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**CLIMATE CHANGE PROGRAM STUDY
SYNTHESIS REPORT**

FOREWORD

1. The GEF Council, at its meetings in December 1999 and May 2000, requested a review of GEF operations prior to the next replenishment, which begins in 2001.¹ This review, the Second Study of GEF's Overall Performance (OPS2) is to be carried out by a "fully independent team" which is expected to complete its work by the end of 2001. The OPS2 is the third major GEF-wide review to take place since the Facility was created.² Among the broad topics the OPS2 team will assess are:

- (a) Program Results and Initial Impacts
- (b) GEF Overall Strategies and Programmatic Impacts
- (c) Achievement of the Objectives of GEF's Operational Policies and Programs
- (d) Review of Modalities of GEF Support
- (e) Follow-up of OPS1

2. To facilitate the work of the OPS2 team, GEF's Monitoring and Evaluation team, in cooperation with the implementing agencies, decided to undertake program studies in the biodiversity, climate change, and international waters focal areas. The role of these program studies is to provide portfolio information and inputs for the OPS2 team's consideration.

3. The Climate Change program study was undertaken by an inter-agency team comprised of staff from the GEF Secretariat, the three Implementing Agencies, and the GEF Scientific and Technical Advisory Panel with additional support from consultants contracted to undertake detailed studies on specified parts of the portfolio. The team worked under the guidance of the Steering Committee.

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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. Ofosu-Amaah and Michael Philips, *Study of GEF's Overall Performance*. Global Environment Facility (1998).

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EXECUTIVE SUMMARY

Introduction

1. During the last decade, the GEF has provided financial support for more than 270 projects for a total GEF allocation of over a billion US Dollars in 120 countries under its climate change focal area. Not counting enabling activities and some short-term measures, there are 120 projects covering 60 countries demonstrating an impressive range of approaches to promoting energy efficiency, renewable energy, and to a lesser extent sustainable transport.

2. The GEF Climate Change Program Study, initiated in June 2000, set out to answer four questions:

- (a) Are activities relevant to country needs and global objectives?
- (b) What are the most significant implementation issues and lessons?
- (c) What are the impacts/likely impacts of GEF projects?
- (d) What are the factors influencing sustainability and replication?

3. As of April 2001, the Program Study has resulted in eight new draft reports and has incorporated one completed report:

- (i) Efficient products manufacturing and marketing thematic review
- (ii) Grid-connected renewable energy thematic review
- (iii) Energy service company thematic review
- (iv) Solar thermal power plant thematic review
- (v) Solar PV review (published August 2000)
- (vi) Assessment of GEF climate change portfolio coverage
- (vii) Country reviews of China, India, and Mexico, with overall objectives to assess how GEF projects are collectively addressing country and global environment objectives.

4. The content and lessons to be drawn within these individual draft reports are substantially complete, although they continue to undergo agency review, integration, final revisions, and editing. The India country review is an exception, as it is still in progress, with results to be incorporated into the thematic reviews and synthesis report. All reports are expected to be finalized by June 2001. Copies of individual draft reports are available upon request by May 2001. This synthesis report provides a brief overall look at the results from these reports, organized by the four basic questions laid out in the program study initiating memorandum.

Scope of the Climate Change Portfolio

5. The program study has not been able to definitively assess, within the confines of time and resources available to the study, the degree to which country needs have been met through GEF-financed projects. Such an assessment would require explanation of where countries were prior to GEF, what baselines might have been, and where countries are now. Such data are often lacking or difficult to obtain. Further, the national communications do not always fully reflect national development priorities. Most GEF projects do not result from coherent, integrated approaches to development and environment at the country level. Nevertheless, the GEF has clearly helped to promote renewable-energy-based rural and agricultural development programs.

6. Reviews of GEF-financed climate change portfolios in Mexico and China have indicated that GEF projects are consistent with national priorities in those countries. Across all countries, the technology applications promoted in GEF projects are broadly relevant to at least some national objectives. For example, off-grid solar PV projects are serving fairly universal objectives of rural electrification. However, there is a need to further document how these projects serve other development objectives like employment and livelihood, health, sanitation, water, and literacy.

7. Meeting global environmental objectives depends greatly on the replication occurring as a result of demonstration of project benefits and on broader indirect impacts, since individual projects are small relative to the scale of the climate change problem. The challenge of measuring global objectives is compounded by the fact that replication is difficult to monitor. In general, the portfolio is still too immature to gauge how well replication is providing global environmental benefits. Replication has occurred in some projects -- efficient lighting, efficient refrigerators,, solar PV,, coal-bed methane , and electric power demand-side management. Replication from other projects has been minimal or remains undocumented.

8. Project approaches have clearly evolved from the pilot phase to the present. The initial direction for the climate change portfolio came from the Ad-hoc Working Group on Global Warming and Energy (AWGGWE) set up by the GEF Scientific and Technical Advisory Panel (STAP), which came up with a list of interventions that reduce or limit the emissions of greenhouse gases. Early GEF projects often focused on demonstrations of technologies. More recent projects focus on sustainable market-oriented approaches and demonstrations of business models, financing mechanisms, demand-side awareness and incentives, and public involvement. At the same time, the portfolio has become dominated by a few technologies and strategies over time, not necessarily related first and foremost to greenhouse-gas reduction, but reflecting a complex balance of needs, interests, and interactions among governments and GEF implementing agencies.

9. As the portfolio evolved, the need to support rural energy enterprises, provide financial intermediation (particularly to reduce risks), 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 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 US\$200 million of private sector co-financing to-date. Impacts from two of these projects are included in the energy-service company and solar PV thematic reviews, while the others are just starting implementation. This unique group of projects will warrant a separate thematic review in the future.

Emerging Lessons

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

- (a) *Lessons and good practices are emerging but need to be better incorporated into project designs to promote cross-learning.* One of the key advantages of supporting projects through the GEF Operational Programs is to facilitate learning within the portfolio. This study finds that cross learning is slow and has not happened effectively until more recently. While the annual Project Implementation Reviews do provide a forum for learning, the first concerted effort in the climate change portfolio was the Solar PV cluster review completed in 2000.
- (b) *Indirect influences and impacts are key GEF results.* Some of the key impacts of GEF-financed projects are indirect in the sense that they are not explicit objectives of projects. Also, in many cases, significant impacts from projects have been recorded during project preparation (PDF) phases or early in implementation.
- (c) *Replication of project results is not well planned and monitored.* In general, the portfolio is still too immature to gauge how well replication is providing global environmental benefits.
- (d) *Project risk assessment and management needs to be strengthened.* Project implementation is often hindered by the inability to adjust to changes in the market, policy, macroeconomic conditions, cofinancing and government commitment.
- (e) *Technological know-how transfer is more difficult* than projects anticipate given problems with technology acquisition and application to domestic conditions.
- (f) *Long-term programmatic approaches require sufficient GEF “credibility” and experience in a country.* It takes time to accumulate experience with a set of GEF-financed projects before a wide range of country stakeholders can develop a program embracing the principles of GEF operational programs.
- (g) *The GEF’s potential for influencing policy needs to be better utilized.* While influence of GEF projects can be seen in three main areas – national codes and standards, electric power sector policies, and rural electrification policies --, the impacts achieved to date are modest.

- (h) *Impacts on social benefits and poverty alleviation need to be assessed.* Though there is a fair amount of evidence of beneficiary participation in projects, especially those that cater to rural energy development needs, these experiences need to be documented and systematically integrated into country sustainable development programs.

Impacts

11. Project impacts are slow in emerging. Only 11 projects in the portfolio are completed, and perhaps another 25-30 ongoing projects have significant recorded impacts. These 35-40 projects have been analyzed for impacts by application cluster:

12. *Energy-efficient products.* GEF-financed projects have demonstrated important and effective approaches for facilitating and accelerating greater demand and supply of energy-efficient manufactured products, particularly for lighting, but also for refrigerators, motors and building materials. The benefits from almost 5 million efficient lights installed through GEF projects are being sustained and replicated on larger scales. Sustained market price reductions are occurring as a result of projects. The carbon abatement impacts from such approaches appear to be highly cost-effective.

13. *Grid-connected renewable energy.* The GEF has facilitated important regulatory frameworks supportive of grid-connected renewable energy, but has done so in only two countries so far (Mauritius and Sri Lanka). Otherwise, one-time demonstrations, research, and broad-based increases in capacities and awareness have characterized impacts so far. The GEF's largest impact has been in India, where direct and indirect influences on private-sector power project development and financing have been very significant and resulted in close to 1000 MW of new renewable energy generating capacity.

14. *Off-grid solar PV.* A small number of installed systems (18,000) relative to the expected number of installations from all projects in the portfolio (600,000) shows that this cluster, the largest single group of projects in the portfolio, is still immature. Still, several promising business and consumer credit models are showing initial success, with good prospects for replication and scale-up, and progress has been made with increased awareness and technical standards in several countries. Impact on rural electrification planning and policies has been modest despite the relative importance of this issue and emphasis placed upon it in more recent projects.

15. *Energy service companies.* Viable energy-service companies 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, which are a new phenomena in developing countries many of which often have commercial conditions that are not suitable or supportive of energy saving applications. With the exceptions of China and Hungary, no replication or energy-savings impacts have been documented. Prospects for replication and sustainability appear strongest in the China project, which is also pioneering the resolution of key policy and legal issues needed for a growing ESCO industry. Several

of the projects appear to be increasing the familiarity and acceptance of ESCO approaches among industrial clients, policy-makers and financiers.

16. *Other applications.* A collection of other applications, from coal-bed methane, gas pipeline leakage repair, fuel switching, decentralized wind power, demand-side management, village-scale mini-grids, and district heating efficiency improvements, have all shown significant impacts that could be replicated on larger scales and used to inform 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 resulting in replication.

Sustainability

17. A number of examples of factors that influence sustainability, both positively and negatively, can be seen through the climate program study. Some examples of positive influences on sustainability:
- (a) Demonstration of sustainable business models, whether that business is public, private, utility, or even permanently subsidized, is key to achieving project sustainability.
 - (b) “Market transformation” approaches, whereby viable markets have been developed for energy efficient products.
 - (c) Voluntary agreements with the private sector in weeding out inefficient products out of the market.
 - (d) Establishment or precedents of new legal frameworks for establishment of ESCO businesses.
18. A number of examples illustrate factors that can negatively influence sustainability:
- (a) Privatization of power utilities without consideration of the future existence and role of demand-side management units.
 - (b) Short-term power-purchase tariffs for grid-based renewable energy, holding it hostage to fluctuations in conventional fuel prices.
 - (c) Consumer finance and rural business dependence on project resources, without creating viable and sustainable commercial sources.
 - (d) Project implementation arrangements that do not demonstrate business models, but fall into an “equipment installation and demonstration” role.

I RELEVANCE OF GEF-FINANCED PROJECTS TO COUNTRY NEEDS AND GLOBAL OBJECTIVES

1. The question of whether activities across the entire GEF portfolio are relevant to client country needs is a very complex one. Such an assessment would require explanation of where countries were prior to GEF, what baselines might have been, and where countries are now. Such data are often lacking or difficult to obtain. Further the national communications do not always fully reflect national development priorities. In the end, the climate program study is only able to address this question based on the three specific country reviews for China, India, and Mexico.

2. 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 climate change convention, the GEF operational strategy and operational programs were developed to respond to guidance from the convention. The scope of activities eligible under the operational programs actually increased or expanded from the pilot phase to the restructured GEF. The GEF interpretation has been judged to be flexible, and rarely have sensible proposals in the renewables or energy saving areas proposed by countries been rejected. As such, existing projects under the operational programs cover a very diverse set of technologies, applications and sectors. Of course, it is difficult to make a judgment on those proposals that never were presented to the GEF because of decisions made by governments or GEF implementing agencies.

3. Portfolio coverage ranks well on two key priorities of developing countries—technology transfer and capacity building. Most climate change projects have a high degree of technology content directed towards technology understanding, awareness, diffusion, adaptation, know-how transfer, and/or domestic manufacturing appropriate to recipient countries. In some cases, as in the projects to introduce CFLs, the technology has been locally adapted and manufacturing capacities established or further supported. In others, 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. Also, most projects during their implementation seem to have enhanced local capacity. There are many examples in the portfolio where projects have trained local technicians, developed financing and institutional capacity, and/or supported regulatory or legal development, all setting the stage for project replication.

4. The evolution of the portfolio has left no obvious and undue over-concentration of any technology application in Operational Program 5 (Removal of Barriers to Energy Efficiency and Energy Conservation). However, this is not true for Operational Program 6 (Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs). A significant share of projects in the OP6 portfolio focus on solar home systems for off-grid applications. These projects are directed towards rural populations and meet rural electrification objectives. Although projects need to continue to improve approaches to handle the questions of affordability and sustainability, they have demonstrated the viability of using renewables as a plank in rural electrification. However, linkages between rural electrification strategies and rural development needs related to health, education, water, sanitation and employment have yet to be systematically incorporated in project designs. Although no

income-generation or other social benefits have yet been surveyed or recorded in the portfolio of rural solar PV projects, such impacts are known to be occurring and need to be the subject of more focused future review

5. Under Operational Program 7 (Reducing the Long-term Costs of Low Greenhouse Gas-Emitting Energy Technologies) , four solar thermal power plant projects are proceeding under the original philosophy of OP7—that sequential support of multiple projects would catalyze cost reduction from economies of scale and learning-by-doing—although the sequential concept for these four projects remains in question, since in practice they may all occur at the same time. Most technologies envisioned under this program are now represented by at least one project under implementation or in the pipeline, with the exception of stationary fuel cells.

II SIGNIFICANT IMPLEMENTATION ISSUES AND LESSONS

6. Eight significant lessons emerging from the climate change program study are highlighted here. While some of these lessons are country-specific, most are applicable across the portfolio and hence provide an opportunity for the GEF to fertilize cross-learning.

1. Lessons and good practices are emerging but need to be better incorporated to promote cross-learning.

7. The available lessons from early projects are just emerging as a body of knowledge with which to inform current and future project designs. The exceptions are projects that directly follow prior projects. For example the Efficient Lighting Initiative employed lessons from prior efficient lighting projects in the portfolio, the China TVE Phase II built upon 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 in the past few years are beginning to note experience from some of the early solar PV projects in the portfolio, particularly with the completion of the solar PV portfolio review by the GEF Secretariat in 2000. Annual Project Implementation Reviews do provide a forum for learning, even if the level of information available is often not enough to provide in-depth understanding of project performance.

8. There is considerable opportunity and need for the GEF to facilitate cross-learning within the cluster of solar thermal projects. The four projects in the cluster – projects approved by the Council in India, Morocco, and Mexico, and project financing approved for a fourth project in Egypt – account for about \$150 million of GEF resources and are expected to install 137 MW of solar components. The solar thermal thematic review suggests that the GEF would benefit from much greater efforts to facilitate cross-learning between the four projects.

2. Indirect influences and impacts are key GEF results, and influences can begin even before project implementation

9. Many GEF-finance projects have resulted in indirect influences and impacts. These influences were not explicit objectives of projects, but represent important results of GEF support. In addition, significant impacts from GEF projects can occur during project preparation (PDF) phases or early in implementation, even before any hardware is installed. One explanation for this phenomenon is that the GEF commitment of funds itself, as well as the visibility, dialogues, training, priority-setting, and institutional coordination that typically occur during project preparation result in increased awareness and confidence in technologies by a variety of stakeholders, including policy-makers, financial institutions, firms, utilities, other investors, and NGOs. Increased awareness and confidence may lead to investment decisions or policy actions in parallel with the GEF project. Some examples:

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

11. *Mexico Efficient Lighting*. The positive experience by the Mexican utility CFE with the original 1991-97 GEF project led it to run an ambitious follow-on program. From 1998-2000, the new program sold 4.8 million CFLs all over the country. 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 indicated that their experience with the GEF project played an important role in the design of subsequent nationwide energy saving programs

12. *Sri Lanka Energy Services Delivery*. The business climate for rural PV sales and supporting infrastructure, developed in part through this 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 nation-wide department store in Sri Lanka to enter the solar PV business.

13. *Costa Rica Wind Power* helped influence and support the emergence of a significant private sector wind power industry due to the government's decision to re-engage in the power supply business. Although the planned government-owned 20 MW demonstration windfarm has not yet been installed, the GEF-supported project did promote a renewed dialogue with private developers and helped put in place an appropriate regulatory framework that resulted in more than 50 MW of operational privately-financed wind-farms.

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

15. *China Efficient Refrigerators*. This project developed and helped enact new national refrigerator standards during the PDF phase. Chinese refrigerator manufacturers, influenced by project preparatory activities, began to expect a much larger market for efficient refrigerators and began to develop high-efficiency prototypes and production models even before the project started.

16. *China Efficient Lighting*. Other countries in Asia are launching projects to emulate this project, even before the GEF phase starts implementation. An earlier UNDP project done in collaboration with other donors, together with the expected GEF-supported project, are providing a base of experience and confidence for these other countries.

17. *Mexico Renewable Energy in Agriculture*. Preparation activities, studies, dialogues and GEF commitment associated with this project had impacts before that project began implementation. These activities, together with enhanced capacities fostered through GEF-supported enabling activities, assisted the Mexican government in redesigning its rural development plans to focus more on renewable energy rather than costly grid extensions. The approach was first tried in a few municipalities and is now being scaled up to 28 states and potentially more than half a million farms.

18. *Malawi Renewable Energy*. The success of pilot microcredit and community banking approaches in rural areas of Malawi, with primarily women as clients, has been scaled up to more widespread application because of the GEF renewable energy project there, even before the GEF project started. Facilitated by the GEF project, the Malawi government has incorporated the microcredit and community banking approaches into its energy and sustainable development program.

19. *Solar Thermal Power Plant* projects approved by the GEF for India, Morocco, Mexico and Egypt have lent credibility to the technology, created fresh interest 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.

3. Replication of project results is not well planned or monitored

20. Replication has occurred following some projects. A good example was noted above for Mexico, where the utility has subsequently replicated the GEF project on a larger scale after the GEF project completed. Another example is the China coal-bed methane project, which led to replication through a newly established intermediary institution. 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, even in early implementation, has spawned parallel efforts that could be considered a form of replication. And the Hungary Energy Efficiency Co-financing Program (HEECP) has contributed to additional parallel financing of energy efficiency investments by Hungarian commercial banks.

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

22. Replication of GEF project designs have taken place repeatedly, for example with recent solar home systems projects replicating earlier project designs. But this replication been at the design level, not in terms of replicating successful on-the-ground experience.

23. In general, the portfolio is still too immature to gauge how well replication is providing global environmental benefits. Replication has tended to happen unpredictably rather than through specific planned activities within projects. And it is highly likely that many other instances of replication have occurred, but remain undocumented because they have not been well monitored.

4. Project risk assessment and management need to be strengthened

24. The need to recognize, in project design and implementation, the state of energy efficiency markets, macroeconomic conditions, and education of users are important lessons from the Peru, Tunisia and Chile energy efficiency projects. 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. However, no agreements were ever completed, partly because client companies did not understand the ESCO concept and insufficient efforts were made to promote such understanding. The economic recession and changes in government also contributed to energy saving projects having a lower priority generally in Peru. Finally, companies unexpectedly could not meet the financial guarantees demanded by banks as part of a financing mechanism under the project.

25. 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. However, the local Tunisian ESCO has been successful in marketing its services under contractual arrangements that do not rely on performance contracts. And in Chile, electric power restructuring led to decreased bulk power tariffs to the copper mines, which along with higher profits from increasing world prices for copper, left these mines with less interest and incentive to invest in energy efficiency. Planned investments under the Chile project never happened.

26. For solar home systems projects, the selection of suitable consumer credit schemes has greatly affected project progress. The Sri Lanka project started with dealer-supplied credit but soon switched to microfinance as more viable, in part because of the long-established history and tradition of microfinance institutions in that country. The Indonesia solar home systems project ceased implementation during that country's macroeconomic crisis, partly 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 profitability of the venture (and thus its sustainability) into question.

27. For grid-connected renewable energy projects, institutional conditions have played major roles in project progress. 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, and almost all of that investment will be cancelled.

28. A few examples can be seen so far where 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 a number of years. This issue should be tracked carefully in the future to gauge how significant it is across the portfolio.

29. While it might be difficult to design a project to exactly fit the market, macroeconomic, and policy conditions, adjustment during project implementation can go a long way towards enhancing project performance. Even if the projects have been designed taking initial conditions into account, their flexibility during implementation to respond to changing conditions is important. Given that there are only a few examples of projects that 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.

5. Technological know-how transfer is more difficult than projects anticipate

30. Two China projects for efficient boilers and efficient refrigerators provide direct support to manufacturers to acquire 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 conditions (i.e., necessity to burn raw coal). The project did acquire one license for a new technology package for one Chinese manufacturer by allocating 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 study tours for China manufacturers to visit foreign manufacturers were refused by the foreign manufacturers because of market competition concerns. Instead, Chinese manufacturers are having to rely on foreign academic

and research institutions during study tours, which do not adequately convey the most practical technological and commercial know-how that manufacturers want.

6. Long-term programmatic approaches require sufficient GEF “credibility” and experience in a country

31. The China country review highlights the challenges of programmatic assistance frameworks and the need for sufficient credibility by the GEF. Two programmatic assistance frameworks have been under development in China, one for energy efficiency and one for renewable energy. But even as late as 1996, the credibility and awareness of the GEF in China was relatively low and such frameworks would not have been possible, the review found. A few projects had been approved, some were under development, but little experience had accumulated. But now, there is a solid base of projects under implementation, Chinese stakeholders have embraced the principles of the GEF operational programs, and the GEF has gained credibility among officials and industry. Given this situation, the GEF and China have recently been able to agree on development of long-term programmatic approaches to energy efficiency and renewable energy, currently under development by the UNDP and World Bank.

7. The GEF’s potential for influencing policy need to be better utilized.

32. Influence of GEF projects on policy development can be seen in three main areas so far: (i) national codes and standards; (ii) electric power sector policies; and (iii) rural electrification policies. However, impacts achieved to-date are modest in all three areas except in a handful of projects. Yet the projects that have had policy impacts suggest that the GEF potential to facilitate appropriate policies is 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 in at least two projects—Argentina and Sri Lanka. When asked what was the most important influence of the GEF in China (for both existing and new projects), a Chinese government official ranked policy influence in first place.

8. Little information is available about impacts on social benefits and poverty alleviation

33. There is a fair amount of evidence of beneficiary participation in projects, especially those that cater to rural energy development needs, particularly the off-grid renewable cluster of projects, but these experiences need to be documented and systematically integrated into country sustainable development programs. More than three-quarters of GEF-support off-grid projects are implemented through multi-stakeholder steering or advisory committees. Aside from representatives from the private sector, non-governmental organizations and consumer groups are also included in these committees.

34. Despite the high degree of participation, more work is required in evaluating project impacts on-the-ground, specifically, how these projects have benefited communities in terms of increasing incomes and employment and expanding social services. Such effects can be expected from the portfolio as it matures, but have not been measured yet. Two emerging patterns are expected: (a) the integration of renewable energy with redefinitions of sustainable development and poverty alleviation programs; and (b) value-added alternatives to traditional delivery and financing models, including microfinance and community-based enterprises.

35. An example of redefinition of sustainable development programs is Mexico, where the government redesigned its rural development plan from grid-connected rural electrification to solar- and wind- powered systems. Another example is Malawi, where the government has integrated microcredit and community banking approaches being applied in the GEF-supported renewable energy project into its energy and sustainable development program. An example of value-added approaches is 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. Another example is the Bolivia project, which sets up a revolving fund to support small enterprises in 23 municipalities..

III IMPACTS/LIKELY IMPACTS OF GEF PROJECTS

36. There are about 32 projects in the current portfolio of OP5/6/7 projects for which significant documented impacts can be found, either in PPRs, country visits, thematic reviews, agency reports, or informal communications. In addition, impacts from 3 energy-related short-term response measures have been documented. Of these 35 total projects, 11 are formally completed. This section summarizes the prominent impacts from projects in the four thematic clusters reviewed, plus samples of impacts from other projects outside of these four clusters. This section does not discuss likely impacts of other, less mature, projects in the portfolio. A recent M&E working paper (Measuring Results from Climate Change Programs: Performance Indicators for GEF, Monitoring and Evaluation Working Paper 4, September 2000) suggested that impacts should be organized by cluster, and discussed according to seven indicator types. The discussion below follows these suggestions.

Efficient Products Cluster

Projects with impacts (year of Council approval, 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	

37. *Summary:* GEF-financed projects have demonstrated important and effective approaches for facilitating and accelerating greater demand and supply of energy-efficient manufactured products, particularly for lighting, but also for refrigerators, motors and building materials. The benefits from almost 5 million efficient lights installed through GEF projects are being sustained and replicated on larger scales. Sustained market price reductions are occurring as a result of projects. The carbon abatement impacts from such approaches, through sustainability and replication, appear to be highly cost-effective.

38. *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 1000 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 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% more efficient.

39. *Costs per technology unit or measure installed.* The most visible price-reduction effects in 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%; in fact, one of the project's key influences 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 project completion, average CFL prices have declined further, by up to 30%, and the project is credited with accelerating price reductions that would have happened more slowly otherwise.

40. *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. Many signs point to the capabilities of this office, including successful negotiation of voluntary T-12 to T-8 lamp changeover, bulk procurement of CFLs and distribution through convenience stores nationwide, and campaigns to promote public awareness of energy efficiency and conservation, appliance energy labels, and dissemination of classroom educational materials. The experience that the Mexican utility CFE gained during the Mexico project has allowed it to proceed with further DSM programs without GEF support, including plans for selling 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 provided 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-up effects. The Mexico project introduced to Mexico two new mechanisms for consumer financing of CFLs: (i) pay-on-the-bill financing, where the price of the lamp is deducted by installments off of a customer's electricity bill; and (ii) a similar procedure managed by employers, in which an employee's investment in CFLs is made through paycheck deductions. Both of these Mexican financing approaches continue to be used after the close of the project.

41. *Policy development.* Policy development in at least three projects has focused on national codes and standards for efficient equipment. In Mexico project, the development of national CFL quality standards began in the early stages of project development, and were launched and enforced during the project. Since then, 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 standards for refrigerators were enacted.

42. *Awareness and understanding of technologies.* The Poland project has produced the most data of any project* on changes in awareness and understanding of technologies, in this case of compact fluorescent lamps (CFLs). CFL penetration increased from one in ten Polish households owning at least one CFL prior to PELP, to one in three, a year after the program. About 97% of CFL purchasers surveyed intended to replace their CFLs with another one upon burn out. After PELP, CFLs were sold by a larger number of shops, and in a wider variety of shops (ranging from small shops to hypermarkets), than before the program, and shops carried a wider variety of 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 resulted in 87% of Thais aware of energy efficiency issues, and particularly on the advantages of energy efficient lighting, refrigerators, and air-conditioners.

43. *Energy consumption, fuel-use patterns, and impacts on end-users.* Impacts on energy-consumption patterns can be seen through changes in market shares associated with a few projects in this cluster. The Poland project resulted in an increase in the number of households with CFLs from 11.5% to 19.6%. 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% in 1996 to 38% in 1998, and a refrigerator program transformed the single-door refrigerator market, increasing the market share of the most efficient units from 12% in 1995 to 96% in 1998. One of the most notable achievements of that project was the complete transformation of the fluorescent-light market,

* The Poland Efficient Lighting Project had a very comprehensive monitoring and evaluation program that was designed along with the project and implemented very effectively.

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% more efficient.

Grid-Connected Renewable Energy Cluster

Projects with impacts (year of Council approval, 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 Project I	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	

44. *Summary:* The GEF has facilitated important regulatory frameworks supportive of grid-connected renewable energy, but has done so in only two countries so far (Mauritius and Sri Lanka). Otherwise, one-time demonstrations, research, and broad-based increases in capacities and awareness have characterized impacts so far. The GEF's largest impact has been in India, where direct and indirect influences on private-sector power project development and financing have been very significant and resulted in close to 1000 MW of new renewable energy generating capacity.

45. *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 50 MW of private finance and operated wind farms.. The Philippines project expanded the capacity of an existing geothermal facility and transmission system to influence an increment 390 MW of geothermal. 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, with other subprojects nearing completion, including a 1-MW power plant based on biogas from a sugar factory.

46. *Business and supporting services development.* Business development has been fostered by facilitating conditions for independent power producers in Mauritius, Sri Lanka, Costa Rica, and India. For example, the India Small Hydel project has resulted in supporting services for small hydro business

development. Capacity-building activities have trained more than 50 officials in small hydro power planning, design, construction, management, and maintenance. Local ownership and management models are being tested at three of the demonstration sites. An “Alternate Hydro Energy Center” has strengthened its ability for testing equipment and training 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. Renewable energy business associations have been fostered in Sri Lanka and China; 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.

47. *Financing availability and mechanisms.* Projects in Costa Rica, Sri Lanka, and India (Small Hydel, 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, which was a key project goal. Other impacts on financing availability from other projects have not been documented.

48. *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 IPPs, including standardized “non-negotiable” power-purchase tariffs and contracts (PPAs). This project provided enough incentive for the national utility to adopt IPP frameworks and agree to PPAs, which together with demonstration effects 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 independent-power-producer (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.”

49. *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. One example of broad-based capacity and awareness building is the India biomethanation project, which has resulted in increased awareness and knowledge about biomethanation technologies in India. Representatives from 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 a number of conferences and workshops to share experiences with biomethanation. Costa Rica is another example where greater awareness has helped to foster government decisions that allowed greater private-sector investments in wind farms.

Off-Grid Solar PV Cluster

Projects with impacts (year of Council approval, 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	

50. *Summary:* A small number of installed systems (18,000) relative to the expected number of installations from all projects in the portfolio (600,000) shows that this cluster, the largest single group of projects in the portfolio, is still immature. Still, several promising business and consumer credit models are showing initial success, with good prospects for replication and scale-up, and progress has been made with increased awareness and technical standards in several countries. Impact on rural electrification planning and policies has been modest, despite the relative importance of this issue and emphasis placed upon it in more recent projects.

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

52. *Costs per technology unit or measure installed.* Very little data is available from solar PV projects on how or whether costs have declined during the project. Reports from the Zimbabwe project stated that market prices declined, partly through elimination of import duties on imported components. Data from other projects indicates current prices for systems being sold, but not the changes in prices over time. Reduced import duties for PV system components have been influenced in at least two projects: in Zimbabwe import duties were reduced from 40% to zero and in Sri Lanka duties were reduced from 30% to 10%.

53. *Business and supporting services development.* Impacts on business and supporting services development are prominent so far in five of the solar home systems projects. The technical and business capabilities of individual dealers have been enhanced for dealers in Zimbabwe (some tens of dealers), Sri Lanka (3 primary dealers), Bangladesh (1 dealer), Vietnam (1 dealer), and the Dominican Republic (1 dealer). 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 also reflect demonstrations that can spur business development patterned after successful models. For example, the Dominican Republic project helped a dealer to develop a promising fee-for-service business model that targets up to 50% of the population in the rural communities it serves and charges \$10 to \$20 per month for electricity service. Through continuing improvement to the business model, the dealer is approaching a "proof of concept" at a scale of 5000 fee-for-service customers. Such a model could be replicated elsewhere by other firms.

54. *Financing availability and mechanisms.* Consumer credit for rural households to purchase solar home systems has been a central feature of many of GEF project designs. Three projects so far have provided actual demonstrations of credit delivery models (although many more projects are designed to demonstrate a variety of credit models as they progress). The Zimbabwe project provided consumer credit by 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, and embodies a long tradition of micro-finance in Sri Lanka.

55. *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 consumer demand and solar insolation characteristics. Later, in both Indonesia and Sri Lanka, minimum requirements were further reduced due to consumer demand for a variety of systems, and because some dealers still had trouble meeting the standards. Rural electrification policies and planning by governments have been influenced by at least two GEF projects so far: (a) 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 (b) the Argentina project has resulted in the government taking a stronger policy towards supporting rural energy service concessions.

56. *Awareness and understanding of technologies.* Several solar home systems projects have conducted activities to increase awareness of end-users about the technologies and benefits, but the impacts of these activities have not been directly measured. For example, the Sri Lanka project

conducted village-level workshops throughout the country to promote solar home systems. In these workshops, dealers are able to 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. The Mexico project conducted a first series of training courses in 7 states for promotion and information to farmers and state and local authorities, resulting in 180 qualified people.

57. *Energy consumption, fuel-use patterns, and impacts on end-users.* No data is available so far on the amounts of fuel that are displaced by solar home systems in GEF projects, nor on the impacts on end users in terms of social benefits and income-generation effects. In general, project M&E plans have not addressed these issues.

Energy Service Company (ESCO) Cluster

Projects with impacts (year of Council approval, year completed)

Peru TA for Energy Efficiency	UNDP	1991	1995
Tunisia ESCO (SME)	IFC	1994	
Hungary Energy Efficiency Co-financing program (HEECP)	IFC	1996	
China Energy Conservation	World Bank	1997	
Egypt and Palestinian Authority Energy Efficiency	UNDP	1997	

58. *Summary:* The ESCO cluster review documents that viable energy-service companies have been established in two countries (Tunisia and China) as a result of GEF projects. Financing for existing ESCOs has been facilitated through commercial financial intermediation 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, which are a new phenomena in developing countries and still inappropriate to commercial conditions found in most countries. With the exceptions of China and Hungary, no replication or energy-savings impacts have been documented. Prospects for replication and sustainability appear strongest in the China project, which is also pioneering the resolution of key policy and legal issues needed for an ESCO industry. Several of the projects appear to be increasing the familiarity and acceptance of ESCO approaches among industrial clients, policy-makers and financiers.

59. *Energy production or savings and installed capacities.* Few energy savings impacts have been quantified for 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 to 2.2 Mt carbon emissions reduction.

60. *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 are

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, as more than 80 potential ESCOs have expressed interest in participating in a second phase of the project more than ten additional ESCOs have already started 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 so far undertaken one investment project. The Egypt project has supported 70 industrial audits, with 12 sites currently employing the audit results to implement a number of energy saving measures. The Egypt project has not yet resulted in the development of a commercial ESCO model, although other developments in Egypt, including an operating ESCO funded through the IFC/GEF SME program, suggest that commercial ESCO models can be viable.

61. *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 the 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 good foundations 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

Projects with impacts (year of Council approval, 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	1996	

62. *Summary:* a collection of other applications, from coal-bed methane, gas pipeline leakage repair, fuel switching, decentralized wind power, demand-side management, village-scale mini-grids, and district heating efficiency improvements, have all shown significant impacts that could be replicated on larger scales and used to inform 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 resulting in replication.

63. *Sri Lanka Energy Services* influenced development of 80 village-scale mini-grids using small hydro serving about 3500 people (using 500 kW total capacity). Seven of these schemes were financed directly through the GEF project (totaling 70-100 kW capacity), while the remaining ones have been financed by international donors and local government.

64. *China Sichuan Gas* made a substantial contribution to increasing gas reserves and gas production capacity in Sichuan province, as well as 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 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 went from 3.6% in 1996 (the first time leakage had ever been monitored) to 1.5% in 1998.

65. *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. The project demonstrated at three sites a number of techniques and technologies that Chinese coal mines can employ to reduce atmospheric methane emissions and recover methane as a fuel, and held training workshops at these sites. The project published a detailed assessment of China's coal-bed methane

resources and strengthened national 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 completed.

66. *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.

67. *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 with many boiler conversions taking place using Polish government and private financing. The project helped contribute to a greater awareness and priority within the government 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.

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

IV FACTORS INFLUENCING SUSTAINABILITY AND REPLICATION

69. A number of examples of factors that influence sustainability, both positively and negatively, can be seen through the climate program study. A more complete synthesis and ongoing cataloguing of such factors will be needed in the future. Given the early development of the portfolio and limited examples of replication so far, a discussion of the factors influencing replication is premature; rather, the lesson on "indirect impacts and influences" under Question #2 above addresses replication.

70. Some examples of positive influences on sustainability:

- (a) *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 thematic review. While no projects have yet to conclusively demonstrate sustainable business models, two projects appear close. In Sri Lanka, a partnership between solar home systems dealers 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.
- (b) *“Market transformation” approaches.* The market changes brought about by *Poland Efficient Lighting* have been sustainable. Two years after the close of the program, the market changes resulting from the project were still in place. Retail prices of CFLs in Poland decreased by 34% 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 where 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 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 efficient products, which suggests that the gains from the market transformation programs are not likely to be reversed.
- (c) *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% market share, and by the end of 1995, the efficient lamps had achieved a 100% market share.
- (d) *Establishment or precedents of new legal frameworks.* The ability of projects to foster new legal frameworks, whose development might not have been possible in the absence of the project (i.e., no need for lawmakers or administrators to consider the legal issues raised by projects), is an important element of sustainability. For example, the value of the China *Energy Efficiency* project 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 precedent for the legal accounting status of ESCOs in China. Such 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 warrant government scrutiny. Second, 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 greater confidence in applying the performance contracting models, in establishing business plans, and in understanding the legal and tax implications of performance contracting.

71. A number of examples illustrate factors that can negatively influence sustainability:

- (a) *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 the project, is uncertain in the face of EGAT's planned privatization. Thus despite impressive achievements under the project, the main innovation piloted by the project—the publicly-supported DSMO office itself—may not be sustainable.
- (b) *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. However, because of the downturn in oil prices in 1998-99, 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” said a project status report in 2000.
- (c) *Consumer finance and rural business dependence on project resources.* The *Zimbabwe Solar Home Systems* project resulted in a greatly expanded network of private dealers and 10,000 systems sold, but there are questions about how the consumer credit will be sustained after the Agricultural Finance Corporation revolving fund winds down. This fund is depleted, partly because of concessional terms and partly 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, some of these businesses have been unable to operate on their own and have closed.

- (d) *Project implementation arrangements that do not demonstrate business models.* The Ghana project was originally designed to demonstrate a business model in which the national utility would provide fee-for-service to rural households using solar home systems (see Annex 2). At the conclusion of the project, the costs, service, cash flow and management of these installations could be assessed in terms of the viability of this model from the utility's perspective. The demonstration of this business model could also be used to convince other private companies to enter the market, which is an explicit project objective. But project implementation responsibility was transferred to a "project" established under the Ministry of Mines and Energy early in the project implementation. Although this office may succeed in installing and servicing a given number of systems, given that it is under a government ministry subject to its rules and regulations, demonstrating and judging business viability in a transparent commercial manner is bound to be difficult, meaning that sustainability is seriously called into question.

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