needs associated with health, education, water, sanitation, and employment; and (c) documenting income generation and other social benefits known to have resulted from the projects.

This last point is particularly important because very little documentation is available on the extent to which GEF-supported rural energy projects serve development objectives such as increased employment and livelihood, health, sanitation, water access, and literacy.

Under Operational Program #7 (Reducing the Long-term Costs of Low Greenhouse Gas-Emitting Energy Technologies), four solar thermal power plant projects are proceeding in accordance with the program's original philosophy—that sequential support of multiple projects would reduce costs through economies of scale and learning by doing. In practice, however, the projects may be undertaken simultaneously, rather than sequentially. With the exception of stationary fuel cells, most technologies envisioned under the program are represented by at least one project in progress or in the pipeline.

Significant Implementation Issues and Lessons

Eight significant lessons emerging from the Climate Change Program Study are highlighted here. Although some of these lessons are country-specific, most are applicable to all programs in the GEF program portfolio.

Lesson 1: Lessons and good practices are emerging but need to be better incorporated into project designs to promote learning.

Lessons from completed projects can inform the design of other GEF projects, as well as other initiatives external to the GEF. In general, the available lessons from early projects are just emerging as a body of knowledge. A few recent projects have built on the lessons from earlier projects: the *Global Efficient Lighting Initiative* employed lessons from earlier efficient lighting projects in the GEF portfolio; the *China TVE Phase II Project* built on the lessons of the *China TVE Phase I Project*; and a recent demand-side management (DSM) project in Vietnam has drawn from the DSM project in Thailand. Off-grid solar PV projects have begun to benefit from some of the early solar PV projects in the portfolio, particularly since completion of the solar PV portfolio review by the GEF Secretariat in 2000. Annual project implementation reviews do provide one forum for learning, even if the information available is insufficient to provide in-depth understanding of project performance.

The opportunity and need for the GEF to facili-

tate learning among participants in the GEF's four solar thermal projects is considerable. The projects (three approved by the GEF Council in India, Morocco, and Mexico, and one approved for project development financing in Egypt) account for about \$150 million of GEF resources and are expected to install 137 MW of solar components. The cluster review of those projects suggests that the GEF would benefit from much greater efforts to disseminate lessons learned by participants in any one project to participants in the other projects.

Lesson 2: Indirect influences and impacts are key GEF results.

Many GEF-financed projects have indirectly influenced investment decisions and policy actions, sometimes even before any hardware is installed through the project. These influences may not be explicit objectives of projects, but nonetheless represent key GEF results. In a surprising number of cases, indirect influences and impacts have occurred during early project preparation activities. A variety of stakeholders, including policy-makers, financial institutions, firms, utilities, investors, and NGO, have become more knowledgeable and confident about technologies as a result of the GEF's commitment of funds, along with the dialogues, training efforts, priority-setting exercises, and institutional coordination that typically occur during project preparation and implementation. Increased awareness and confidence have in turn influenced investment decisions or policy actions in parallel with the GEF project. Some examples:

The *Mauritius Bagasse Power Project* influenced several sugar mills to make bagasse power plant investments on their own, independent of the project. The project also prompted the government to create stronger regulatory frameworks for independent power producers using bagasse. These indirect impacts occurred even though a demonstration power plant planned for the project was never built.

The positive experience of the Mexican utility

CFE with the *Mexico Efficient Lighting Project* (1991-97) led it to run an ambitious follow-on program. From 1998 to 2000, the new program sold 4.8 million CFLs all over Mexico. With the experience gained from the GEF project, the new program was able to run without subsidies, with reduced administrative costs, and with shorter repayment terms. CFE staff have indicated that their experience with the GEF project played an important role in the design of subsequent nationwide energy saving programs.

The business climate for rural PV sales and supporting infrastructure created in part through the *Sri Lanka Energy Services Delivery Project* convinced Shell International Renewables to enter the Sri Lanka PV market (by purchasing an existing dealer). In addition, the project indirectly influenced a decision by a nationwide department store in Sri Lanka to enter the solar PV business.

The *Costa Rica Wind Power Project* helped support the emergence of a significant private sector wind power industry due to the government's decision to engage in the power supply business. Although the planned government-owned 20 MW demonstration wind farm has not yet been constructed, the GEF-supported project did renew the government's dialogue with private developers and helped establish a regulatory framework that resulted in more than 30 MW of operational privately financed wind farms.

Soon after the *Poland Coal-to-Gas Project* was initiated, many of Poland's environmental investment funds began to fund coal-to-gas conversions. In fact, a large coal-to-gas industry emerged. Many boiler conversions took place with government and private financing, long before any GEF-supported installations occurred. The project is credited with catalyzing these broader trends.

The *China Efficient Refrigerators Project* developed and helped enact new national refrigerator standards during the project development phase. Chinese refrigerator manufacturers, influenced by project preparations, began to expect a much

larger market for efficient refrigerators and started to develop high-efficiency prototypes and production models even before the project started.

Other countries in Asia are launching projects to emulate the *China Efficient Lighting Project*, even before the project is implemented. Together with an earlier UNDP project in which the GEF and other donors collaborated, the efficient lighting project is increasing the countries' experience with and confidence in efficient lighting.

Preparation activities, studies, dialogues, and GEF commitment associated with the *Mexico Renewable Energy in Agriculture Project*, together with enhanced capacities fostered through GEF-supported enabling activities, assisted the Mexican government in redesigning its rural development plans to emphasize renewable energy rather than costly grid extensions. The approach, first tried in a few municipalities, is being implemented in as many as 28 states, potentially affecting more than half a million farms.

The approval of the *Malawi Renewable Energy Project* encouraged the government to pay greater attention to the success of prior pilot microcredit and community banking approaches, serving primarily women, and to incorporate those approaches into its energy and sustainable development program, even before the GEF project started.

Solar thermal power plant projects approved by the GEF for India, Morocco, Mexico, and Egypt have lent credibility to the technology, created fresh interest in applications of that technology, and positively affected the development of other projects in both developed and developing countries. GEF support has helped put this technology on the agenda of other organizations and given credence to or helped expand ongoing research, development, and commercialization programs in several countries.

Lesson 3: Replication of projects is not well

planned or monitored.

A few projects have been replicated. A good example is the *Mexico Efficient Lighting Project*, which has been replicated by the national utility CFE on a larger scale. Another example is the *China Coal-bed Methane Project*, which has been replicated by the newly established China Coal-bed Methane Corporation. Replication can occur within a project, as happened in Thailand. The *Thailand DSM Project* was expanded in 1997 to include a DSM component for the Bangkok distribution utility, MEA, under a World Bank-supported power distribution project. Similarly, the *China Efficient Refrigerators Project* spawned parallel efforts during early project stages that could be considered replication. And the *Hungary Energy Efficiency Co-financing Program* has promoted financing of energy efficiency investments by Hungarian commercial banks, another form of replication.

Replication of a successful GEF approach led to a subsequent GEF project in one case. During the implementation of the *Poland Efficient Lighting Project*, the IFC received requests from other countries wishing to host a similar CFL promotion program. These requests prompted IFC to design the GEF-supported *Efficient Lighting Initiative*, now being implemented in seven countries.

In general, projects in the GEF project portfolio are too new to gauge how well their replication is providing global environmental benefits. Replication has tended to happen unpredictably rather than through specific planned activities within projects, and has tended to be reported anecdotally. Many more instances of replication may already have occurred but remain undocumented because project monitoring has not focused on replication.

Lesson 4: Project risk assessment and management need to be strengthened.

Energy-efficiency projects in Peru, Tunisia, and Chile illustrate the need to recognize, in project design and implementation, the state of energy-

efficiency markets, macroeconomic conditions, and education of users. The Peru project supported the Centro de Conservacion de Energia in establishing energy service contracts for energy-efficiency investments within the textile and steel industries. But no agreements were completed, in part because insufficient efforts were made to help client companies understand the ESCO concept. The economic recession and changes in government made energy saving projects a lower priority in Peru. Finally, companies unexpectedly failed to meet the financial guarantees demanded by banks as part of a financing mechanism under the project.

Unfamiliarity with performance contracting and a distrust of consultants among industrial firms in Tunisia have thwarted attempts by a GEF-supported energy service company to engage in energy performance contracting. The local Tunisian ESCO has been successful, however, in marketing its services under contractual arrangements that do not rely on performance contracts. And in Chile, electric power restructuring led to a decrease in the bulk power tariffs imposed on copper mines. This decrease, along with higher profits from increasing world prices for copper, left these mines with less interest in and incentive to invest in energy efficiency. Planned investments under the Chile project never were made.

Selection of suitable consumer credit schemes has greatly affected the progress of projects involving solar home systems. The *Sri Lanka Energy Services Delivery Project* started with dealer-supplied credit but soon switched to microfinancing, which appeared more viable, in part because of the long-established history and tradition of microfinance institutions in that country. Implementation of the *Indonesia Solar Home Systems Project* ceased during that country's macroeconomic crisis, in part because dealers were unable to obtain commercial finance to support the dealer-supplied credit model employed in that project. In solar home systems projects in Sri Lanka and Vietnam, uncertain rural electrification policies have depressed demand for solar home systems. In Ghana, imported equipment costs are rising due to currency depreciation, while political pressure is

reducing fees charged to rural households for system use, thus calling into question the profitability (and the sustainability) of the project.

Institutional conditions have played major roles in the progress of grid-connected renewable energy projects. In Sri Lanka, the tough challenge of allowing third-party, small-hydropower producers into a previously monopoly utility system has resulted in compromise power purchase frameworks that are not sustainable from the private producers' viewpoint. In China, changing institutional arrangements in the electric power sector due to restructuring have left provincial utilities unable or unwilling to embark on planned investments of 190 MW in new wind power capacity as part of a GEF-supported project. Almost all of that investment will be cancelled.

In some cases, changes in co-financing or government commitment have hindered project progress. In the China biomethanation project, for example, changes in local government leadership and lack of promised co-financing for demonstration projects have delayed implementation by many years. Such changes should be tracked carefully in the future to gauge how significantly they could affect other projects in the GEF portfolio.

Designing a project to exactly fit market, macro-economic, and policy conditions is difficult. But adjusting the design during project implementation can enhance project performance. Even if the design reflects conditions at the time of project start, flexibility during implementation to respond to changing conditions is important. Given that only a few projects have successfully adapted to changing conditions during implementation, it will be useful for the GEF to employ flexible funding mechanisms such as adaptable program loans.

Lesson 5: Transfer of technological know-how is more difficult than project proponents anticipate.

Two China projects for efficient boilers and effi-

cient refrigerators provide direct support to manufacturers for acquisition of technological know-how. In both cases, this acquisition is proving more difficult than originally expected, suggesting that attempts in other GEF projects to transfer technological know-how directly to domestic manufacturers may prove difficult. The efficient boilers project had problems with a first round of technology license acquisition because foreign manufacturers wanted more money than the project had allocated and because foreign technology was not directly applicable to China's need to burn raw coal. The project did acquire one license for a new technology package for one Chinese manufacturer by allocating that manufacturer a larger share of project funds, but settled for acquisition of lesser improvements to existing boiler designs and of product design tools for the remaining eight manufacturers. In the efficient refrigerators project, planned visits of Chinese manufacturers to foreign manufacturers were refused by the foreign manufacturers because of market competition concerns. Instead, Chinese manufacturers must rely on study tours to foreign academic and research institutions, which do not adequately convey the technological and commercial know-how that Chinese manufacturers want.

Lesson 6: Long-term programmatic approaches require sufficient GEF "credibility" and experience in a country.

The China country review highlights the challenges of programmatic assistance frameworks and the need for the GEF to possess sufficient credibility in its recipient countries. Two such frameworks have been under development in China, one for energy efficiency and one for renewable energy. However, the review found that even as late as 1996, the credibility of the GEF in China was relatively low and such frameworks would not have been viable. Only a few projects had been approved or put into development. Now that more projects have been implemented, Chinese stakeholders have embraced the principles of the GEF's operational programs, and the GEF has gained credibility among offi-

cial and industry. The GEF and China have recently been able to agree on development of long-term programmatic approaches to energy efficiency and renewable energy under development by the UNDP and the World Bank.

Lesson 7: The GEF’s potential for influencing policy needs to be better utilized.

GEF projects have influenced policy development in three areas—national codes and standards, electric-power-sector policies, and rural electrification policies. Although generally modest, project impacts on policy have been significant in a few cases, suggesting that projects’ potential to facilitate appropriate policies has been underutilized. Projects have successfully supported codes and standards for efficient lights in Mexico, efficient refrigerators in China and Thailand, and solar home systems in Zimbabwe, Sri Lanka, and Indonesia. The GEF has proven quite capable of facilitating important regulatory frameworks supportive of grid-connected renewable energy in two countries—Mauritius and Sri Lanka. And rural electrification policies and planning have been influenced by at least two projects in Argentina and Sri Lanka. When asked to identify the most important impacts of existing and new GEF projects in China, a Chinese government official ranked highest the projects’ influence on policy.

Lesson 8: The contribution of GEF-financed projects to social benefits and poverty alleviation needs to be assessed.

GEF projects, especially those that cater to rural energy development needs (particularly off-grid renewable energy projects) provide social benefits for participants, but those benefits need to be documented. More than three-quarters of GEF-supported off-grid projects are implemented

through multi-stakeholder steering or advisory committees made up of representatives of the private sector, NGOs, and consumer groups. But these stakeholders are generally not encouraged or required to report or document social and development impacts.

The extent to which GEF projects have benefited communities by increasing incomes and employment and by expanding social services needs to be assessed. As projects mature, efforts to use renewable energy are expected to be integrated with redefined sustainable development and poverty alleviation programs and with new technology delivery and financing models, including community-based enterprises and microfinance. Assessment and documentation of social and development benefits from renewable energy are important for promoting the incorporation of renewable energy into sustainable development programs.

Mexico and Malawi are among the countries that are redefining their sustainable development programs. In Mexico, the government’s redesigned rural development plan reflects a switch from grid-connected rural electrification to solar- and wind-powered systems. In Malawi, the government has integrated microcredit and community banking approaches into its energy and sustainable development program. Other examples of rural “productive use” approaches in the GEF portfolio that could affect sustainable development programs by documenting social benefits include the energy and water sector reform project in Cape Verde, which extends wind power and solar PV to community-based electricity cooperatives for street lighting and water pumps, and a GEF project in Bolivia that established a revolving fund to support small enterprises in 23 municipalities.

4. Findings from Cluster Reviews

Annual Project Performance Reports, country visits, cluster reviews, agency reports, and informal communications have documented the impacts of 32 projects in operational programs #5, #6, and #7. In addition, the impacts of three energy-related, short-term response measures have been documented. Of these 35 total projects, 11 are formally completed. This section summarizes the significant impacts of projects in four thematic clusters and notes the impacts of other projects outside these four clusters. A recent working paper suggested that impacts should be organized by cluster and discussed with respect to seven performance indicators.⁷ The discussion below follows these suggestions.

Energy-Efficient Products Cluster

Summary: GEF-financed projects have demonstrated important and effective approaches for facilitating and accelerating greater demand for and supply of energy-efficient manufactured products, particularly lighting, but also refrigera-

tors, motors, and building materials (see table below). The benefits from almost 5 million efficient lights installed through GEF projects are being sustained and replicated on larger scales. Some project approaches have resulted in sustained reductions in the price of the products and in highly cost-effective abatement of carbon emissions. Market gains for efficient lights in particular are being sustained and replicated.

Energy production or savings and installed capacities. Three projects in Thailand, Mexico, and Poland have resulted in installation of more than 4.6 million compact fluorescent lamps (CFLs) and electricity savings of 3,400 GWh (equivalent to several months' output from a 1,000 MW coal or oil power plant). Other energy consumption reductions were achieved through industrial, commercial, and residential energy-efficiency improvements in the Thailand project. One of the most notable achievements of that project was the complete transformation of the fluorescent-light market, representing 20 million

Energy-Efficient Products Cluster

Project	Implementing Agency	Year Approved by GEF	Year Completed
Mexico Efficient Lighting	World Bank	1991	1997
Thailand DSM	World Bank	1991	2000
Poland Efficient Lighting	IFC	1994	1998
China Efficient Boilers	World Bank	1996	
China Efficient Refrigerators	UNDP	1998	

⁷ See *Measuring Results from Climate Change Programs: Performance Indicators for GEF*, GEF Monitoring and Evaluation Working Paper 4, September 2000 (Washington, DC: GEF).

annual sales, in which virtually all sales of less-efficient T-12 lights were replaced with sales of T-8 lights that are 10 percent more efficient.

Costs per technology unit or measure installed.

The most visible price-reduction effects of the GEF portfolio have occurred in this cluster. Three completed projects clearly decreased prices of the technologies they targeted. The Poland project resulted in a sustainable price decrease for CFLs of at least 35 percent. In fact, one of the project's key impacts was the lowering of CFL prices. In Thailand, sales of low-price CFLs increased in part because of the widespread publicity campaign promoting the benefits of CFLs sold at "7-11" convenience stores nationwide, and offered at lower prices due to bulk purchases by the national electric utility. Bulk procurement in the Mexico project, coupled with utility-provided subsidies, reduced consumer prices to \$5-8, from pre-project prices of up to \$25. Since the project was completed, average CFL prices have further declined, by up to 30 percent, and the project is credited with accelerating price reductions that would have happened more slowly otherwise.

Business and supporting services development.

Supporting institutions for energy efficiency have been strengthened through several projects. As part of the *Thailand DSM Project*, the national electric utility (EGAT) created a demand-side management office. This office has successfully negotiated voluntary T-12 to T-8 lamp changeovers, conducted bulk procurement and distribution of CFLs through convenience stores nationwide, led campaigns to promote public awareness of energy efficiency and conservation, promoted awareness of appliance energy labels, and disseminated classroom educational materials. The experience that the Mexican utility CFE gained during the Mexico project has allowed it to proceed with additional DSM programs without GEF support, including the sale of an additional 4 million CFLs. The *China Efficient Refrigerators Project* resulted in the enactment of new energy-efficiency standards for refrigerators. The *China Industrial Boilers*

Project has provided nine Chinese boiler manufacturers with technology licenses from foreign suppliers for upgraded or new industrial coal-fired boiler technologies that are more efficient.

Financing availability and mechanisms. The Poland project established an innovative subsidy mechanism whereby an overall GEF subsidy of \$2.6 million leveraged a total CFL retail price reduction worth \$7.2 million through competitively solicited manufacturer subsidies and retail markup effects. The Mexico project introduced to Mexico two new mechanisms for consumer financing of CFLs: (a) pay-on-the-bill financing, whereby the price of the lamp is deducted in installments off of a customer's electricity bill, and (b) a similar procedure managed by employers, in which an employee's investment in CFLs is made through paycheck deductions. Both of these financing approaches continue to be used after the completion of the project.

Policy development. Policy development in at least three projects has focused on national codes and standards for energy-efficient equipment. In the Mexico project, the development of national CFL quality standards began in the early stages of project development. The standards were then launched and enforced during the project. An increasing number of CFL models are being sold and labeled according to these standards. In the Thailand project, EGAT's DSM Office worked with the Thai Consumer Protection Agency to make energy-efficiency labeling mandatory on single-door refrigerators. In the China project, national energy-efficiency standards for refrigerators were enacted.

Awareness and understanding of technologies.

The Poland project has produced the most data of any project⁸ on changes in awareness and understanding of technologies, in this case of CFLs. Before the project began, only one in 10 Polish households owned at least one CFL. This increased to one in 3 households a year after the program. Also, about 97 percent of the CFL purchasers surveyed intended to replace their

⁸ A comprehensive monitoring and evaluation program was designed and effectively implemented for the *Poland Efficient Lighting Project*.

existing CFLs with new CFLs after they burn out. After the project, a larger number and wider variety of stores (from small shops to supermarkets) began to sell CFLs. Stores also began to carry a wider variety of CFL models. Print media coverage of CFLs increased and shifted from describing CFLs to explaining where and how to best use them. The Ministry of Education wrote that “it is apparent that as a result of the project large numbers of students and teachers have gained useful insight into the use of energy and its impact on the environment.” The Thailand project conducted a major public awareness campaign that made 87 percent of Thais aware of energy-efficiency issues, particularly the advantages of energy-efficient lighting, refrigerators, and air conditioners.

Energy consumption, fuel-use patterns, and impacts on end users. Several energy-efficiency projects affected energy consumption patterns, as evidenced by changes in market shares associated with those projects. The Poland project increased the percent of households with CFLs from 11.5 percent to 19.6 percent. The Thailand project also had significant impacts on market shares: An air conditioner program increased the market share of energy-efficient air conditioners from 19

percent in 1996 to 38 percent in 1998, and a refrigerator program transformed the single-door refrigerator market, increasing the market share of the most efficient units from 12 percent in 1995 to 96 percent in 1998. One of the most notable achievements of that project was the complete transformation of the fluorescent-light market, representing 20 million in annual sales, in which virtually all sales of less-efficient T-12 lights were replaced with sales of T-8 lights that are 10 percent more efficient.

Grid-Connected Renewable Energy Cluster

Summary: The GEF has facilitated implementation of important regulatory frameworks supportive of grid-connected renewable energy, but has done so in only two countries so far (Mauritius and Sri Lanka). Other impacts have been limited to one-time technology demonstrations, research, and increased skills and awareness. The GEF’s largest market impact has been in India, where direct and indirect influences on private sector power project development and financing have resulted in nearly 1000 MW of new renewable energy generating capacity.

Grid-Connected Renewable Energy Cluster

Project	Implementing Agency	Year Approved by GEF	Year Completed
India Renewable Resources	World Bank	1991	
India Small Hydel	UNDP	1991	
Mauritius Bagasse Cogeneration	World Bank	1991	1997
Philippines Geothermal Power	World Bank	1991	2000
Brazil Biomass Gasification I Project	UNDP	1992	1996
Costa Rica Wind Power	World Bank	1992	
India Biomethanation	UNDP	1994	
Sri Lanka Energy Services	World Bank	1996	
Brazil Biomass Gasification Project II	UNDP	1996	
China Renewable Energy Capacity Building	UNDP	1997	

Energy production or savings and installed capacities. Directly installed grid-connected renewable energy capacity from two projects totals 110 MW (86 MW in India and 24 MW in Sri Lanka). Indirectly, at least another 840 MW of capacity has been influenced by GEF support. The *India Renewable Resources Project* assisted the India Renewable Energy Development Agency (IREDA) to promote and finance more than 360 MW of wind projects and 65 MW of mini-hydro projects by the private sector. The Mauritius project indirectly influenced almost a doubling of electricity generated from bagasse in that country, with the addition of an estimated 3-5 MW of new bagasse generation capacity. The Costa Rica project indirectly helped to support more than 30 MW of privately financed and operated wind farms. The Philippines project expanded by 390 MW the capacity of an existing geothermal facility and transmission system. The *India Biomethanation Project* has so far resulted in six demonstration installations, including three 180-kW biogas engines and four 450-kW dual-fuel engines for power generation from biogas from two sewage treatment plants. Other subprojects nearing completion include a 1-MW power plant that uses biogas from a sugar factory.

Business and supporting services development. GEF projects have fostered business development in Mauritius, Sri Lanka, Costa Rica, and India by facilitating conditions for independent power producers in those countries. The *India Small Hydel Project* has resulted in supporting services for small hydro business development. Through capacity-building activities, more than 50 officials have been educated about the planning, design, construction, management, and maintenance of small hydro power. Local ownership and management models are being tested at three of the demonstration sites. An "Alternate Hydro Energy Center" has strengthened its capability to test equipment and train stakeholders, and a local educational establishment now offers a postgraduate program on alternate hydro energy. Thirteen states have issued guidelines for engaging the private sector in the commercial installation of small hydro plants. Renewable energy business associations have been fostered in Sri Lanka and

China, and the *China Renewable Energy Capacity Building Project* created the China Renewable Energy Industry Association, which has supported new activities by its members to expand their business and link with foreign expertise.

Financing availability and mechanisms. Projects in Costa Rica, Sri Lanka, and India (small hydro, biomethanation, and renewable resources) have provided direct financing for power project developers and for demonstration installations. But only one project has so far facilitated a long-term financing mechanism for grid-based power: The *India Renewable Resources Project* strengthened the capabilities of the India Renewable Energy Development Agency (IREDA) to promote and finance private sector investments. As a result, more than 360 MW of wind projects and 65 MW of mini-hydro projects have been financed through IREDA. The project also helped to raise awareness among investors and banking institutions of the viability of wind power technology and helped to lobby for lower import tariffs for wind systems. During the 1990s, many financial institutions decided to offer financing for wind farms in India, a key project goal. Other impacts on financing availability of other projects have not been documented.

Policy development. Electric-power-sector policies supportive of renewable energy have been influenced by the GEF in Sri Lanka and Mauritius. The Sri Lanka project has developed regulatory frameworks for independent power producers (IPPs), including standardized "non-negotiable" power-purchase tariffs and contracts (PPAs). This project encouraged the national utility to adopt IPP frameworks and agree to PPAs, which together with demonstrations of prior mini-hydro installations and new incentives for developers (such as import duty waivers and income tax concessions), spurred the market. Likewise, the Mauritius project led to the establishment of a framework for IPP development. A project evaluation states that "the project's major accomplishment was progress in helping to establish an institutional and regulatory framework for private power generation in Mauritius and the

provision of technical studies and trials to support technologies for improved bagasse production and improved environmental monitoring.”

Awareness and understanding of technologies. All projects have fostered greater awareness of grid-connected renewable energy technologies among policy-makers, utilities, private firms, and financiers. The *India Biomethanation Project* has increased awareness of and knowledge about biomethanation technologies in India. Representatives of various technical institutes and government agencies have participated in overseas study tours to visit biomethanation plants, manufacturers, and experts in the field of waste-to-energy. A quarterly newsletter on bioenergy is being published. The project has also prepared a directory of entities and individuals working in the field of waste-to-energy and sponsored conferences and workshops to share experiences with biomethanation. In Costa Rica, greater awareness of wind energy applications has helped to foster government decisions that allowed greater private sector investments in wind farms.

Off-Grid Solar PV Cluster

Summary: Rural applications of solar photovoltaics (PV) constitute the largest single group of projects in the climate change portfolio, but most of these projects have little or no implementation experience yet. Of roughly 600,000 solar home systems expected from approved projects, only 18,000 have been installed thus far. Several business models and schemes to extend credit to businesses and consumers show promise of being sustainable and further replicated. Awareness of solar home systems is increasing in several countries and technical standards are improving. The impact of projects on rural electrification planning and policies has been small, but more recent projects are emphasizing these issues.

Energy production or savings and installed capacities. About 18,000 individual solar home systems have been installed through five projects in Zimbabwe (10,000), Sri Lanka (2,000), Bangladesh (1,500), the Dominican Republic (3,500), and Vietnam (1,000). The India project supported village-scale applications of PV, in

Off-Grid Solar PV Cluster

Project	Implementing Agency	Year Approved by GEF	Year Completed
India Renewable Resources	World Bank	1991	
Zimbabwe Solar Home Systems	UNDP	1991	1997
Bangladesh Grameen Shakti (SME)	IFC	1994	
Dominican Republic Soluz (SME)	IFC	1994	
Vietnam SELCO (SME)	IFC	1994	
Sri Lanka Energy Services Delivery	World Bank	1996	
Argentina Renewable Energy in Rural Markets	World Bank	1997	
Mexico Renewable Energy in Agriculture	World Bank	1999	
Malawi Renewable Energy Program	UNDP	1999	

which five PV power plants of 25 kWp each supply electricity to about 500 families connected into village-scale mini-grids managed and maintained by a cooperative society. The Mexico project has so far resulted in installation of one solar water-pumping station for agricultural use.

Costs per technology unit or measure installed.

Very little data are available on any cost reductions occurring during solar PV projects. Reports from the Zimbabwe project stated that market prices declined, in part through elimination of import duties on imported components. Data from other projects indicate current sale prices for systems, but do not indicate the changes in those prices over time. Two projects have influenced a reduction in import duties for PV system components: in Zimbabwe, import duties were reduced from 40 percent to zero and, in Sri Lanka, duties were reduced from 30 percent to 10 percent.

Business and supporting services development. Five solar home systems projects have had significant impacts on business and supporting services. The technical and business capabilities of dealers were enhanced in Zimbabwe (more than 20 dealers), in Sri Lanka (three primary dealers), and in Bangladesh, Vietnam, and the Dominican Republic (one dealer in each country). The Zimbabwe project expanded the network of dealers, established PV module standards to certify and warranty installed systems, and developed equipment certification institutions. Evolving business models in these five projects serve as examples to spur business development. The Dominican Republic project, for example, helped a dealer to develop a promising fee-for-service business model that targets up to 50 percent of the population in the rural communities it serves and charges \$10 to \$20 per month for electricity service. By improving the business model, the dealer is approaching a “proof of concept” at a scale of 5,000 fee-for-service customers. Such a model could be replicated elsewhere by other firms.

Financing availability and mechanisms.

Consumer credit for rural households to purchase solar home systems has been a central feature of

many GEF project designs. Three projects have demonstrated credit delivery models (as they progress, many more projects are designed to demonstrate a variety of credit models). The Zimbabwe project provided consumer credit through the Agricultural Finance Corporation (AFC) to 4,200 households through a revolving fund mechanism. The Bangladesh project is demonstrating a successful application of a “dealer-supplied credit” model in which one organization (Grameen Shakti, legally a non-profit), performs all functions: marketing, sales, service, credit provision, collections, and guarantees. The Sri Lanka project is demonstrating the initial viability of a microfinance model, in which households purchasing solar home systems from dealers can obtain consumer loans from a national microfinance institution (MFI). The MFI has many local branches and strong ties to the communities in which it operates.

Policy development. Policy development in off-grid solar PV projects has focused on standards and rural electrification policies. Standards for solar home systems were first developed under the Indonesia project. The *Sri Lanka Energy Services Project* at first adopted the standards used in Indonesia, but then modified the standards to allow smaller systems better suited to Sri Lanka’s consumer demand and solar insolation characteristics. Later, in both Indonesia and Sri Lanka, minimum requirements were further reduced because of consumer demand for a variety of systems, and because some dealers continued to have trouble meeting the standards. Rural electrification policies and planning by governments have been influenced by at least two GEF projects: The Sri Lanka project has encouraged the national electric utility and the government to more explicitly recognize and incorporate solar home systems into rural electrification planning, and the Argentina project has resulted in the government developing a policy that increases support for rural energy service concessions.

Awareness and understanding of technologies.

Several solar home systems projects have conducted activities to increase end users’ awareness of the technologies and benefits, but the

impacts of these activities have not been directly measured. The Sri Lanka project conducted village-level workshops throughout the country to promote solar home systems. In these workshops, dealers demonstrate their products, and village leaders learn about the technology. In addition, potential local microfinance organizations have learned about the project and gauged local interest in solar home systems. In its first series of training courses, the Mexico project trained 180 farmers and state and local authorities to use the systems.

Energy consumption, fuel-use patterns, and impacts on end users. Neither data on amounts of fuel displaced by solar home systems in GEF projects nor data on social benefits and other income-generation effects are available. In general, project M&E plans have not addressed these issues.

Energy Service Company (ESCO) Cluster

Summary: Viable energy service companies (ESCOs) have been established in two countries (Tunisia and China) as a result of GEF projects. Financing for existing ESCOs has been facilitated in the Hungary project. Other projects with ESCO components provide technical assistance, training, and audits, but are not expected to lead to full-service (i.e., “performance-contracting”) ESCOs. With the exceptions of China and Hungary, no other countries have documented replication or energy savings impacts of ESCOs from GEF projects. Prospects for the emergence

and sustainability of ESCOs appear strongest as a result of the China project, which is also pioneering the resolution of key policy and legal issues to allow growth of the ESCO industry. Several GEF projects appear to be increasing awareness and acceptance of ESCOs among industrial clients, policy-makers, and financiers.

Energy production or savings and installed capacities. Few energy savings impacts have been quantified for projects in this cluster, with the exception of the China and Hungary projects. Estimated lifetime energy savings from approved subprojects under the China project amounts to 3.3 million tons coal equivalent (mtce), or the equivalent of 2.2 Mt carbon emissions reduction.

Business and supporting services development. Two projects have established new ESCOs to work with industry and utilities to make energy-efficiency investments. These ESCOs pilot business models that are the first of their kind in these countries, and thus a major result of the projects is demonstrations of the viability of such business models. The Hungary project has strengthened the capabilities of 20 energy-efficiency companies to market, assess, and finance energy-efficiency projects. The China project established three pilot, private sector ESCOs that have so far invested \$30 million in 150 projects using energy performance contracting models for the first time in China. The project is also encouraging more widespread use of the ESCO business model throughout China. More than 80 potential ESCOs have expressed interest in participating in a second phase of the project,

Energy Service Company (ESCO) Cluster

Project	Implementing Agency	Year Approved by GEF	Year Completed
Peru TA for Energy Efficiency	UNDP	1991	1995
Tunisia ESCO (SME)	IFC	1994	
Hungary Energy Efficiency Co-financing Program	IFC	1996	
China Energy Conservation	World Bank	1997	
Egypt and Palestinian Authority Energy Efficiency	UNDP	1997	

and more than 10 additional ESCOs have begun operating. The Tunisia project established one ESCO as a joint venture between a Canadian ESCO and a group of Tunisian banks; after two years of operation, this ESCO has completed 70 energy audits, made 35 proposals, and undertaken one investment project. The Egypt project has supported 70 industrial audits, and 12 sites currently employ the audit results to implement energy saving measures. The Egypt project has not yet resulted in creation of a commercial ESCO model, although other developments in Egypt, including an operating ESCO funded through the IFC/GEF Small and Medium Enterprises Program, suggest that commercial ESCO models can be viable.

Financing availability and mechanisms. Three projects in particular have expanded financing availability. The Hungary project has piloted new financing mechanisms that have facilitated and guaranteed financing for energy service companies. Three Hungarian financial institutions have utilized the project's "partial guarantees" (provided on a "first loss" basis), to fund, on a transaction-by-transaction basis, an initial six investment projects valued at \$1.6 million. The project has helped lower credit risks and hence has demonstrated the financial viability of investment projects. The project has also generated interest from most major commercial banks in Hungary, providing a good foundation for expansion

via a recently approved IFC parallel investment program. In the Egypt project, commercial banks are lending to individual energy-efficiency projects. The China project has attracted the interest of commercial banks in financing ESCOs, and increased their willingness to do so.

Other Applications/Impacts

Summary: Projects for coal-bed methane, gas-pipeline leakage repair, fuel switching, decentralized wind power, utility demand-side management, village-scale mini-grids, and district heating-efficiency improvements have all shown significant impacts and could all be replicated on larger scales and used as models for ongoing and future GEF projects. So far, three projects—coal-bed methane in China, decentralized wind in Mauritania, and demand-side management in Thailand—are being replicated.

Sri Lanka Energy Services influenced development of 80 village-scale mini-grids using small hydro serving about 3,500 people (using 500 kW total capacity). Seven of these schemes were financed directly through the GEF project (totaling 70-100 kW capacity); the remaining schemes were financed by international donors and local government.

China Sichuan Gas made a substantial contribution to increasing gas reserves and gas production

Other Applications

Project	Implementing Agency	Year Approved by GEF	Year Completed
China Coal-bed Methane	UNDP	1991	1997
Poland Coal-to-Gas	World Bank	1991	
China Sichuan Gas	World Bank	1992	
Mauritania Decentralized Wind	UNDP	1992	1996
Jamaica Demand-Side Management	World Bank	1993	1999
Sri Lanka Energy Services Delivery	World Bank	1996	
Bulgaria Energy Efficiency	UNDP	199	

capacity in Sichuan province, as well as to improving safety and environmental protection throughout the province's gas transmission network. The project increased the proven reserves from 400 bcm in 1993 to 554 bcm in 1998 and increased annual production capacity from 6.5 bcm to 9.3 bcm over the same period. The project also helped to reduce pipeline leakages and introduced the process of leakage detection and repair to the gas transmission company for the first time. The company hadn't realized the importance of pipeline monitoring and had to bring in new analytical tools and gain new skills, including the establishment of a new pipeline monitoring and rehabilitation center. As a result of the project, system leakage rates reduced from 3.6 percent in 1996 (the first time leakage had been monitored) to 1.5 percent in 1998.

China Coal-bed Methane created the China Coal-Bed Methane Corporation, which is facilitating joint ventures and providing financing for exploitation of coal-bed methane. This project has created new business infrastructure and supporting services to recover coal-bed methane. At three sites, the project demonstrated techniques and technologies that Chinese coal mines can employ to reduce atmospheric methane emissions and recover methane as a fuel. Training workshops were held at these same sites. The project published a detailed assessment of China's coal-bed methane resources and strengthened the country's capacity to conduct such assessments routinely. More than 500 people were trained, from senior government policy makers to senior managers and engineers of coal mining companies. Several additional exploration and development agreements with foreign partners have been negotiated since the project was completed.

Mauritania Decentralized Wind installed demonstration wind-electric systems for rural electrification in 19 villages with 900 households. The project piloted sustainable service-delivery

models (with cooperatives), trained local technicians, promoted consumer awareness, and developed financing and institutional capability for further development of small wind-electric systems. A second phase, extending the experience to 100 villages, has started with financing from the French government.

Poland Coal-to-Gas promoted the conversion of small- and medium-sized boilers from coal to natural gas fuels. The project raised awareness of the potential for coal-to-gas conversions in Poland. In particular, many of Poland's environmental investment funds, like the Bank for Environmental Protection, began to fund coal-to-gas conversions. In fact, a large coal-to-gas industry emerged in Poland. Many boiler conversions have occurred with Polish government and private financing. The project helped increase the government's awareness of the need to address boiler conversions nationwide. The project generated information, publicity, and promotion that influenced the thinking of boiler owners and financiers. In addition, the EU Phare* program took note of the project and began to develop similar projects for coal-to-gas conversions in neighboring countries.

Bulgaria Energy Efficiency has conducted studies of the feasibility of several municipal energy-efficiency projects, and a number of energy-efficiency investment projects are now underway as a result of the project's capacity building and institutional development. These projects involve a school, district heating improvements, residential apartment buildings, and street lighting.

Factors Influencing Sustainability and Replication

The Climate Change Program Study highlighted some of the factors that appear to influence sustainability, either positively or negatively.

* The Phare program is one of the three pre-accession instruments financed by the EU to assist the applicant countries of Central Europe in their preparations for joining the EU.

Some examples of positive influences on sustainability:

- *Demonstration of sustainable business models.* “Demonstration of a viable business model, whether that business is public, private, utility, or even permanently subsidized, is key to achieving project sustainability and achieving the GEF programmatic objective of transforming (or developing) markets for solar PV,” concluded the solar PV cluster review. Two projects may be close to demonstrating sustainable business models. In Sri Lanka, a partnership between dealers of solar home systems and a rural microcredit organization appears to offer a sustainable model for household purchases of these systems. In the Dominican Republic, the firm Soluz Dominicana is close to demonstrating a “proof of concept” for a business model for serving up to 5,000 households using a “fee-for-service” approach.
- *“Market transformation” approaches.* The market changes brought about by the *Poland Efficient Lighting Project* have been sustainable. Two years after the close of the project, the market changes resulting from the project were still in place. Retail prices of CFLs in Poland decreased by 34 percent in real terms, and Polish CFL market experts and manufacturers agree that the project was largely responsible for this dramatic price decrease. The project helped increase sales volumes and manufacturer competition, and the public education campaigns helped increase consumer demand to the point at which the price decrease was sustainable. In Thailand, a refrigerator program appears to have sustainably transformed the refrigerator market. High-efficiency refrigerators are now the norm, and the unit with the highest highest level of efficiency became the dominant unit on the market as early as the second year of the program. In fact, surveys show that a variety of energy-efficient appliances promoted through the Thailand project have sustained markets. Customers have been highly satisfied with the reliability of the energy-efficient products, which suggests that the gains from the market transformation programs are not likely to be reversed.
- *Voluntary agreements with the private sector.* Two of the Thailand DSM market transformation programs (fluorescent tubes and refrigerator labeling) have had sustainable impacts on the market. The voluntary agreement concluded between EGAT and fluorescent tube manufacturers effectively and completely “washed” the Thai market clear of inefficient T-12 fluorescent tubes. In 1994, when the program began, efficient tubes had a 40 percent market share, and by the end of 1995, the efficient tubes had achieved a 100 percent market share.
- *Establishment or precedents of new legal frameworks.* Projects can foster new legal frameworks and promote sustainability through adoption of these frameworks. A project may encourage lawmakers or administrators to consider and define legal issues they otherwise would have ignored or considered unworthy of attention. The best example is the *China Energy Efficiency Project*, whose value may be as much about encouraging new legal precedents or contractual forms as it is about direct energy-efficiency investments. The project is likely to set a precedent for the legal accounting status of ESCOs in China. Such a precedent is important for the future growth of the ESCO industry in China, and was only possible after the three pilot ESCOs had grown and accumulated assets sufficient to draw government scrutiny. The contractual forms that the three ESCOs have used with their clients also came under government auditor scrutiny and created the need for the government to formally classify these types of contracts. Once a legal ruling occurs, other future ESCOs and their clients will face lower risks and place greater confidence in applying performance contracting models, establishing business plans, and understanding the legal and tax implications of performance contracting.

Some examples of factors that can negatively influence sustainability:

- *Privatization of power utilities supporting demand-side management.* In Thailand, the fate of the highly successful Demand-Side Management Office (DSMO) of the national electric utility (EGAT), created under a GEF project, is uncertain in the face of EGAT's planned privatization. Despite impressive achievements under the project, the publicly supported DSMO (the main innovation piloted by the project) may not be sustainable.
- *Short-term power-purchase tariffs for grid-based renewable energy.* A sustained market for small hydropower development under the *Sri Lanka Energy Services Project* is questionable, given the way power-purchase tariffs were established. Tariffs were tied to short-run avoided utility costs based on the international price of oil. In 1997 and 1998, tariffs were set at the equivalent of 5 cents/kWh, and mini-hydro development flourished. Because of the downturn in oil prices in 1998-99, however, prices were only the equivalent of 3.5 cents/kWh in 1999. As a result, all development essentially stopped in 1999. And this fluctuation has seriously hurt the longer term interest of private mini-hydro developers in Sri Lanka. "The low tariffs and unresolved dispute [on tariff calculation methods] have caused a deep slump in mini-hydro development," stated a project status report in 2000.
- *Consumer finance and rural business dependence on project resources.* The *Zimbabwe Solar Home Systems Project* greatly expanded the network of private dealers and resulted in the sale of 10,000 systems, but there are questions about how the consumer credit will be sustained after the Agricultural Finance Corporation revolving fund winds down. This fund is becoming depleted, in part because of concessional terms and in part because of macroeconomic conditions. Also in question is whether many of the businesses established or strengthened during the project are sustainable. During the project, businesses were dependent on the Project Management Office (PMO) for customers, credit, equipment subsidies, and even the equipment itself. Without the PMO, many of these businesses have been unable to operate on their own and have closed.
- *Project implementation arrangements that do not demonstrate business models.* The *Ghana Solar PV Project* was originally designed to demonstrate a business model in which the national utility, the Volta River Authority, would provide fee-for-service to rural households using solar home systems. At the conclusion of the project, it was intended that the utility would assess the costs, service, cash flow, and management of these systems in terms of the viability of this business model. The demonstration of this model could also be used to convince other private companies to enter the market, an explicit project objective. But responsibility for implementation of the project was transferred to the Ministry of Mines and Energy early on. This office may succeed in installing and servicing a given number of home solar systems. But given that the office is subject to government rules and regulations, its ability to demonstrate and judge business viability in a transparent commercial manner is questionable.



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