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EVALUATION

Climate Change Mitigation

GEF Support to Market Change in China, India, Mexico, and Russia

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GLOBAL ENVIRONMENT FACILITY

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INDEPENDENT EVALUATION OFFICE

Impact Evaluation on Climate Change Mitigation

GEF Support to Market Change in China, India, Mexico, and Russia

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Cover photo: Many GEF projects, including the Ilumex project in Mexico, have phased out inefficient incandescent bulbs like these; by Anil Bruce Sookdeo

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Foreword

Climate change is probably the most important challenge that the world faces today. Given its enormity, it is not only important that the global community devote adequate resources to address the challenge, but also that it learn from the experience so far and improve its approach to address it.

Since its inception in 1991, the Global Environment Facility (GEF) has provided support for climate change mitigation; since 2001, it has also provided support for climate change adaptation. Given the long-standing and deep commitment of the GEF to addressing climate change–related concerns, it is important to assess the impacts of the supported activities and distill lessons from the experience. The GEF Independent Evaluation Office undertook the Impact Evaluation of Climate Change Mitigation: GEF Support to Market Change in China, India, Mexico, and Russia to meet these ends. While this evaluation does not cover the fully diversity of countries that have received GEF support, the four countries it does cover account for 40 percent of the global population and more than a third of global greenhouse gas emissions.

The fieldwork for this evaluation was undertaken during the period from August 2012 to January 2013. The evaluation found that projects that tended to demonstrate a high level of progress toward impact had adopted a comprehensive approach to addressing market barriers. It also found that recipient countries play a key role in sustaining and building on project results.

The findings of the evaluation were presented as part of the Office's *Annual Report on Impact* during the meeting of the GEF Council in November 2013. Based on the evaluation's conclusions and recommendations, the Council asked the Secretariat to ensure that GEF-supported climate change mitigation projects adequately address the critical barriers that impede the targeted market change. It also requested the GEF Secretariat, in collaboration with the GEF's Scientific and Technical Advisory Panel, to improve greenhouse gas emissions reduction calculation methodologies.

The GEF Secretariat has already started taking action on the Council decisions. It has established a working group to propose improvements in the methodologies. While the report has been useful across the GEF partnership, we hope it will also be useful for others as well.

The evaluation was conducted and completed when Rob D. van den Berg was Director of the GEF Independent Evaluation Office. Final responsibility for this report remains firmly with the Office.

Juha Uitto
Director, GEF Independent Evaluation Office

Acknowledgments

The Impact Evaluation of Climate Change Mitigation: GEF Support to Market Change in China, India, Mexico, and Russia was jointly led by Aaron Zazueta, Chief Evaluation Officer at the Global Environment Facility's (GEF's) Independent Evaluation Office; and Neeraj Kumar Negi, Senior Evaluation Officer. In addition, Christine Woerlen, Consultant, was part of the core team of the evaluation. This report was prepared jointly by these three.

The evaluation draws from data on sampled projects gathered from the field. Field verification was carried out by the following consultants: Bjorn Conrad in China; Shankar Haldar and P. R. K. Sobhan Babu, InsPIRE Network for Environment, in India; Odon de Buen Rodriguez in Mexico; and Christine Woerlen in the Russian Federation.

Xueying Wang, Consultant, provided research assistance. Evelyn Chihuguyu, Program Assistant at the GEF Independent Evaluation Office, provided administrative support. Ruben Sardon coordinated the publication process. Nita Congress edited and designed the publication.

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Abbreviations

CBM	coal bed methane capture and commercial utilization
CCM	climate change mitigation
CDM	Clean Development Mechanism
CFE	Comisión Federal de Electricidad
CFL	compact fluorescent lamp
CO_2eq	carbon dioxide equivalent
FCB	fuel cell bus
FIRCO	Trust Fund for Shared Risk (Fideicomiso de Riesgo Compartido)
GEF	Global Environment Facility
GHG	greenhouse gas
IBRD	International Bank for Reconstruction and Development
IREDA	Indian Renewable Energy Development Agency Ltd.
OECD	Organisation for Economic Co-operation and Development
PV	photovoltaic
PVMTI	Photovoltaic Market Transformation Initiative
RED	renewable energy development
RESP	Renewable Energy Scale-up Program
TVE	township and village enterprises

All dollar amounts are U.S. dollars unless otherwise indicated.

1. Background, Conclusions, and Recommendations

1.1 Background

Through its climate change focal area projects, the Global Environment Facility (GEF) supports efforts to reduce greenhouse gas (GHG) emissions of developing countries and countries with economies in transition. Among these countries, the major emerging market economies—which account for 40 percent of the global population—are especially important in terms of their climate change mitigation (CCM) potential. Most show an increasing trend in emissions and have received a large share of GEF funding in the past.

The Climate Change Mitigation Impact Evaluation undertaken by the GEF Independent Evaluation Office focuses on the impact of completed GEF energy-related mitigation projects in four large emerging markets: China, India, Mexico, and the Russian Federation. More specifically, the impact evaluation looked at the following key questions:

- What have been the GEF contributions to GHG emissions reduction and avoidance?
- What has been the progress made by GEF-supported activities toward transforming markets for CCM?
- What are the impact pathways and factors affecting further progress toward market transformation?

This evaluation covers 18 completed GEF CCM projects in China, India, Mexico, and Russia; these are listed in annex A in table A.1 and consist of all relevant projects in India, Mexico, and Russia and a selection of completed projects in China. The implementation start dates of the projects covered range from 1992 to 2007, with completion dates spanning 1997–2012. The projects cover various sectors with opportunities for renewable energy, energy efficiency, and methane emissions reductions (table 1.1).

TABLE 1.1 Number of Projects Included in the Evaluation by Country and Technology/Market Coverage

Technology/market	China	India	Mexico	Russia
Renewables/wind	2	1	1	0
Renewables/biomass or methane	0	2	1	0
Renewables/solar	2	1	1	0
Renewables/hydro	0	2	0	0
Energy efficiency/industry	1	0	0	0
Energy efficiency/lighting	0	0	1	0
Energy efficiency/buildings	0	0	0	2
Energy efficiency/other	0	1	0	1
Transportation	2	0	1	0
Total projects	5	6	5	2

NOTE: Some projects cover more than one technology.

Of the projects covered by the evaluation, many were approved during the early phases of GEF evolution. Because most of the projects were completed several years ago, they offer an opportunity to observe postcompletion project impacts and the pathways through which these impacts were achieved. Furthermore, because the GEF portfolio of completed CCM projects in these countries—except Russia—covers several sectors and fields of operation, their evaluation provides an opportunity to capture experiences that may be relevant for a wide range of contexts. Extrapolation of the findings beyond the covered emerging markets would require additional triangulation.

The evaluation included desk reviews of completed projects and extensive country work to assess progress toward impact since project completion, as well as to assess the relevant contextual country and global factors affecting the markets under consideration. The fieldwork for the evaluation took place between August 2012 and January 2013.

The conclusions are relevant to the countries included in the review and may also have relevance to other large emerging economies. The evaluation findings are important to the GEF, given the large contributions of emerging economies to GHG emissions.

1.2 Conclusions

CONCLUSION 1: **Sixteen of the 18 projects assessed have resulted in significant direct GHG emissions reductions. Indirect GHG emissions reductions, achieved through causal links from the projects to other activities, are estimated to be multiple times greater than direct emissions reductions but could not be verified.**

Projects had significant **direct GHG emissions reduction impact**. Together, the projects have resulted in annual emissions avoidance of 10.8 Mt of carbon dioxide equivalent (CO_2eq). Relative to the magnitude of the challenge of stabilizing the global atmosphere—and even measured against the overall emissions of the emerging markets—all direct GHG impacts are very small.

Of the 16 projects that did achieve direct GHG emissions reductions, 8 achieved and/or exceeded their targets. For three, no target had been specified at the start of the project. Five fell short of expectations. At the portfolio level, the 18 projects exceeded their combined GHG emissions reduction target by 39 percent: the projects were estimated to have achieved 169 Mt of CO_2 emissions avoidance against a combined specified target of 122 Mt. When the three projects for which targets had not been specified are excluded from the analysis, the extent to which GHG emissions targets were exceeded is marginally reduced to 35 percent.

Four projects dominated in terms of making significant contributions to GHG avoidance: the Renewable Energy Scale-up Program (RESP; GEF ID 943) and the Energy Conservation and GHG Emission Reduction in Chinese Township and Village Enterprises (TVE), Phase II (TVE II; GEF ID 622) projects in China, and the Energy Efficiency Project (GEF ID 404) and the Alternate Energy Project (GEF ID 76) in India.[1] Several supporting factors aided these projects in achieving their significant emissions avoidance. For example, the TVE II project was implemented when production in its targeted sector was expanding, thus providing a unique opportunity for GHG emissions avoidance by replacing carbon-intensive processes and inefficient production of construction material in rural areas of China.

The analysis of **indirect GHG emissions reduction impacts**—impacts of activities that have a causal link to project activities but are not part of, or funded by, the project—identified such impacts for 14 projects. The sum of the indirect GHG impacts is about five times the sum of direct

[1] Throughout this report, short names are used for the projects included in the evaluation. These names are provided at first mention; all are listed in table A.1.

impacts. Project design and delineation have a major affect on whether GHG impacts are counted as direct or indirect. For example, in the original project design of China's TVE II project, replications would have been counted as indirect impacts. Through an approved change in the project design (the inclusion of a replication mechanism), these replications were converted into direct impacts, thus reducing the scope for indirect impacts but enlarging the scope for direct.

Indirect impacts were generally the result of two different types of approaches. The first approach is typified by **demonstration projects** that provided opportunities to learn about promoted technologies. Examples of such projects where the efficacy of new technologies was demonstrated are India's Coal Bed Methane Capture and Commercial Utilization project (CBM; GEF ID 325), the Mexico Methane Gas Capture and Use at a Landfill—Demonstration Project (Landfill Gas; GEF ID 784), and Mexico's bus rapid transit project, Introduction of Climate Friendly Measures in Transport (Transport, GEF ID 1155). Some projects—such as the Mexico Efficient Lighting Project (GEF ID 575) or the China TVE II project—were able to transform significant market segments and achieve large-scale impact. Others, such as the India CBM project, did not extend beyond the proof-of-concept stage.

The second approach comprised projects where the GEF helped support an existing national drive for sustainable energy, such as in China's Renewable Energy Development project (RED; GEF ID 446) and its RESP. Although the former approach is riskier, both approaches can achieve large-scale impacts, as long as local conditions are conducive.

The projects show a broad range of GHG impacts at different scales. The determining factors for the ultimate scale of direct GHG impact are the combination of market size and specific mitigation impact of the technology, the project approach, and the country's emission factors. In some cases, project GHG emissions objectives were not achieved because they were assessed to be overly ambitious. Note that lack of a standardized accounting methodology at the time of the approval of these projects to establish targets and measure results made for measurement inconsistencies.

In addition to reducing GHG emissions, the projects have achieved significant positive economic development impacts, job creation, local benefits, and a general awareness of the importance of CCM and energy saving. These benefits have been substantial, although there are indications that some of the projects may also have had disadvantageous effects for some people.

CONCLUSION 2: Broader adoption of technologies, approaches, and strategies tested by GEF projects was observed in 15 cases.

In previous studies, as well as in the GEF generic theory of change, the GEF Independent Evaluation Office has identified five pathways for broader impact of GEF projects—sustaining, mainstreaming, replication, scaling-up, and market change. Of the 18 projects covered in this evaluation, evidence of broader adoption was noted in 15 cases (table 1.2).

Sustaining of the outcomes and benefits of GEF investments was achieved in 14 cases. Sustaining takes place when technologies or approaches originally supported through the GEF continue to be implemented beyond actual project duration through clear budget allocations, implementing structures, and institutional frameworks defined by the government or other project stakeholders. Most projects had technologies or approaches that were sustained. The exceptions were the three projects that were first proofs of concept in a country: Capacity Building to Reduce Key Barriers to Energy Efficiency in Russian Residential Buildings and Heat Supply Based on the Example of the City of Vladimir (Boilers; GEF ID 292) and China's Fuel Cell Buses, Phases I and II (FCB I and II; GEF

TABLE 1.2 **Causal Links of Broader Adoption of GEF Projects and Progress to Impact Ratings**

GEF ID	Short name	Country	Sustaining	Main-streaming	Replication	Scaling-up	Market change	Progress to impact
76	Alternate Energy	India	✔	✔	✔	✔	✔	Significant
112	PVMTI	India	✔	✔	✔	✔	✔	Moderate
292	Boilers	Russia						Low/negligible
325	CBM	India	✔	✔	✔		✔	Significant
370	Biomethanation	India	✔	✔	✔	✔	✔	Significant
386	Hilly Hydel	India	✔	✔	✔	✔	✔	Significant
404	Energy Efficiency	India	✔	✔	✔	✔	✔	Moderate
446	RED	China	✔	✔	✔	✔	✔	High
575	Ilumex	Mexico	✔	✔	✔	✔	✔	High
622	TVE II	China	✔	✔	✔	✔	✔	High
643	Agriculture	Mexico	✔	✔	✔		✔	Moderate
784	Landfill Gas	Mexico	✔	✔		✔	✔	Significant
941	FCB I	China			✔			Unable to assess
943	RESP	China	✔	✔	✔	✔	✔	High
1155	Transport	Mexico	✔	✔	✔	✔	✔	High
1284	Wind	Mexico						Low/negligible
1646	Education	Russia	✔	✔	✔			Moderate
2257	FCB II	China						Unable to assess

ID 941 and GEF ID 2257). However, as the investments in the relevant projects were relatively small compared to the size of the challenge and the size of the emerging markets, the resulting impacts of sustaining them were also relatively small.

Broader adoption through **mainstreaming** was observed in 14 GEF projects. Mainstreaming takes place when information, lessons, or specific results of the GEF are incorporated into broader stakeholder mandates and initiatives such as laws, policies, regulations, or programs. Such mainstreaming may occur not only in governmental organizations but also in nongovernmental organizations and the private sector. As mainstreaming covers a variety of impacts of GEF projects, not all of these dimensions could be quantified in the evaluation, but the variety of activities is discernible. In all 14 of the instances in which mainstreaming was observed, a causal link to the GEF project was established. However, in two instances, there were other factors that also contributed significantly, and the primacy of the GEF project in causing the observed change was difficult to establish.

Capacity building of public institutions has taken place in 13 projects. Among these institutions are non-energy entities that have enhanced their capacities to become knowledge centers for the mitigation option for their specific constituency—for example, the Mexican Agricultural Trust Fund for Shared Risk (Fideicomiso de Riesgo Compartido—FIRCO) and several institutions in India. The private sector has benefited from capacity-building activities in 14 projects.

Replication of the technologies and approaches tested by GEF projects was observed in relation to 14 projects. Replication takes place when GEF-supported initiatives are reproduced or adopted at a comparable administrative or ecological scale, often in another geographical area or region. All projects that ultimately claimed large GHG impacts had replication factored into their project design. Conversely, if replication had been incorporated into the project design, some replication activity did take place during or after the project, once the project effectively executed its core activities. Some projects included an active replication component. Notably, in China's TVE II project, this component was sustained after completion of project implementation, ensuring that the project not only had very large direct GHG emissions reduction impacts but also that it continued promoting industrial energy efficiency after project closure.

In 13 of the 14 instances where replication was observed in targeted markets, it could be linked to the effects of the GEF projects. Causal links were difficult to establish for one project, Cost Effective Energy Efficiency Measures in the Russian Educational Sector (Education; GEF ID 1646). Twelve projects experienced replication through the private sector, including one instance at the local scale. Replication of promoted approaches and technologies in the private sector was supported through national institutions, strategies, or policies. Replication was aided for nine projects through further official development assistance activities (both GEF and non-GEF) or national budgetary support.

Broader adoption through **scaling-up** was observed for 12 projects. Scaling-up occurs when broader adoption includes dimensions that go beyond those initially introduced by the project. Scaling-up includes cases where GEF-supported initiatives are implemented at a larger geographical scale or are expanded to include new aspects or concerns that may be political, economic, administrative, or ecological in nature.

Although scaling-up was observed for 12 projects, it was linked with GEF projects in 11 instances; causal linkage of the GEF-supported project with the observed scaling-up was difficult to establish for Russia's Boilers project. In five instances, the causal links were very strong; for the remainder, there was at least some contribution from the GEF project, although other factors were equally important.

Where causal links could be established, they were often rooted in projects' capacity-building activities (as in India's Alternate Energy project and China's RESP). An interesting avenue for this was capacity building with the private sector, as occurred in India's Optimizing Development of Small Hydel Resources in Hilly Areas project (Hilly Hydel; GEF ID 386) and China's RED project. For three Mexican projects (Ilumex, Landfill Gas, and Transport), replication was identified with significant scale-up effects in other Latin American countries.

The most important supporting factor in substantial broader adoption through scaling-up of technologies was the establishment or development of relevant government policies and technical standards. At least 12 projects led to government policies, including on renewable energy or energy efficiency; for 11 of these, a causal link was established between these changes and the relevant GEF project. The evaluation found that higher levels of scale decreased attribution of causality to GEF projects, as the influence of other factors and actors becomes more prominent.

Broader adoption through **market change** was observed in relation to 13 projects. Market change is an important pathway for broader impact. Its extreme case—market transformation—was observed in one project. The Mexico Ilumex project, initiated in the early 1990s, has significantly contributed to energy-saving compact fluorescent lamps (CFLs) completely replacing the old technology. Incandescent light bulbs are gradually being withdrawn from the market in Mexico, a process that began with the 2011 banning of light bulbs of 100 W or more and the 2012 ban of 75 W bulbs.

Market changes were found in one or more of four tracked dimensions: improved product quality, more and better suppliers, more demand, and long-term cost reduction. Barriers relevant to these four dimensions were also tackled by the projects.

Products and technologies were improved qualitatively in 12 projects. Quality enhancement of local products was observed to assist broader diffusion in several projects, but the adoption of new technologies was difficult in at least three projects when safety concerns could not be mitigated (even for technologies that were used in other geographic contexts, such as autonomous boilers in multistoried buildings). Introducing technical standards, enhancing the number of suppliers and technical capacities in the supply chain, and promoting local production and bulk sales were assisted by global market development for sustainable energy technologies and led to reduced costs.

Other observations of market change related to market stakeholders: that is, suppliers and customers. Seven projects aimed to encourage suppliers and producers that provide hardware or services to consumers of climate-friendly technologies and improve their capabilities. In China's RED and RESP initiatives, a GEF financial incentive was contingent on manufacturing quality, requiring that Chinese manufacturers had to adhere to international standards. The RED project, which focused on strengthening the quality of manufacturing, has contributed to the current situation where Chinese manufacturers export renewable energy equipment to many other countries, including members of the Organisation for Economic Co-operation and Development (OECD).

On the consumer demand side, significant barriers to technology adoption had been identified at the outset, and most projects were able to mitigate these barriers. Ten of the 18 projects were able to increase consumer demand, including projects that received follow-up support through government subsidies—for example, Ilumex and Mexico's Renewable Energy for Agriculture (Agriculture; GEF ID 643). Market transformation in the Ilumex case took more than 15 years. Although most projects were implemented over a very long period of time, none was able to achieve its market change potential or transformation within its implementation period. This finding indicates that market change on the demand side and complete market transformation may take longer to manifest than the implementation period of a GEF project.

Lack of or inadequate financing was one of the major barriers at the outset of 14 projects. New technologies are generally more expensive than existing ones and are not sufficiently established to secure bank loans. Apart from financing demonstration installations in 16 of the 18 projects, 9 included specific financing components, providing subsidies, bank loans, or investment guarantees. Many of these mechanisms—as well as technical assistance and capacity-building support—helped facilitate financing through banks; for example, by helping prepare "bankable" project documents or providing partial loans that reduced the size of the bank loans.

CONCLUSION 3: **Projects demonstrating a high level of progress toward impact are those that have adopted comprehensive approaches to address market barriers and specifically targeted supportive policy frameworks.**

The five projects that demonstrated the highest level of progress toward impact were designed to target multiple pathways to achieve broader adoption and supported several mechanisms to achieve market change.

All projects with a high progress to impact rating have supportive policy frameworks. Broad impact through national-level support policies was observed in many projects. Stated national targets did not suffice to ensure broader adoption of a technology. Of the 12 projects where private sector replication was observed, it was supported by national institutions, strategies, or policies in 8. Of these, in at least six instances, this support was causally linked to the given GEF project. Thus, GEF support was able to trigger changes in the policy environment that subsequently facilitated broader adoption of technologies by the private sector. In some cases in which subsidies were critical, they were continued by the national government after GEF support had ended (e.g., in China's RED and Mexico's Agriculture projects). In some projects, such as China's TVE II, co-evolution of technical standards, market development, and technology development was included, and the project was able to reach significant impact with that strategy. Often, non-energy-specific legislation (such as safety standards, grid regulations, or tariffs) posed a barrier for broader adoption; these were successfully removed in some projects (e.g., Mexico's Landfill Gas project); in other cases, they were responsible for a lack of sustaining of project results (e.g., the Russia Boilers and China FCB I and II projects).

Many projects used local agencies as implementation hubs. In a number of cases, these agencies were able to strengthen their role as local champions and knowledge centers. For example, FIRCO is now recognized as an important source of information on renewable energy in Mexico. The China TVE II project resulted in the creation of a technology advisory service company that continues to provide support to industrial companies in energy efficiency efforts. India's Biomethanation and CBM projects were implemented in collaboration with research and sector-specific institutions that had access to, and good standing with, the industrial enterprises targeted to use the promoted technologies.

Of particular importance for broad impact are the pathways of scaling-up and market change, as these are able to leverage the most pervasive broader impacts. Mainstreaming, when it involves the design of enabling national policies, also proved to be important in broader adoption. Market change has been achieved through working with technology suppliers, improving product quality, and lowering costs. Several markets—or renewable energy and energy-saving technologies—were thus significantly changed. In many cases, the GEF contribution to this change was substantial, although in a few cases the markets changed without traceable linkages to the given GEF project.

CONCLUSION 4: **The GEF has contributed toward addressing CCM by undertaking activities that might not have been undertaken without its support, by speeding up the process of broader adoption, and/or by improving the processes through which such adoption may take place.**

The evaluation established that the GEF has contributed to the progress made by confirming the causal links between GEF support and the observed impacts. These observed impacts cannot be attributed to the GEF alone. In most cases after GEF projects ended, broader adoption continued, largely due to support provided by national governments and private sector agents. Overall, the last 15 years have shown a global trend toward more energy efficiency and more systematic use of renewable energies. GEF efforts went hand in hand with this global trend and the efforts of many other agents. As a result, the distinction between the effects of GEF projects and those of other activities or factors becomes blurred, making it more difficult to answer the counterfactual question: what would have happened without GEF support?

GEF projects target unique markets and involve considerable indirect impacts that may take place at a much wider scale than the scale of the demonstration. Consequently, experimental design-based evaluations are difficult to undertake to determine the net value added by GEF projects. This question was therefore addressed by posing it to diverse stakeholders and experts who were familiar with GEF projects and their broader contextual conditions, and by cross referencing these perspectives with other evidence obtained during the evaluation.

For 8 of the 18 projects, stakeholder and expert opinion maintained that without GEF support, the project activities would not have taken place.

In these cases, impact can be attributed to the GEF. For nine projects, the feedback received led to the conclusion that the activities supported by the GEF project would have taken place without GEF support. Nevertheless, in seven of these nine cases, stakeholders confirmed that the GEF significantly accelerated the process of project implementation and its consequential results. The conclusion reached was that the supported activities would have taken place, but not necessarily at the same pace or level of quality. For the remaining project, key stakeholder feedback was insufficient to develop an informed perspective on the counterfactual.

GEF project impacts took multiple forms. GEF projects resulted in actual emissions reductions and thus had a direct, but relatively small, effect on reducing stress on the global climate. Most significant and relevant to the GEF's mandate was GEF support to countries to speed up and improve the quality of approaches to change emissions behavior, support the adoption of new technologies, and change markets to more sustainable forms of energy.

CONCLUSION 5: **The methodology to measure GHG emissions and calculate emissions reductions at project completion is not robust and contains uncertainties.**

One of the reasons several projects did not demonstrate the GHG impacts envisioned at project outset is the lack of a standardized GHG accounting methodology during the GEF's early years. In 2008, a methodology was officially announced that has since been used in projects endorsed by the GEF Chief Executive Officer. This evaluation did not include enough of such projects, so it is unclear to what degree the monitoring and evaluation findings presented here are applicable to projects approved since 2008.

The GHG accounting results for the 18 projects included in the evaluation are briefly reviewed with respect to the GEF accounting methodology. This methodology defines clear rules for GHG impact assessment based on project logframes. Under this methodology, at least one of the projects with significant impact—Mexico's Transport project—would not have achieved any direct emissions reduction impact, as the investment in infrastructure was accomplished through non-GEF sources. Thus, the reductions are not counted as direct impacts of the project, even though they would not have been feasible without the project. So, while the methodology has the benefit of clarifying the attribution of GHG impacts to project activities, the results of this attribution rule are sometimes counterintuitive and depend on the wording of the project document.

In several ways, the measurement methodology did not prove robust. Typical and persistent challenges include the following:

- GEF outcomes are difficult or expensive to measure or monitor (e.g., exact energy production or utilization).
- Key parameters of the methodology, such as the national grid emission factors, have changed over time.
- There is a lack of consistency regarding assumptions on the likely benefit period for emissions mitigation; also, there are errors in calculation.

This last point, inconsistencies in the likely benefit period for emissions mitigation, can alone potentially influence the results for cumulative and indirect GHG emissions reductions by orders of magnitude. The 2008 methodology has taken steps to address this by introducing the use of benchmarks and other criteria applicable to specific types of interventions, but it has not removed uncertainties when assessing completed projects. The other two sources of error cited above cannot be fully eliminated as long as there is scope for variation in the GHG accounting methodology used by project proponents, and the resources for measuring and validation are limited. Because the methodology has been designed for planning purposes and includes assumptions about the future that might change rapidly because of factors internal or external to the project, an ex post assessment is almost bound to lead to different results—in some cases, widely different. The current methodology also lacks provisions for ex post verification.

1.3 Recommendations

RECOMMENDATION 1: **The current focus on interventions that tackle barriers to broader adoption in a comprehensive way should be continued and, where necessary, further strengthened in GEF-6.**

Although many of the projects modeled a series of activities designed to introduce new technologies, demonstrate effectiveness, and tackle barriers to further adoption of these technologies, barriers in several cases were analyzed and recognized but not specifically targeted in the projects. As a result, progress toward impact was halted or was slow. Not all barriers may be within the span of a project's control, but certainly projects could take initiatives that would put these barriers on political or economic agendas, or make stakeholders aware of their existence. The GEF Independent Evaluation Office found in its focal area strategy work for the Fifth Overall Performance Study of the GEF (OPS5) that a shift toward tackling broader adoption in a more comprehensive way is visible in project concepts for the GEF-5 period (2010–14) (GEF IEO 2013b). This is a promising development which should continue in GEF-6 (2014–18).

Ensuring quicker progress toward impact is, in the final analysis, more important than a focus on sometimes elusive approaches toward high promised levels of indirect impact. A high level of expected indirect impact is an indicator of what market change or transformation may achieve, but it is the actual market change or transformation that should be the aim of the intervention. It is thus essential that the intervention focus on removing barriers through mainstreaming, replication, and scaling-up to lead to market change or transformation—amply demonstrated in the projects evaluated—be continued in GEF-6 and where possible further strengthened.

RECOMMENDATION 2: **Measurement of GHG emissions reduction, both direct and indirect, needs to be improved. The GEF Scientific and Technical Advisory Panel should be requested to formulate a targeted research project to ensure that assessments of direct and indirect GHG emissions reductions can be verified over time.**

The GEF Scientific and Technical Advisory Panel has provided advice on GHG emissions reduction measurement and analysis. The Secretariat has adopted new standards since the projects included in this evaluation were designed, yet uncertainties remain—especially when reporting on indirect GHG emissions reductions. The levels of direct reduction are impressive in themselves, but they are potentially increased manifold through indirect GHG emissions reductions, which at the moment cannot be verified, as too many assumptions and uncertainties are involved. The Scientific and Technical Advisory Panel and the Secretariat should continue work on adapting methodologies to meet uncertainties, make methodologies more suitable for ex post evaluation, include verification instruments, and ensure greater sensitivity to contextual challenges.

2. Background and Methodology

Climate change is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC 2007). Global GHG emissions from human activities have grown since pre-industrial times, with an increase of 70 percent between 1970 and 2004 (IPCC 2007). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that while some of the observed changes in climate may be attributed to natural causes, "most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations" (IPCC 2007, 39; emphasis in original).[1] The report's business-as-usual scenario is expected to lead to severe impacts on ecosystems, food supply, coastal areas, human settlements, health, freshwater availability, etc.; these in turn are expected to negatively affect the general well-being of human populations. It is therefore necessary to undertake measures to mitigate and adapt to climate change.

The GEF was established in 1991 to assist in the protection of the global environment and promote environmentally sound and sustainable economic development. It is a "mechanism for international cooperation for the purpose of providing new and additional grant and concessional funding to meet the agreed incremental costs of measures to achieve agreed global environmental benefits" (GEF 2011, 12). It serves as a financial mechanism for the United Nations Framework Convention on Climate Change on an interim basis.

Since the GEF's inception, it has provided funding support for climate change. As part of its climate change focal area programs and strategies, the GEF has addressed concerns related to mitigation and adaptation.[2] As of August 2011, the GEF had provided funding of $9.12 billion for the generation of global environmental benefits. Of this, it provided $3.04 billion for CCM-related activities.

To understand the extent to and ways in which the GEF is transforming CCM-relevant markets in major emerging markets, this study sought to understand the causal mechanisms that affect market transformation, the resultant reduction in and avoidance of GHG emissions, and the lessons that could be learned from experiences in major emerging markets. More specifically, the impact evaluation looked at the following key questions:

- What have been the GEF contributions to GHG emissions reduction and avoidance?
- What has been the progress made by GEF-supported activities toward transforming markets for CCM?

[1] IPCC (2007) clarifies the terms used to denote level of uncertainty. The usage of "very likely" indicates at least a 90 percent probability.

[2] The GEF has also supported adaptation activities through various trust funds it manages.

- What are the impact pathways and factors affecting further progress toward market transformation?

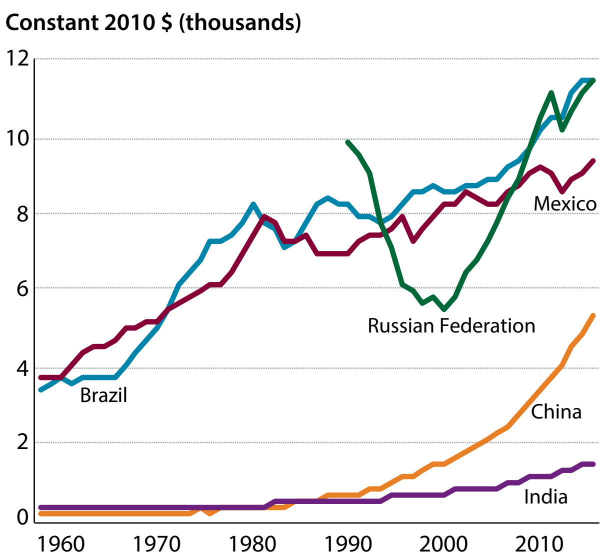
The evaluation took place between September 2012 and March 2013. This report is based on four country analyses that investigated 18 completed and fully evaluated GEF mitigation projects performed in China, India, Mexico, and Russia (GEF IEO 2012a).

2.1 Climate Change Mitigation and Large Emerging Markets

While the four countries selected are those with the largest amounts of climate finance from the GEF, none of them individually is representative of the group of emerging markets. They have followed different development tracks and experienced different levels of economic growth over the past two decades (figure 2.1). Since the inception of the GEF in 1991 to 2012, China and India have experienced substantial growth, and their per capita gross domestic product has increased by a factor of about 2.5. This socioeconomic development has led to a more Westernized lifestyle for some of their population and in some parts of their countries. Although Mexico and Russia started from a higher baseline than China and India, they have not experienced similar growth rates; their economies have also changed over the period. Many emerging markets have developed important export sectors and are producing more than is consumed domestically, which is especially true of China.

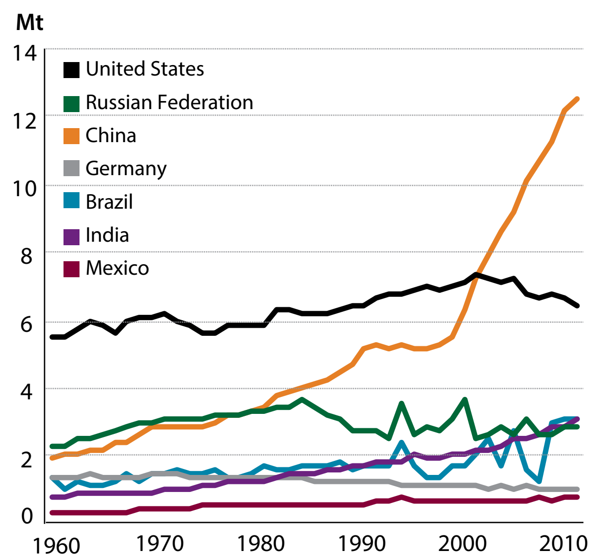
In contrast to economic development, which has been mostly characterized by upward movement, GHG emissions in the four countries included in this evaluation do not reveal a steady trend (figure 2.2). After dropping significantly in the 1990s, Russia's emissions have plateaued at an average of 2.76 Mt CO_2eq between 2000 and 2010. China's emissions grew significantly—and for a short while, disproportionately to economic growth—so it is now the largest absolute emitter in the world. The emissions growth rates in Latin America have been slower than those in Asia, even though overall economic development in this

FIGURE 2.1 **Per Capita Gross Domestic Product in Selected Countries, 1960–2012**



SOURCE: World Bank, World Development Indicators DataBank, http://data.worldbank.org/indicator/NY.GDP.PCAP.KD.

FIGURE 2.2 **Total Carbon Dioxide Emissions in Selected Countries, 1960–2011**

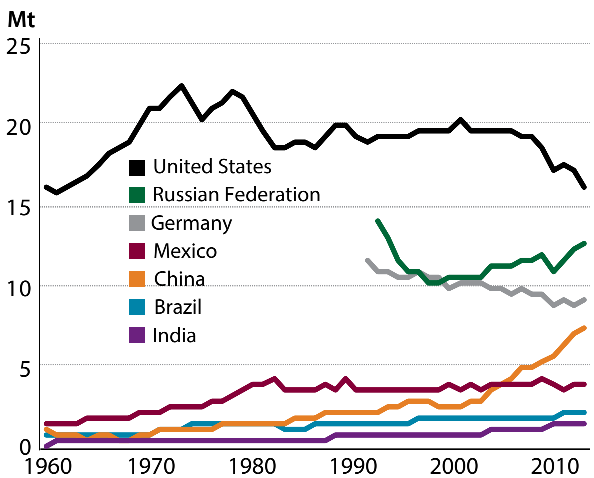


SOURCE: World Bank, World Development Indicators DataBank, http://data.worldbank.org/indicator/EN.ATM.CO2E.KT.

region was also positive. The emissions intensities of the Brazilian and Mexican economies remained lower throughout the period than those in Asia.

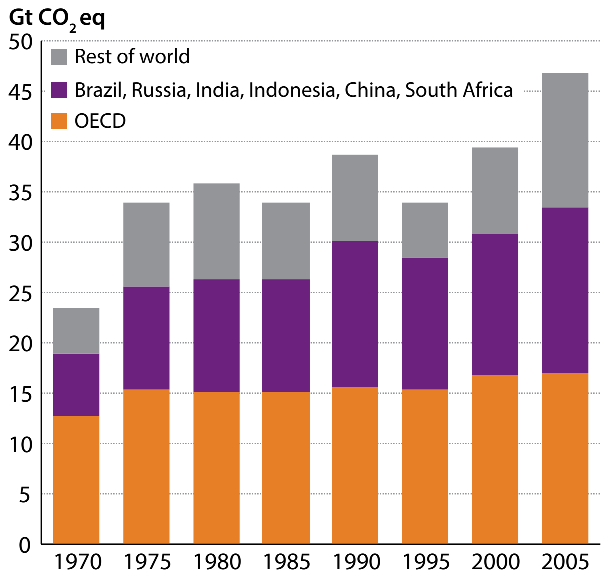
While aggregate economywide GHG emissions figures show the extent to which an economy is contributing to global GHG emissions, per capita emissions allow comparisons across countries, after taking population size into account. Figure 2.3 shows that in 2012 the economically booming countries of China and India were exhibiting upward trends in absolute as well as per capita emissions, while OECD emissions were dropping. Nonetheless, per capita emissions of all emerging markets are far below the levels of the OECD countries. In the aggregate, however, the four countries of Brazil, Russia, India, and China (BRIC) emit about as much as all OECD countries together (figure 2.4). The OECD expects that technological progress and structural shifts in the composition of growth will improve the energy intensity of all economies in the coming decades. But particularly "in the OECD and the emerging markets of Brazil, Russia, India, Indonesia, China and South Africa (BRIICS)," the pace of improvement will be

FIGURE 2.3 **Greenhouse Gas Emissions per Capita in Selected Countries, 1960–2011**



SOURCE: World Bank, World Development Indicators DataBank, http://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE.

FIGURE 2.4 **Greenhouse Gas Emissions from Different Country Groups, 1970–2005**



SOURCE: OECD 2012.

outstripped by increased global energy demand (OECD 2012, 73). For this reason, in stabilizing the global climate, it is as important to reverse energy trends in the large emerging markets as in the OECD countries.

2.2 Methodology

This impact evaluation focuses on one specific subgroup of countries. As discussed, large emerging markets as a group have an important role to play in addressing CCM because of the overall size of their economies, emissions, and economic growth which will make them even more important in the future. As GEF funding for CCM in major emerging markets has been considerably more than for other country groups, selection of this group allowed the Independent Evaluation Office to cover a larger group of projects with fewer countries. To identify the countries to be covered through fieldwork, six major emerging economies—Brazil, China, India, Mexico, Russia, and South Africa—were initially considered. Their CCM portfolios are listed in table 2.1.

TABLE 2.1 GEF Climate Change Mitigation Portfolio in Countries Considered for This Evaluation (million $)

Country	Small Grants Programme	Enabling activity		Medium-size project		Full-size project		All modalities
Brazil	0.0	5.7	(2)	0.0	(0)	78.0	(9)	83.8
China	0.0	8.6	(2)	1.8	(2)	502.1	(38)	512.5
India	1.8	3.5	(2)	3.8	(5)	199.4	(20)	208.5
Mexico	0.2	0.3	(1)	1.0	(1)	159.0	(14)	160.5
Russia	0.0	0.0	(0)	2.7	(3)	111.5	(13)	114.2
South Africa	0.2	0.3	(1)	3.8	(5)	27.2	(5)	31.5

NOTE: Figures in parentheses indicate number of projects .

As the table illustrates, South Africa had a rather small portfolio. Brazil had been previously covered in a 2012 country portfolio evaluation undertaken by the GEF Independent Evaluation Office. The four remaining countries were included in this study. Further analysis of the respective GEF CCM portfolios was undertaken to identify projects in these countries that address CCM-relevant markets that remain relevant for GEF programming. The analysis included projects expected to lead to GHG emissions reductions that had been approved during GEF-3 (2003–06) or earlier and were expected to have been completed at the time the evaluation started.[3] All of the projects that met these criteria in India (six projects) and Mexico (five projects) were selected for field verification. In Russia, although the GEF CCM portfolio is quite large, the number of completed projects is quite small. The only market where Russia provides a critical mass of completed projects involves efficient buildings; thus, two completed efficient buildings–related projects from Russia were selected for fieldwork.

China has the largest CCM portfolio of the six countries. It has also been covered through several recent evaluations undertaken by the GEF Independent Evaluation Office, although not in as much detail as Brazil. As a result, it was deemed appropriate to focus on a few markets in the country in which the GEF has invested considerable resources and that continue to be relevant for the future work of the GEF. Of the five candidate projects identified in the approach paper for coverage through fieldwork, the Heat Reform and Building Energy Efficiency Project (GEF ID 1892) was replaced with the TVE II project during the course of the evaluation. This substitution was made after consultations with national stakeholders, whose feedback on the original choice was that projects that had been completed for a longer time would be more appropriate for inclusion. The five projects that were eventually covered in China represented the renewable energy, transportation, and industry energy efficiency–related markets.

The evaluation thus covered 18 completed GEF projects, each seeking changes in at least one market segment. The projects included in this evaluation are listed in table A.1; for India, Mexico, and Russia, they are the same projects as were selected in the approach paper (GEF IEO 2012a, annex 3). They address various renewable energy, energy efficiency, and methane emissions reduction opportunities, as shown in table 1.1.

[3] Projects under implementation were thus excluded, as were canceled projects. Identified completed projects excluded enabling activities funded by the GEF or projects that primarily focused on foundational activities.

Many projects in these countries had been started in the early stages of the GEF and have been completed and fully evaluated by now. The completed projects from these earlier stages offer an opportunity to observe postproject impacts and impact pathways. As the GEF portfolio in most of these countries spans several sectors and fields of operation, the sample can be used to identify cross-country and cross-sectoral findings.

The fieldwork and analysis for this evaluation was undertaken from August 2012 to January 2013. The questionnaire guiding the evaluation is presented in annex B. After a short summary section of formal project information (e.g., funding volumes, time frames, and technologies covered), the evaluators were asked to assess the project's barrier removal and market transformation impact. Post-project assessment of GHG impacts was based on actual investments and the use of project-supported technologies. The evaluators then used the GEF theory of change to arrive at a progress to impact rating and identify causal factors for success. The project-specific questionnaires were then compiled into a large spreadsheet and analyzed as a group.

3. Impacts

GEF support intends to help countries reduce GHG emissions by facilitating transformation of specific markets or sectors. GEF projects have supported investments that have led to direct emissions reductions, enhanced capacities, and contributed to the improvement of legal frameworks—which in turn have led to indirect emissions reductions and developed markets for clean energy technologies. GEF projects have also led to local benefits: environmentally sound job creation, better economic performance of existing businesses, the development of new business models, and—in many cases—improvements in local environmental quality. This chapter details these impacts.

3.1 GHG Direct Emissions Reductions through Projects

Direct GHG emissions reductions are those caused by installations and measures that were part of a GEF project or were facilitated directly under a GEF project. Jointly, the 18 projects included in this evaluation resulted in more than 10 $MtCO_2eq$ in annual avoided emissions. The details are displayed in table 3.1. Using the guidance provided in the 2008 GEF GHG accounting methodology, three projects were assessed as having had no direct GHG emissions reduction or avoidance contribution.

TABLE 3.1 **Direct Greenhouse Gas Emissions Reductions of the Projects Included in This Evaluation**

Annual GHG emissions reduction	Number of projects	Country: project short name
> 1 $MtCO_2eq$	2	China: TVE II, RESP
100,000 tCO_2eq – 1 $MtCO_2eq$	6	India: Energy Efficiency, Alternate Energy, Biomethanation Mexico: Agriculture, Landfill Gas China: RED
10,000 tCO_2eq – 100,000 tCO_2eq	4	Mexico: Ilumex, Transport India: PVMTI, CBM
1,000 tCO_2eq – 10,000 tCO_2eq	2	India: Hilly Hydel Russia: Education
< 1,000 tCO_2eq	1	Russia: Boilers ,China
Not measured/negligible	3	Mexico: Wind China: FCB I, FCB II

NOTE: For GHG emissions reductions per project, see table A.3.

The GHG impact assessments rely on terminal evaluations. The field studies and a peer review process within the evaluation team reviewed these assessments.[1] Most projects reviewed overestimated their direct GHG impact at the design stage. Of the 18 projects, 4—China's FCB I project, India's Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions (Biomethanation; GEF ID 370) project, the Mexico Transport project, and Russia's Boilers project—did not specify quantitative GHG targets in their project documents. Eight projects—China's RED, TVE II, and RESP projects; India's Alternate Energy and Energy Efficiency projects; and Mexico's Ilumex, Agriculture, and Landfill Gas projects—achieved or exceeded their GHG emissions avoidance objectives. Of these eight, the RED, TVE II, and Energy Efficiency projects exceeded their targets multiple times over.

Of the 14 projects that specified direct emissions reduction targets, 6 did not achieve them. This group includes India's Hilly Hydel project, which achieved about 60 percent of its target; the remaining five projects achieved less than half of their targets: India's Photovoltaic (PV) Market Transformation Initiative (PVMTI; GEF ID 112) and CBM project; the Action Plan for Removing Barriers to the Full Scale Implementation of Wind Power in Mexico (Wind; GEF ID 1284); Russia's Education project; and China's FCB II project.

Changes during project implementation account in large part for the broad divergence between expected and actual impacts. For example, the China TVE II project was modified after project approval to include a replication component, which allowed it to achieve greater direct emissions reductions. In other cases, expected project results had to be revised downward during project implementation when they proved unrealistic and components were changed.

In most cases, this impact evaluation was able to confirm that the direct GHG impacts had been sustained after project completion, thereby upholding the assessments of the terminal evaluations for cumulative direct GHG impacts. In other cases, the GHG impacts changed after the project's terminal evaluation, making it necessary to adjust these assessments downward. For example, in the Russia Boilers project, the GEF-financed demonstrations have been discontinued. In China, the fuel cell buses from the FCB I project are not in operation because of a lack of sufficient expertise; instead, the buses are on display in museums for public awareness purposes. At the time of the field visit, the FCB II fuel cell buses had not received an operations permit, and thus were not avoiding any GHGs. Such changes in circumstance are not unique to GEF projects but an inherent risk in all development projects.

In summary, the differences between expectations at project outset, project termination, and postproject evaluation can reflect a more or less normal level of failure and mistakes in implementation and maintenance shortcomings. Several other reasons for deviations were also noted.

- In the extreme cases of overachievement of expected GHG impacts, the technologies met the demand in a timely manner. This was particularly true for China's TVE II project. In many of the extremely underachieving cases, the technologies were greeted with skepticism or not adopted at all, as they did not match local preferences; this was the case in the Boilers project in Russia and China's FCB I and II.
- GHG emissions might have been overstated in the beginning because of a lack of clarity in the GHG accounting methodology. There are also strong incentives at the project approval stage

[1] The technical assumptions underlying these data were rarely fully disclosed; in many cases, the data cannot be measured but rely on expert judgment. The meta-evaluation conducted during the course of this evaluation was not always able to reconstruct the basic calculation assumptions underlying these assessments and mostly used the data given.

to overstate GHG impacts. The natural uncertainty in ex ante GHG impact estimations can be used to highball expected impacts, which might make the project look more attractive to the GEF.

All direct GHG emissions reduction impacts are small relative to the challenge of CCM in the emerging markets. In addition, the direct impacts of most GEF projects on GHG emissions reductions were small in absolute terms as well. The direct GHG impacts vary by several orders of magnitude (table 3.1). The major achievers in terms of large direct emissions avoidance were China's RESP and the TVE II project, which avoided 6.4 MtCO_2eq and 1.5 MtCO_2eq annually, respectively. At the other extreme, the estimated direct GHG emissions reductions of the Russia Boilers project was about 125 tCO_2eq per year.

3.2 Factors Determining Extent of GHG Direct Emissions Reductions

The factors that seem to determine the extent of GHG emissions reduction impact independent of quality of project implementation are the choice of the technology market, the technology's maturity (these two factors are not unrelated), and the (country) emissions factor.

TECHNOLOGIES PROMOTED

The technologies promoted in the projects vary widely. The magnitude of GHG emissions reduction and avoidance seems to depend mainly on the size of the market for a technology and the savings per energy service/investment. For example, the overall market for improvements in the China TVE II project theoretically comprises 23 million enterprises at the township and village levels, which account for 30 percent of China's gross domestic product and more than half of its output of cement, coking, and cast metal (UNDP and UNIDO 2007). These are generally among the most emissions-intensive industries in an economy. Given the nature of the sector in rural China and the inefficient technologies relied upon, four TVE groups alone accounted for one-sixth of China's GHG emissions from around 2000 to 2007. This situation created an opportunity for significant GHG emissions reductions, both at the targeted sites and at an aggregate level. On average, the savings in each of the eight pilot sites of the project were close to 200 ktCO_2eq per year—equivalent to the emissions of a small city.

Globally, there may be fewer opportunities for such high direct impact projects. The 11 MW solar home systems installed in the context of the China RED project, for example, saved only a tenth of that amount.[2] In the sample covered by the evaluation, the RESP and the TVE II project in China provided the largest GHG savings; the sustainable transportation projects provided the least GHG savings.

MATURITY OF TECHNOLOGIES

Some of the technologies targeted, particularly in the transportation sector, are at stages of development where replication in the private sector is not yet feasible due to their level of maturity. For example, China's FCB I and II projects were not able to generate large savings, as the technologies entailed were—and are still—not ready for broader adoption in the country. Those projects with large quantitative impacts were all promoting technologies "at the right time in the right place."

EMISSION FACTORS

The third aspect that affects GHG impacts is the emissions factor of the replaced or avoided fuel. The projects in the sample substituted renewable energy for diesel or coal (for on-grid renewable projects) or avoided energy or electricity consumption. The specific emissions of these avoided fuels differ widely. For example, rural electrification replaces diesel generators, and the GHGs that these

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[2] The savings from these were roughly calculated to be 25 t per year.

generators would have emitted vary, depending on utilization and system setup. In addition, in the Mexico Landfill Gas and India CBM projects, the net effect of CO_2 being released into the atmosphere instead of methane also needs to be counted toward the GHG impact of the project. When coal-bed methane is used to displace coal cooking by coal miners, the GHG impact is several times higher than where a hydropower facility or solar home system brings lighting to rural villages that previously burned candles for lighting. Thus, rural energy programs targeting sectors with low initial emissions, such as the Indian Hilly Hydel and Mexican Agriculture projects, will result in small GHG benefits, despite impressive project results in other areas, such as inclusive development.

Emission factors can be misestimated and can vary over time, which is of significance to all projects that avoid or substitute grid electricity.[3] For example, within a broader context where the weighted average emissions per kWh of grid electricity are declining, a system installed at the beginning of a project would avoid more GHGs per unit of electricity output than one installed at the end of a project. And both systems would today avoid less GHGs per unit of electricity than at the time of project completion. Moreover, at the time the older projects in the sample were approved, there was significant uncertainty about actual emission factors, as the local capacity and databases for such assessments were in the process of being developed.

Other observations relate to project approach. Three of the four projects with the largest direct, as well as indirect, GHG emissions reductions were implemented in China. These three projects (RED, TVE II, and RESP) share several traits. For instance, they not only were conducted in the largest emerging market, but they also successfully used centralized economic structures to multiply their impact. They each addressed the quality of the innovation rather than simply the quantity, and all explicitly considered and made provisions for replication during and after the respective project. Each took a multiple-component approach and worked with various stakeholders (policy makers, industry and innovation agents, and laboratories) to achieve comprehensive change in the market. Only two other projects in the portfolio pursued holistic approaches in a comparable fashion: India's CBM and Mexico's Agriculture projects. In both these cases, the GHG emissions reduction potential of the technology was significantly overestimated; and the CBM project encountered a number of technical difficulties. Issues related to project approaches for achieving broader adoption are discussed in chapter 4.

3.3 GHG Indirect Emissions Reductions

In 14 of the 18 projects in the sample, the evaluation was able to track replication and scale-up activities that were not part of the projects' immediate results but rather represented long-term impact. Table A.3 presents both direct and indirect GHG benefits of the evaluated GEF projects. Four projects did not have any indirect GHG impacts during or after project completion, and no replication or follow-up activities have taken place yet.

Of the 14 projects with indirect GHG impacts, it was possible to make quantitative assessments of indirect GHG benefits for 11 projects (table 3.2). The record is incomplete, as institutionalized monitoring is normally discontinued after completion of GEF projects. Overall, the indirect GHG impacts of the projects in the sample account for about 75 Mt per year in GHG emissions reductions. Of this, 60 Mt, or roughly 80 percent, were claimed by two Chinese projects: TVE II and

[3] Typically, there are national statistics published on emission factors, for example, in national communications. However, answering the question of which fuel is not burned because of a CCM intervention is a matter of judgment.

TABLE 3.2 Profile of Projects with Indirect Greenhouse Gas Impacts

Impact/technology feature	No	Yes
Quantifiable	3	11
First-time application	1	4
Embedded in national push	2	7

NOTE: *n* = 14.

RESP. These projects represent two different groups of GEF projects. The former, along with the India CBM and Mexico Landfill Gas projects, is the **first application of a particular technology** in its country. Such demonstrations provide encouragement or learning opportunities and are expected to be replicated within the country. For these three projects, stakeholders maintained that the technologies were viable and useful in the respective national context. Significant follow-up activities were triggered by these projects that led to important impacts in terms of GHG emissions reductions. GEF support not only made it possible to undertake these activities sooner and more decisively than would otherwise have been the case, but the projects also served as triggers for actual developments. Thus, such projects as Ilumex and TVE II served as laboratories and triggers for complete market transformation or at least wider-ranging market change. Without these projects, it would have probably taken another decade for the technologies to take hold in the country. The second group of projects—which include the China RESP and other highly successful projects in terms of quantitative outcomes—is typically deeply **embedded in a strong national or global push** for sustainable energy. These projects are some of the most important interventions of the GEF, as they all made notable contributions to the acceleration and sustainability of the national push. In the three countries where such initiatives took place—China, India, and Mexico—renewable energies have gained significant momentum over the last two decades. While GEF projects have not triggered these pushes, they have certainly contributed to GHG emissions avoidance/reduction by influencing the direction and quality of the pushes: very successfully in China, with some success in India, and without significant success in Mexico (with the exception of the Agriculture project). Further discussion of the pathways and factors leading to broader impact follows in later sections of this report.

3.4 Other Impacts of GEF Climate Change Mitigation Activities

Local environmental and economic benefits have been studied previously by the GEF Independent Evaluation Office.[4] These studies show that GEF-supported activities have led to several beneficial impacts. In the portfolio analyzed for this study, impacts on local environments and economy have been demonstrated. Table 3.3 contains a number of examples for the sample of projects covered by the evaluation; note that this is not an exhaustive summary of all non-GHG impacts.

Local environmental benefits have been proven in 13 of the 18 projects in the sample. Most projects reduced local pollution from power generation (the various renewable energy and energy efficiency projects), transportation (Mexico's Transport project), and waste management (Mexico's Landfill Gas project and India's Biomethanation and CBM projects). Typical local benefits also include providing energy for improved living conditions (as in the India CBM project) or for enhanced productivity in economic activities (as in Mexico's Agriculture project). In these cases, the energy supply became cleaner and more secure. Analysis of the socioeconomic impact of solar home systems in the context of the China RED project found differences in the interpretation of poverty impacts.

[4] For example, with regard to local benefits (GEF IEO 2006) and the South China Sea (GEF IEO 2012b).

TABLE 3.3 Examples of Other Impacts and Benefits from Projects Included in This Study

Benefit	Example
Pollution reduction	• Wood stoves led to reduced indoor air pollution (India Hilly Hydel) • Rural electrification led to less burning and better air quality (China RED) • Bus rapid transit reduced emissions in urban areas (Mexico Transport)
Other environmental benefits	• Increased resource efficiency led to land and soil savings (China TVE II) • Power generation from landfill gases in urban areas led to better waste management and reduced emissions (Mexico Landfill Gas)
Other economic and social benefits	• Rural electrification led to reliable energy supply (China RED) • Small hydro resources led to power reliability (India Hilly Hydel) • Solar PV and small wind turbines for water pumping led to reliable water supply (Mexico Agriculture)
Direct job creation effects	• Installing PV systems led to local jobs (India PVMTI) • Energy efficiency led to an increase of companies and the creation of jobs (India Energy Efficiency) • Rural electrification led to an increase in manufacturers (China RED)
Indirect job creation effects	• Small hydel resources led to an increasing number of technology providers (India Hilly Hydel) • Increased energy efficiency led to higher demand for operations and maintenance workers (India Energy Efficiency) • Perforation of bricks led to increased demand in the capital goods industry (China TVE II)
New business models	• The need for more PV installations led to the creation of several new companies and innovative business models (India PVMTI) • Biomethanation led to new businesses in the field of waste to energy (India Biomethanation) • Measures for energy-efficient buildings led to commercial lending for energy efficiency, energy service, and metering companies (Russia Boilers) • PV systems for water pumping led to additional PV sellers (Mexico Agriculture)
Improved financial situation of users	• The use of small hydel resources led to better performance of water mills (India Hilly Hydel) • Energy-efficiency projects led to economic benefits (India Energy Efficiency) • Energy and capital stock can be saved by efficient processing (China TVE II) • PV systems for water pumping led to reduced expenses for diesel (Mexico Agriculture)

Some projects led to job creation. For example, China's RED project and RESP focused on enhancing local manufacturing capacity through grants used to secure manufacturing equipment in compliance with international quality standards and training. This created local technical capacity and enabled the country's solar and wind companies to compete internationally. A domestic industry was thereby created that offered new jobs in China. In addition, the industry's ability to export to other countries—including many OECD countries—made these jobs more stable than if they were solely dependent on the local (national) market (Sovacol and D'Agostino 2011). Similarly, India was able to build up a significant domestic renewables industry. As these GEF projects have significantly contributed to market development in these countries, the GEF has thus also contributed to the build-up of the relevant sectors. Project reviews have also identified clear and direct job impacts.

Not all projects were able to leverage their market change for domestic job growth, however. The evaluation of the Mexico Ilumex project found that after the switch from incandescent light bulbs to CFLs, the Mexican market share for Chinese manufacturers rose significantly.

Several projects had negative social and welfare consequences for specific sectors of the population in terms of dislocating jobs, including for disenfranchised population groups. For example, while planning the Mexico Transport project, the project organizers attempted to include the informal transport operators (*peseros*), but were unable to reach agreement with them. Ultimately, the project displaced the *peseros* to secondary routes, resulting in congestion and pollution problems in other areas.

It is sometimes difficult to ascertain whether a given project had negative consequences—as in the displacement by the Mexico Landfill Gas project of informal landfill dwellers or waste pickers—making the net effects of the project difficult to determine.

4. Progress to Impact and GEF Impact Pathways to Broader Adoption

4.1 Progress to Impact Ratings

Within the context of evaluation of GEF interventions, the Fourth Overall Performance Study of the GEF (OPS4) emphasized the need to go beyond project boundaries to assess the extent to which the GEF had the intended catalytic impact, to assess whether GEF support had any unintended consequences, and to understand the processes through which such impacts were taking place (GEF IEO 2010). Subsequently, the GEF Independent Evaluation Office developed a theory of change for GEF operations to track progress toward impact and underlying factors. This analysis has been used here and provides ratings on a four-level scale.

Of the 18 projects reviewed, 5 showed high progress, 5 showed significant progress, 4 showed moderate progress, and 2 showed low or negligible progress toward wider adoption (table 4.1; see annex B for ratings criteria). No rating was given for the FCB I and II projects.

For 11 projects, it was possible to obtain progress to impact ratings from the time of the terminal evaluation. Table 4.2 compares these with the ratings provided by the evaluation team, taking into account additional information on project impacts available after project completion. While the average ratings are similar, it is interesting to note that at the time of the terminal evaluation, none of the projects had a low rating.

In the case of the Russia Boilers project, the drop in rating from moderate to low can be explained by the fact that, at the time of the terminal evaluation, there was still hope that the boilers would be operating for a long time and that the consumption-based billing system would eventually be used. The rating for Mexico's Landfill Gas project also dropped a level.

In three cases, the ratings improved from moderate to significant or high. For the Mexico Ilumex project, the ultimate success of a phaseout of incandescent lights has taken place 10 years after the end of the project, justifying the improvement in the rating. The projects that had a high rating in this evaluation had achieved a similar score at the time of their terminal evaluation. As is to be expected, the level of consistency between the two sets of ratings directly depends on the length of time that has passed—for older projects, larger differences are justified.

While the rating at project termination focuses on achievement of project outcomes and direct results, the progress to impact rating assesses how far a project has helped meet the challenge—in this case, addressing a certain GHG-emitting behavior or technology. These might be different things and can have different causes: A project might have achieved highly satisfactory results, but if the project strategy did not target removing the threat level in terms of GHG emissions or assist in barrier removal, it would not receive a high progress to impact rating.

TABLE 4.1 Progress to Impact Rating for Sampled Projects That Could Be Rated

GEF ID	Short name	Country	Start	End	Duration (months)	Financing at completion (million $) GEF	Financing at completion (million $) Total	Rating
446	RED	China	6/99	6/08	109	27.00	UA	High
575	Ilumex	Mexico	3/94	12/97	46	10.70	25.95	High
622	TVE II	China	12/00	7/07	80	7.99	55.60	High
943	RESP	China	6/05	12/11	80	40.22	98.11	High
1155	Transport	Mexico	10/02	3/09	78	5.95	9.74	High
76	Alternate Energy	India	11/92	12/00	98	26.00	284.00	Significant
325	CBM	India	6/98	1/10	141	9.20	19.11	Significant
370	Biomethanation	India	3/94	8/00	79	5.50	11.00	Significant
386	Hilly Hydel	India	1/95	12/03	110	7.50	14.64	Significant
784	Landfill Gas	Mexico	5/01	6/06	62	6.53	12.59	Significant
112	PVMTI	India	6/98	6/10	146	10.73	UA	Moderate
404	Energy Efficiency	India	6/00	3/06	70	5.00	47.23	Moderate
643	Agriculture	Mexico	12/99	6/06	79	8.90	21.70	Moderate
1646	Education	Russia	10/02	9/06	48	1.00	2.98	Moderate
292	Boilers	Russia	2/98	12/04	83	2.98	3.19	Low/negligible
1284	Wind	Mexico	1/04	12/10	85	4.74	11.81	Low/negligible

NOTE: UA = unable to assess. China's two FCB projects were rated UA, and are therefore not included here.

TABLE 4.2 Comparison of Progress to Impact Ratings at Project Termination and at Time of This Evaluation

Rating at evaluation	Rating at project termination: High	Significant	Moderate	Low/negligible	Unable to assess	Total
High	3	0	1	0	0	4
Significant	1	1	2	0	0	4
Moderate	0	0	0	0	1	1
Low/negligible	0	0	2	0	0	2
Total	4	1	5	0	1	11

NOTE: *n* = 11.

4.2 Pathways to Broader Adoption

In the context of its overall body of evaluation work, the GEF Independent Evaluation Office has developed a theory of change which is used to trace the chains of causality by which GEF interventions lead to desired impacts (GEF IEO 2012c). The framework is an abstract description of possible mechanisms that can result in the broader adoption of the approaches, technologies, policies, or behaviors supported by the GEF to generate global environmental benefits and other co-benefits. Individual projects may focus on a few or all of the depicted aspects. The framework has been used in—among others—the Office's evaluation of the GEF impact in the South China Sea (GEF

IEO 2012b), and the progress to impact analysis presented in the GEF's Fifth Overall Performance Study (GEF 2013a, 2014). For this evaluation, it served as a tool to generate and test hypotheses to help understand the causal pathways to broader global environmental benefits.

The types of impacts are discussed in chapter 3. Many of the projects were linked to broader (indirect) GHG impact and/or to local co-benefits such as reduced pollution and enhanced economic activity. Other benefits or interim results include enhanced industrial energy efficiency (and therefore competitiveness), a sound manufacturing basis for clean energy, and the availability of financing for sustainable energy technologies at various scales. This section looks at the processes through which these impacts have been achieved.

The pathways to broad adoption and impact as originally identified in the generic GEF theory of change and adopted for the present CCM impact evaluation are as follows.

- **Sustaining.** Technologies, mechanisms, and other approaches originally supported through the GEF activity continue to be used beyond the actual project duration through integration into the regular activities of stakeholders.
- **Mainstreaming.** Information, lessons, or aspects of a GEF initiative are incorporated into a broader initiative, such as policies, institutional reforms, and behavioral transformation. This study includes mainstreaming the GEF-supported technology into the general practice.
- **Replication.** Results of GEF activities are reproduced at a comparable scale, often in different geographical areas.
- **Scaling-up.** Results of GEF activities are expanded to address concerns at larger geographical, ecological, or administrative scales.
- **Market change.** GEF activity catalyzes changes in the market, through self-sustaining stimulation of significant demand for a sustainable energy technology or practice, or through a significant reduction of the more polluting technology or practice in a significant share of the market or application realm.

The definition of market change used here has been adjusted slightly from that used in other Office evaluations. Originally, it was formulated as "GEF activity catalyzes market transformation," which has a specific connotation in the sustainable energy realm; here, the more extensive formulation noted above was used.

Table 4.3 lists the broader adoption pathways observed in the projects covered by the evaluation. These pathways are further delineated in the remainder of this chapter.

4.3 Sustaining

In 14 of 18 cases in the sample, the processes supported by the projects were sustained after the project had ended (table 4.4; see table A.4 for project products). Because of the heterogeneity of the portfolio, there are different levels of activities that could be, and have been, sustained: the operation of hardware and equipment, the delivery of capacity-building and institutional-strengthening measures, policy advisory services, and the continuation of investment subsidies.

Ongoing operation of project investments in hardware and equipment was the most prevalent sustaining practice, found in 11 projects. In these cases, installations are still under operation to the degree that normal wear and tear allows (e.g., in China's and India's renewable energy projects, Mexico's Ilumex project, and India's CBM project). For those cases where hardware was not installed (e.g., the Mexican Wind project) or was not sustained (e.g., the Russia Boilers project and China's FCB I and II projects), GHG impacts are very small or nonexistent. In the Mexico Wind project, outputs as well as impacts were limited to learning from technical studies. In three cases,

TABLE 4.3 GEF Pathways to Broader Adoption Observed in Projects Included in This Evaluation

GEF ID	Short name	Country	Sustaining	Mainstreaming	Replication	Scaling-up	Market change
76	Alternate Energy	India	✔	✔	✔	✔	✔
112	PVMTI	India	✔	✔	✔	✔	✔
292	Boilers	Russia					
325	CBM	India	✔	✔	✔		✔
370	Biomethanation	India	✔	✔	✔	✔	✔
386	Hilly Hydel	India	✔	✔	✔	✔	✔
404	Energy Efficiency	India	✔	✔	✔	✔	✔
446	RED	China	✔	✔	✔	✔	✔
575	Ilumex	Mexico	✔	✔	✔	✔	✔
622	TVE II	China	✔	✔	✔	✔	✔
643	Agriculture	Mexico	✔	✔	✔		✔
784	Landfill Gas	Mexico	✔	✔		✔	✔
941	FCB I	China			✔		
943	RESP	China	✔	✔	✔	✔	✔
1155	Transport	Mexico	✔	✔	✔	✔	✔
1284	Wind	Mexico					
1646	Education	Russia	✔	✔	✔		
2257	FCB II	China					

TABLE 4.4 Sustaining of Project Outcomes after Project Completion

Type of sustaining	Number of projects	Country: project short name
GEF-supported investments are still operating	14	China: RED, TVE II, RESP India: Alternate Energy, PVMTI, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas, Transport Russia: Education
GEF-supported businesses are still selling new installations/ products	11	China: RED, TVE II, RESP India: Alternate Energy, PVMTI, CBM, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Transport
GEF capacity-building measures continue	11	China: RED India: Alternate Energy, PVMTI, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Landfill Gas, Transport Russia: Education

the operation of GEF project–supported investments has been discontinued. Both of China's FCB projects were discontinued, although for different reasons. For FCB I, the agreement with DaimlerChrysler was that the procured fuel cell buses were to be discontinued to prevent unauthorized reproduction. For FCB II, no permit for passenger transportation could be obtained. The

Russia Boilers project is the third case of discontinuation; here, various project components—including consumption-based billing and the autonomous boilers themselves—failed to become popular with consumers or operators. In all three discontinued projects, a mixture of cultural and legal issues prevented sustained use of the investments.

Seven projects marked the first or one of the first installations of a specific technology in the respective country.[1] But the Russia Boilers and China FCB projects demonstrate that where technologies were not locally accepted as safe and useful, sustaining did not take place. In both countries, administrative barriers and safety and other concerns related to the relative newness of the technologies limited project impact.

While sustaining comparatively small investments cannot lead to large direct GHG impacts, it can still provide important opportunities for continuation of learning processes beyond the end of the GEF project. Besides the technical and hardware components, various other project activities were also sustained. Sustaining the India PVMTI project, as well as other projects that delivered capacity building to the private sector, project companies continue to operate and sell renewable energy equipment. In the Russia Education project, the curricula designed in the context of the project continue to be used, at least partially, today. Sustaining some of these "softer" measures can make significant contributions to broader impact—as when, for example, the investment framework for clean energy investments developed in China's renewable energy projects was sustainably improved.

[1] China: TVE II; India: Biomethanation and CBM; Mexico: Landfill Gas, Wind, and Transport; and Russia: Boilers.

4.4 Mainstreaming

As per the GEF theory of change, mainstreaming involves incorporating information, lessons, or aspects of a GEF initiative into a broader initiative, such as policies, institutional reforms, and behavioral transformation. Through mainstreaming, elements of GEF-supported approaches are incorporated into laws, policies, regulations, programs, and other stakeholder initiatives that are usually already part of their regular program or mandate. The avenues for mainstreaming are manifold and difficult to fully quantify. Of the 18 projects, mainstreaming was documented for 14 and could be identified in all but the China FCB projects and the Mexico Wind project (see table A.5).

Significant impact can be leveraged through capacity-building activities, and the portfolio contains a number of examples as to how these activities led to mainstreaming approaches that were supported by GEF projects. For example, the India Biomethanation project enhanced research institutes' ability to handle larger and more complex projects. Overall, the capacity-building impacts of the sampled GEF projects are significant and represent the most prevalent pathway to broader impact across the portfolio. The evaluation found private sector capacity building in 14 cases and public sector capacity building in 13 (table 4.5). This included nonmitigation-related administrative processes (as in the case of the executing agency FIRCO in the Mexico Agriculture project); as well as a significant body of sustainable energy expertise, including with policy makers (in China's RESP), financial intermediaries (in India's PVMTI), energy efficiency (in India's Energy Efficiency), and energy users (in Mexico's Agriculture and Ilumex, and Russia's Education).

Table 4.6 presents examples of mainstreaming of technologies promoted by the GEF projects. It also includes instances where technologies have become more mainstream through policies but with no clear causal link to GEF projects. Important

TABLE 4.5 Mainstreaming Activities Associated with Projects Included in This Evaluation

Type of mainstreaming	Number of projects	Country: project short name
Capacity building in the public sector	13	China: RED, TVE II, RESP India: Alternate Energy, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas, Transport Russia: Education
Capacity building in the private sector	14	China: RED, TVE II, RESP, FCB II India: Alternate Energy, PVMTI, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture Russia: Boilers, Education

intermediary stepping stones to mainstreaming new technologies are the establishment of product specifications and standards, which have also been a prevalent strategy in the sample projects. Four projects led to such standards; these do not include the China FCB projects where, despite a presence of standards, no mainstreaming occurred because of the technology's lack of maturity.

4.5 Replication

Replication refers to reproduction of project activities at a comparable scale outside the narrower realm of the GEF project. Activities of 14 projects were replicated and, for these, causal links could be traced back to the respective project. All the projects that ultimately claimed large GHG impacts had replication factored into their project design. In four cases—the Russia Boilers, Mexico Wind, Mexico Landfill Gas, and China FCB II projects—no replication with links to the GEF-supported project was found.

As table 4.7 shows, the projects tested a variety of different replication mechanisms and strategies. When project design aimed at replication and where project activities were implemented

TABLE 4.6 Examples of Mainstreaming of GEF-Supported Technologies in the Project Sample via Policies and Standards

GEF ID	Project short name	Country	Policy/standard
76	Alternate Energy	India	Renewables support policy
112	PVMTI	India	Favorable tax, regulatory, and grid-extension policies
370	Biomethanation	India	Renewables and waste policy
386	Hilly Hydel	India	Renewables and rural support policies
446	RED	China	Standards, rural electrification policy
575	Ilumex	Mexico	Product specifications, phaseout policy
622	TVE II	China	National technology standards
643	Agriculture	Mexico	Product specifications
784	Landfill Gas	Mexico	Environmental standards
943	RESP	China	Technical standards, renewables support policy
1646	Education	Russia	Energy efficiency as a national priority
1284	Wind	Mexico	National policies

TABLE 4.7 Types of Replication Associated with Projects Included in This Evaluation

Type of replication	Number of projects	Country: project short name
Private sector replication	12	China: RED, TVE II, RESP India: Alternate Energy, PVMTI, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture Russia: Education
Private sector replication supported by national institutions, strategies, or policies	8	China: RED, TVE II, RESP India: Alternate Energy, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture
Replication through national, GEF, or official development assistance financial support	10	China: RED, TVE II, FCB I, RESP India: Alternate Energy, Biomethanation, Energy Efficiency, Hilly Hydel Mexico: Ilumex, Transport
Decentralized public sector replication	8	China: RED, TVE II India: Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Transport

effectively, some replication was observed. One project, China's TVE II, had an internal replication mechanism built in to catalyze broader adoption as an integral part of the project itself. It included identification of formal replication sites and the direct implementation of replication using the project's technical and financial support structures. During the project period, 118 replication sites were identified; at the time of this evaluation, replication of technologies had been successfully implemented in 108 sites in 20 counties. The direct replication at these 108 sites not only encouraged sectorwide adoption of the demonstrated technologies, but also acted as a catalyst for crucial local- and national-level regulation—which in turn supported the other pathways to broader impact, as discussed later in this chapter.

Continuation of project activities through government resources alone or complemented by official development assistance or the Clean Development Mechanism (CDM) is a replication strategy used in 10 of the GEF projects. In the Mexico Wind project and the Russia Boilers project, replication of project activities did take place, but the evaluation was not able to identify a causal link between the deployment of these technologies in other locations and the original project activities.

Technologies and approaches promoted by 12 projects were replicated through the private sector,[2] leading to overall cleaner practices or the build-up of renewable energy capacity. Projects such as China's RESP and RED and India's Alternate Energy, Hilly Hydel, Energy Efficiency, PVMTI, and Biomethanation projects contained modalities that built up a pipeline of activities with the private sector. In the Mexico Agriculture and China RED projects, continuation of the government support program appeared necessary to gain traction on activities in the private sector. In some of these cases (such as with India's PVMTI, Hilly Hydel, and Biomethanation projects), the implementation period was very long.

In eight cases, replication was significantly supported by national policies, institutions, or

[2] Of the remaining projects, Mexico's Ilumex involved a utility; the country's Landfill Gas and Wind projects only indirectly targeted the private sector; and China's FCB I and II and Russia's Education project targeted public entities and/or public transit.

strategies, and declared policy objectives that provided more supportive policy environments for sustainable energy. For example, India's PVMTI project and China's RESP had been in the GEF pipeline or under implementation for a significant period of time, but became much more dynamic and effective when their respective policy environments changed in favor of renewable energies.

The technologies and approaches promoted by the projects entailing public services (such as landfills and waste management, transit, and education) were being replicated. In these eight cases, the replication took place through different tiers of government including subnational entities such as municipalities in Mexico; as well as through schools, municipalities, and regional governments in Russia. In Mexico, the evaluation found that the demonstration of successful projects was very important for these entities. In the education sector in Russia, the demonstrations were considered less important than the curricula and a textbook for energy efficiency classes and clubs, which were used in nonparticipating schools across the country.

4.6 Scaling-Up

In more advanced cases of broader adoption, replication may take place at a scale significantly larger than the original project. Such scale-up takes replication further, through expansion to a larger geographic and administrative scale or to different technologies or economic sectors. Scaling-up was identified for 12 projects in the sample (table 4.8). In 1 of these 12 instances—the Russia Boilers project—scale-up was facilitated through avenues independent of the GEF project.

Scaling-up of project results can reach into different dimensions through various channels. Table A.6 illustrates which project outcomes or activities have been expanded. The most important dimensions for scaling-up are geographic (six projects) and widening of technological scope (five projects).

A qualitatively important aspect of scale-up is demonstrated in the roles of the countries as regional leaders. For three of Mexico's projects, the evaluation team was able to identify such a role model effect on other Latin American countries. Aspects of the Ilumex project were replicated first in Cuba. Drawing on the experience in Cuba, the República Bolivariana de Venezuela then incorporated CFLs into its development assistance to Ecuador, Nicaragua, Peru, and other countries in the hemisphere. Similarly, Mexico's Landfill Gas project is now used as a template not only within Mexico but also in other countries, such as Brazil, for relevant projects under the CDM. The Transport project in Mexico City is one of several such transit model projects in Latin America.

The China TVE II project is another instance of South-South transfer and cooperation. Experts from Bangladesh and India regularly visited the TVE test enterprises that had adopted or developed the more energy-efficient technologies. As these countries share comparable structures in their rural industries and face similar energy-related challenges, this form of transfer was quite significant. Technology transfer from OECD countries would be very difficult in these cases as the structural challenges are too different. Unfortunately, given current monitoring and evaluation systems, it is hard to assess the impact of this South-South transfer without specific investigations.

The introduction of technical standards was found to be an effective strategy for scale-up for energy efficiency and renewable energy technologies. In the project sample, this strategy was used successfully in five cases, including the TVE II project. In the TVE II project, innovative feedback and communication channels have been established between the implementation level of the energy efficiency technologies and the policy-making levels in the provinces.

A prevalent and highly effective strategy identified was the development of national support

TABLE 4.8 Scaling-Up Activities Associated with Projects Included in This Evaluation

Type of scaling-up	Number of projects	Country: project short name
Scale-up in the project countries	12	China: RED, TVE II, RESP India: Alternate Energy, PVMTI, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Landfill Gas, Transport Russia: Boilers
With significant contribution of the GEF	5	China: RED India: Hilly Hydel, Energy Efficiency Mexico: Ilumex, Transport
With some contribution of the GEF project	6	China: TVE II, RESP India: Alternate Energy, PVMTI, Biomethanation Mexico: Landfill Gas
With no identified causal link to or significant contribution of the GEF project	1	Russia: Boilers
Scale-up in other countries	3	Mexico: Ilumex, Landfill Gas, Transport
No scale-up	6	China: FCB I, FCB II India: CBM Mexico: Agriculture, Wind Russia: Education
Other scaling-up relevant influences		
National support policies with causal relationship with the GEF project	11	China: RED, TVE II, RESP India: Alternate Energy, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Landfill Gas, Transport, Wind
Product and technology standards and specifications developed in GEF projects	8	China: RED, TVE II, RESP India: Biomethanation Mexico: Ilumex, Agriculture, Landfill Gas, Wind

policies. In six cases, a causal link was found between these policies and the GEF projects.

4.7 Market Change

Most sustainable energy technologies are traded on markets. In 13 of the 18 projects evaluated, these markets have changed over time since project implementation began, and the evaluation found causal links between the respective GEF project and the observed market change. The Mexico Ilumex project provides an especially notable example. Initiated in the early 1990s, the project has significantly contributed to energy-saving CFLs replacing an old technology. Incandescent light bulbs are gradually being withdrawn from the market in Mexico, a process that began with the 2011 banning of light bulbs of 100 W or more and the 2012 ban of 75 W bulbs. Given the dramatic change in the nature of the market, the Ilumex project is indeed a case of market transformation.

In five cases, it was difficult to observe market change either because the targeted markets were nonexistent (China's FCB I and II projects and Russia's Education project), or because the evaluation did not have any tangible impact (the Russia Boilers project and the Mexico Wind project).

Four types of market changes were observed: cost reduction, improvement in the quality of the product, increase in the number and quality of suppliers, and increased demand for sustainable energy products or technologies. The most prevalent pathway was to improve the technology and/or product quality; this occurred in 12 projects. Market change sometimes required the development of national quality assurance facilities or processes (as in the Mexico Ilumex project, and China's RESP and RED project), and the formulation of product standards and specifications.

Ten projects worked on improving demand for a product or technology. This effort generally involved measures such as sales subsidies or providing more attractive offerings in the transportation sector. India's Energy Efficiency and Biomethanation projects affected the markets for energy efficiency and renewable energy technologies by demonstrating functionality and various other benefits, or by introducing mandatory standards.

Eleven projects sought to reduce the cost of the promoted products and technologies. For example, GEF support for the wind farms established as a result of India's Alternate Energy project was aimed at lowering the cost of the technology so that it would compare favorably with conventional energy–related options. Similarly, Mexico's Agriculture project provided about 2,300 farmers, who previously had no electricity, with a low-cost supply of PV energy for water pumping. Projects that focused on cost reduction also sought to increase access to the technologies and/or enhance competition among suppliers.

Seven projects focused on increasing supplier quantity and quality. Approaches taken to improve quality included capacity building, improved access to finance, and/or investment support to suppliers of renewable energy. In most cases, improvement of business skills and number of suppliers went hand in hand with improvements in product quality. Often, a project achieved these goals by requiring adherence to a predetermined quality standard and certification of products or providers in order to qualify for project services/support.

In the case of China's renewable energy projects, GEF activities aimed at improving the technical capabilities of solar and wind manufacturers changed not only local markets but global markets as well. Due to the improved international competitiveness of the products, the manufacture of equipment for generation of wind and solar energy has become an important Chinese export sector. In India, the Alternate Energy project requirement for competition in procurement has fostered development of international joint ventures and has thus led to improved local product quality. The increased manufacturing capability is also due to the opening up of the Indian economy, maturation of the renewable energy industry, technology improvement, and cost reduction.

4.8 Summary: Use of Pathways for Broader Adoption

The GEF theory of change suggests five pathways for broader adoption of the GHG-related measures promoted in GEF projects: sustaining, mainstreaming, replication, scaling-up, and market change. All of these have played a role in the examples investigated in this evaluation. As table 4.9 shows, those projects that have higher progress to impact ratings generally have used more of these pathways more often than have the other projects.

Some projects, such as India's Hilly Hydel and Mexico's Ilumex projects, have had impacts through all the pathways tracked as part of this evaluation. These two are among the oldest projects in the sample, which might indicate that using these pathways does take time. On the other hand, some highly successful projects have had a comparable or larger impact using fewer pathways—for example, the China TVE II and Mexico Transport projects.

The table also indicates that some technologies require more comprehensive "pathway bundles" to lead to broader impact than others, and that not all projects are equally suited for pursuing all pathways. For example, it is not possible to mainstream fuel cell buses at this point, as the technology is not

TABLE 4.9 Summary of Pathways to Broader Impact

GEF ID	Short name	Country	Sus-taining	Main-streaming	Repli-cation	Scaling-up	Market change				Progress to impact rating
							Product quality	More/better suppliers	More demand	Cost reduction	
76	Alternate Energy	India	✔	✔	✔	✔	✔	✔	✔	✔	Significant
112	PVMTI	India	✔	✔	✔	✔		✔	✔	✔	Moderate
292	Boilers	Russia									Low/negligible
325	CBM	India	✔	✔	✔		✔				Significant
370	Biometha-nation	India	✔	✔	✔	✔	✔		✔	✔	Significant
386	Hilly Hydel	India	✔	✔	✔	✔	✔	✔	✔	✔	Significant
404	Energy Efficiency	India	✔	✔	✔	✔	✔	✔	✔	✔	Moderate
446	RED	China	✔	✔	✔	✔	✔	✔	✔	✔	High
575	Ilumex	Mexico	✔	✔	✔	✔	✔	✔	✔	✔	High
622	TVE II	China	✔	✔	✔	✔	✔				High
643	Agriculture	Mexico	✔	✔	✔		✔		✔	✔	Moderate
784	Landfill Gas	Mexico	✔	✔		✔	✔		✔	✔	Significant
941	FCB I	China			✔					✔	UA
943	RESP	China	✔	✔	✔	✔	✔	✔		✔	High
1155	Transport	Mexico	✔	✔	✔	✔	✔		✔		High
1284	Wind	Mexico									Low/negligible
1646	Education	Russia	✔	✔	✔						Moderate
2257	FCB II	China									UA

NOTE: UA = unable to assess.

sufficiently mature. Similarly, broader adoption of the India CBM or Mexico Landfill Gas project is limited to suitable sites.

Comparisons among projects within the same thematic cluster show that the more comprehensive the project approach, the greater the likelihood for larger impact. In the renewable energy field, the projects evaluated range from the research-oriented Wind project in Mexico to the finance-oriented Alternate Energy project in India to China's RESP, which addressed barriers to supply, demand, and policy with a comprehensive set of activities. In the energy efficiency field, a similar range can be found from the demonstration-oriented Boilers project in Russia; through the finance-oriented Energy Efficiency project in India; to China's TVE II project, which included innovation, demonstration, replication, and standard setting and policy components.

This range somewhat reflects a spectrum of pathways—from sustaining to replication to scaling-up to market change. While sustaining is a simple continuation of the activities performed by the GEF project, replication means that these activities are repeated without GEF resources. Scale-up requires even more resources, as does market change/market transformation. When more than one project pathway was followed, a more comprehensive project design and higher resource input were required.

There have been changes in the level of progress to impact achieved by the various projects. While several have achieved greater progress to impact with the passage of time, in a few instances, the gains made by the point of project completion were lost in the postproject completion period.

However, the scope of these projects was still very limited compared to the overall size of the challenges entailed—particularly in the context of the large markets in the sample countries. In order to describe the contribution of the GEF projects, it is necessary to view these efforts in the context of the larger trends discernible in these markets.

5. Factors That Affect Broader Adoption

A global shift toward more renewable energy and energy efficiency has accompanied the GEF GHG-related projects in emerging markets. This shift was triggered in part by a global upward trend in energy prices on the one hand, and enhanced development and cost reduction of renewable energy and energy efficiency technologies on the other. These two trends constitute a backdrop to the overall adoption of GEF-supported approaches. In all countries in the sample, higher energy prices accompanied by—in most countries—strong economic growth have raised concerns about energy security and affordability, and enhanced the value placed on domestic energy sources.

The evaluation found that the GEF used several approaches to target markets:

- Providing better, lower-cost products
- Undertaking activities aimed at stakeholders—that is, suppliers and relevant institutions
- Stimulating consumer demand
- Providing financing
- Addressing the policy and regulatory environment

Based on this finding and the previously discussed assessments of mechanisms for broader adoption of GHG-saving technologies or behaviors, this chapter looks at the extent to which market change took place and was influenced by GEF activities, and whether there are other factors that led to these changes.

5.1 Better, Lower-Cost Products

In 14 projects, the climate-friendly technology or product became better or cheaper during the impact period of the GEF project. Overall, 12 of these 14 projects led to better products and 11 to more cost-effective products (table 5.1). In nine projects, products improved in both aspects.

A special strategy that led to lower costs was the bulk purchase of energy-saving lamps (CFLs) in the Mexico Ilumex project. This bulk purchase—combined with the availability of financing mechanisms, testing, and quality control—made CFLs affordable for consumers. Of the projects covered by the evaluation, the Ilumex project is the only one that has achieved transformation of the target market. The GEF project started in the mid-1990s, and the trajectory of its impact ended in 2013 with the complete phaseout of incandescent light bulbs. The project had built on a local pilot in Mexicali and local testing of CFLs through the national utility, the Comisión Federal de Electricidad (CFE). In the wake of the GEF project, the national energy conservation fund Fideicomiso para el Ahorro de Energía Eléctrica (FIDE) has continued the residential lighting program; consequently, by the end of 2010, 14 million CFLs had been sold under the program. Because of the phaseout of incandescent lights in Mexico and this project's influence on the process, it may be inferred that the project directly contributed to the transformation of the targeted market.

TABLE 5.1 **Summary of Market Change: Better and More Cost-Effective Products**

Factor	Number of projects	Country: project short name
Better product	12	China: RED, TVE II, RESP India: Alternate Energy, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas, Transport
Lower cost	11	China: RED, TVE II, FCB I, RESP India: Alternate Energy, PVMTI, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas
First application in country	6	China: FCB I India: CBM, Biomethanation Mexico: Ilumex, Landfill Gas, Transport
Technical standards (legal or voluntary)	8	China: RED, TVE II, RESP India: Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas
Capacity building and grants to equipment manufacturers	14	China: RED, TVE II, FCB I, RESP India: Alternate Energy, PVMTI, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas, Transport
Local production	7	China: RED, FCB I, RESP India: Alternate Energy, PVMTI, Biomethanation Mexico: Ilumex
Bulk sales	1	Mexico: Ilumex
Drop in price due to more competition among suppliers linked to GEF project	2	China: RESP India: Alternate Energy
Change in national market external to the GEF project	1	India: PVMTI

NOTE: *n* = 14.

Other projects in the sample have been cited in the literature as best practice examples for market transformation (Birner and Martinot 2005; Purohit 2008). All the cases demonstrate that market transformation in emerging markets is a process that takes more than a decade, even for a comparatively easy application, such as CFLs.

An important avenue for improving product quality is technical standards and testing. Eight projects introduced voluntary or legal standards that led to lower costs or a better product.[1]

The China RED project and RESP combined adherence to standards with capacity building and performance grants to manufacturers. There are other examples where projects enhanced local production of energy technologies without directly addressing the manufacturers. For example, the India Hilly Hydel project led to lower costs for small hydropower facilities by intensifying local competition among suppliers.

[1] In many additional markets, standards for the technologies were specified at some stage, but the post-project evaluation was not always able to track whether the development of these standards was funded by or causally linked to the GEF—for example, the Mexico Ilumex project.

Improving technology quality also enhances the impact the technologies may have. Two different approaches may be relevant in this regard. First, easily available technologies need to be tweaked for local use so that the promoted products are sufficiently sturdy and durable to meet usage challenges in rural environments (e.g., China RED) and are reliable (e.g., India Biomethanation and Hilly Hydel). Second, by encouraging the use of technologies that adheres to international standards, producers may be able to access export markets that may generate additional revenues (e.g., China RED and RESP).

On the other hand, it may be difficult to demonstrate viability and enable consumer acceptance of even highly cost-effective technologies. For example, India's Biomethanation and CBM projects both continue to face significant technical challenges, even though the technologies involved are not only cost-effective but also reduce waste.

5.2 Better Stakeholders: Suppliers and Institutions

SUPPLIERS

In seven cases, market change was effected through better and more suppliers. The presence of better suppliers and increased competition among them may lower product and service costs for consumers. In 17 markets, GEF projects made specific efforts to improve the capabilities of the businesses that provided services or hardware to the climate-friendly technologies.[2] These activities ranged from demonstrating the technology or its financial feasibility (Mexico Ilumex), to information platforms (Mexico Wind) and other forms of dissemination (Russia Boilers), to teaching and training (China TVE II) and other more in-depth forms of capacity building. In 14 markets, the evaluators identified some contribution of the GEF to a reduced lack of technical expertise with the supply chain businesses.[3] According to this analysis, the GEF made significant contributions to improvement of the supply chain in the following projects: India CBM, Mexico Transport, China FCB II, and China RED—implying that in most other cases, major improvements of the supply chain might be due to other factors. For example, in the Mexico Wind case, there was significant capacity building of the supply chain outside of the GEF project; therefore, none of the positive change can be attributed to the GEF's capacity-building efforts.

A self-stabilizing effect of broader adoption was observed when a local industry was built up. The best showcase for this effect was in China, where the local policy was conceived and implemented by the government. The GEF supported this policy development with technical assistance. In addition, GEF support was contingent on quality standards, and the GEF provided subsidies for companies to actually reach these quality standards, along with helping the government enforce the standards. Without high quality, Chinese wind and solar technologies might not have been successful in the international market, and would thus not have gained the significance they hold today in terms of jobs and economic growth because fewer people would have adopted the technology. This in turn reinforces Chinese momentum for renewable energy.

In that sense, the build-up of local manufacturing capacities might constitute a viable sustainability and replication approach for some sectors and countries. In some cases, a lack of attention to local manufacturing capacity and value chains might constitute a barrier for sustainable energy

[2] These markets received ratings of at least 2 (moderate intensity) on evaluator assessments of "intensity of the barrier removal activity within the GEF's framework"; these ratings are explained in annex B.

[3] These markets had barrier intensity scores that were lower at the end of the project than in the beginning (16 markets in all), and there was some attribution of the GEF to this improvement.

deployment, as governments and other local stakeholders might be less inclined to support sustainable energy technologies if these technologies put their domestic industries at a competitive disadvantage. This barrier contributed to the limited effectiveness of the Russian Boilers project.

INSTITUTIONS

With the exception of two projects (India PVMTI and China TVE II), all projects in the sample worked with local institutions in the countries. Typically in emerging markets, strong government institutions are available and have significant influence on economic activity—for example, through subsidies, advisory services, and sometimes even financing—making them a natural choice for partnership. Most projects (10) named ministries as executing agencies. In three cases, line agencies were the executing agencies. These line agencies were already dealing with financial flows to the target groups; for instance, the Indian Renewable Energy Development Agency Ltd. (IREDA) is an enterprise of the Indian government whose mission is to finance and promote self-sustaining investment in sustainable energy.[4] FIRCO is a risk-sharing facility of the Mexican Ministry for Agriculture, Rural Development, Fisheries and Food (SAGARPA), which is "channeling additional financial resources" to the rural sectors.[5] One project each was implemented through a national utility, a research institution, and a municipality. With the exceptions of the national utility and the municipality, these various executing agencies ultimately were not reducing their own emissions but were working so that other stakeholders—businesses, public institutions, private households—reduced their carbon footprint.

The executing agencies used various approaches and strategies to reach their target group, as can be seen in table 5.2. In the sample, very few agencies executed more than one project.[6] Depending on the local setup, executing agencies included other stakeholders and agencies on many project components; this ensured effective delivery of project activities.

Sixteen interventions targeted a professional audience, mostly businesses but in some cases public entities as well (schools, landfills, or transportation systems). Even if the projects dealt with technologies that were to be used by consumers, the agencies involved in these projects were partially working with or through businesses (e.g., China RED and India PVMTI). In those cases where professional applications were made more sustainable, many of the successful projects resorted to using knowledge brokers, such as nodal agencies, associations, or other specialist advisers. This was the case at least in the India CBM, Biomethanation, and Hilly Hydel projects, as well as the China TVE II and Mexico Agriculture projects. Often, these were highly specialized institutions for specific industrial sectors (such as in the India CBM and Biomethanation cases). This was helpful, as the knowledge brokers typically have a high degree of credibility with the target group, as had the agricultural fund FIRCO with the farmers. In many cases, these institutions were then the knowledge repositories and motors for replication of the project's activities. A very good example is the China TVE II project. On the other hand, the isolated support from the GEF to such a knowledge broker (a government research center) in the case of the Mexico Wind project did not necessarily yield the envisioned success.

The sample is too small to derive systematic conclusions on the use of knowledge brokers to instill clean energy thinking in professional target

[4] IREDA, "Our Mission," http://www.ireda.gov.in/forms/contentpage.aspx?lid=834.

[5] FIRCO, "About Us," http://www.firco.gob.mx/Paginas/About-Us.aspx.

[6] Only the two Russia projects and two of the India projects were executed by the same agency.

TABLE 5.2 **Executing Agencies, Target Groups, and Approaches of Projects**

				Target group		Project approach			
GEF ID	Short name	Executing agency	Type	Households	Businesses	Capacity building	Dissem-ination	Demon-stration	Financing
76	Alternate Energy	IREDA	Line agency	✔	✔	✔	✔	✔	✔
112	PVMTI	IFC	International government organization	✔	✔	✔	✔	✔	✔
292	Boilers	Ministry of Industry, Science and Education	Line ministry	✔					
325	CBM	Ministry of Coal	Line ministry	✔	✔	✔	✔	✔	
370	Biomethana-tion	Ministry of New and Renewable Energy	Line ministry		✔	✔	✔	✔	✔
386	Hilly Hydel	Ministry of Environment and Forests	Line ministry	✔	✔	✔	✔	✔	✔
404	Energy Efficiency	IREDA	Line agency	✔	✔	✔	✔	✔	✔
446	RED	State Economic and Trade Commission	Line ministry		✔	✔	✔	✔	✔
575	Ilumex	CFE	Utility	✔	✔	✔	✔	✔	✔
622	TVE II	UNIDO and Ministry of Agriculture	International government organization						✔
643	Agriculture	FIRCO	Line agency	✔	✔	✔	✔	✔	
784	Landfill Gas	Ministry of Social Development	Line ministry		✔	✔	✔	✔	
941	FCB I	Ministry of Science and Technology	Line ministry			✔	✔	✔	
943	RESP	Ministry of Finance	Line ministry		✔	✔	✔	✔	✔
1155	Transport	City of Mexico/D.F.	Municipal administra-tion	✔	✔	✔	✔	✔	
1284	Wind	Electrical Research Insti-tute (IIE)	Research institution			✔	✔	✔	
1646	Education	Ministry of Industry, Science and Education	Line ministry	✔	✔	✔	✔	✔	
2257	FCB II	Ministry of Science and Technology	Line ministry			✔	✔	✔	

groups, but it might indicate a need for further research. When these agencies were used, their capacity to understand climate mitigation options was enhanced. Often they continued with climate-related activities because of some endogenous motivations. For example, the agricultural fund FIRCO in Mexico is now nationally recognized as an important source of information on renewable energy. Generally, almost all projects show that capacity building with government institutions and businesses is a necessary requirement for replication of project-generated momentum after project end. In many cases, there is insufficient expert capacity, which severely limits broader adoption—for example, in the areas of energy audits in Russia and India. On the other hand, it is necessary that these institutions then also utilize their knowledge and have access to the relevant decision makers.

A comparatively large share of the sample projects are demonstration or pilot projects. These projects—Mexico Landfill Gas, China TVE II, India Biomethanation, India CBM, Mexico Transport, and Russia Boilers—all introduced a technology for the first time to the respective country context or developed it locally. The comparison of these projects shows that the probability for broader adoption increases when the interplay among research institutions, companies, and national certification and standardization institutions is addressed effectively. Helping these technology transfer networks function well can lead to a situation in which major regulatory and certification uncertainties are removed quickly and commercial deployment of new technologies becomes practical. In this sense, the China TVE II project, for example, helped create its own market by influencing standardization and policy setting, and created as an exit strategy a technology advisory service company that continues to support industrial companies in energy efficiency efforts.

5.3 Consumer Demand

Increased consumer demand was another indicator of market change. In 10 projects, the demand for a clean energy product or technology was increased after the project ended. The barrier analysis demonstrated that in almost all projects, significant barriers to adoption of the climate-friendly technology or behavior resided with the users of the technology. The only projects that had no critical or "show-stopping" barriers in the user realm were the China RESP and the FCB I and II projects. Ignorance about the technology by prospective users was the most pervasive barrier throughout the sample.

Among the projects covered by this evaluation, the entities that accounted for demand for the clean energy solutions were private sector companies (renewable energy projects and industrial energy efficiency projects) and public sector entities (for the projects addressing public transit, landfill gas, schools, and municipal heating systems). Household-scale technologies included in the analysis were CFLs (the Ilumex project) and solar home systems (various renewable energy projects). This breakdown is in line with the mitigation potential in developing countries, as industry and public entities (including the energy sector) typically were, and perhaps still are, the most important consumers of fossil fuels in emerging markets. For businesses, it can be assumed that these entities behave in an economically rational manner and apply a financial calculus in their decision making. In addition, they have a higher degree of technical capacity and knowledge, and the technologies they use are typically more complex than those used in private households. Thus, a lack of technical expertise in utilizing sustainable energy technologies can be a very decisive factor in their demand.

A lack of technical expertise with the customer base was identified for almost all projects in the sample. Accordingly, almost all projects gave attention to addressing constraints that affect consumer choice through outreach, capacity building, or improved affordability and cost-effectiveness. Again, supported activities ranged from dissemination to training, active marketing, and subsidies. With the exception of the Mexico Wind, the Russia projects (Boilers and Education) and the China RESP where the contribution of the GEF was not rated, all projects identified significant or high contributions of the GEF to the removal of the barriers to widespread use of the technologies that had been identified with the users. Particularly in the Russia projects, users were often not in charge of significant shares of their energy consumption because of building and heating system ownership structures, so no significant savings could be achieved (principal-agent dilemma).

While the barrier removal activities were found to be rather successful, only 10 projects were evaluated as changing demand for the project noticeably. In the projects in India and China, the technology adopters or users were private sector companies whose operations became safer or more efficient and economically viable through adoption of the GEF-promoted practices. Industrial energy efficiency or waste disposal was not part of the core competencies of these companies, but it seems that after they had learned to use the technologies, these practices became attractive and the companies became more interested in using them.

Many of the projects took a long time to impress their intentions on the audience. In India, the CBM project was implemented for more than 142 months, the Biomethanation project for more than 140 months, the Hilly Hydel for more than 116, and the Energy Efficiency project for more than 88; the China TVE II project was implemented for more than 83 months. The average implementation period of these projects with the target group of industrial adopters was 114 months, as compared to 84 months for the average implementation period for the whole sample. Five of the seven longest projects are among this group. The other two projects were embedded in long-standing national efforts. The Mexico Ilumex project was under implementation for a short period, but its lasting impact was ensured through the government's consistent continuation of subsidies for CFLs (which were supported for at least 13 years, through 2010). Similarly, the government continued financial incentives for farmers to buy solar systems after the Mexico Agriculture project. Thus, it seems that in all these cases, the time needed for the target group to develop a taste for unconventional technologies and behavior changes was considerably longer than the normally scheduled implementation time for typical GEF projects.

5.4 Financing

Sustainable energy solutions are often associated with some investment—frequently a higher investment than required for conventional energy solutions. In addition, when they are still innovative, these technologies are even more expensive. For example, the CFLs introduced by the Mexico Ilumex project cost less than a dollar today, but they were estimated to cost more than about $20 a piece at bulk purchase prices in 1993 (Sathaye et al. 1993). Thus, the availability of financing is a necessary precondition for broader uptake of climate mitigation options, independent of further GEF support—particularly as the target groups of most of the projects in the sample are businesses. Very often, loan financing would have been necessary but was unavailable from commercial banks. The barrier analysis that was conducted for 18 markets in the context of this evaluation estimated that, in 14 cases, a significant or critical barrier was that consumers were not able to afford the technology.[7]

Apart from financing demonstration installations in 16 projects in the sample for this

[7] These markets received ratings of 3 or 4; these ratings are explained in annex B.

TABLE 5.3 Avenues for Projects to Improve Access to Financing

Avenue	Number of projects	Country: project short name
Loan facility, e.g., revolving fund at national institution	4	China: TVE II India: Alternate Energy, Hilly Hydel, Energy Efficiency
Cost-share grants/subsidies	5	China: RED, TVE II, RESP Mexico: Ilumex, Agriculture
Vendor financing	1	Mexico: Agriculture
Loan facility at GEF Agency	1	India: PVMTI
Facilitation of bank financing through developing a project pipeline	8	China: RED, TVE II, RESP India: Alternate Energy, Hilly Hydel, Energy Efficiency, PVMTI, Biomethanation

NOTE: $n = 9$.

evaluation, 9 projects included specific financing components (table 5.3). Of these, four implemented revolving funds with national agencies—that is, these agencies were endowed with GEF funds, which they could then use alongside their own resources for project financing. The majority of GEF financial support went to subsidies for a large number of investments.[8] In the case of the Mexico Agriculture project, the subsidy was complemented by loan financing provided through the vendors of the renewable energy systems. In the case of the India PVMTI project, financing was provided through concessional lending directly from the GEF Agency. Many of these mechanisms, as well as some of the technical assistance and capacity-building support provided, helped facilitate financing through banks—for example, by helping prepare bankable project documents or providing partial loans that reduced the size of bank loans.

Ultimately, self-sustaining markets require the availability of financing through local financiers. In many cases, governments provided subsidies for these investments, and most technologies were eligible under the CDM. In addition, many countries provided national lending—for example, through the specialized renewable energy financing authority IREDA in India. In order to provide financing, financiers need to trust the technologies and need to understand their advantages at least economically. For some of the approaches, demonstrations ensured that financiers were more willing to lend for these purposes. Examples can be found in the India Biomethanation project, which demonstrated waste-to-energy technologies for a number of industries. Now even municipalities can increasingly finance these projects through public-private partnerships or in fully private setups.

The barriers to affordability at the end of the projects were rated lower than at project start. At project exit, only 5 projects had significant or critical barriers in terms of a lack of affordability for users, down from 14 at project beginning. Overall, the availability of finance at the end of the projects was characterized by more or less predictable investment rationales of the financiers. Where a proven technology was proposed by a creditworthy entity and without significant policy and legislative risks, financing was typically not the limiting factor for broader adoption. In eight projects, this influence was significantly or strongly attributed to the GEF project.

5.5 Policy

Often, policy schemes or the formulation of credible policy objectives (with or without GEF support) have enhanced the success of project financing

[8] Larger than the 16 demonstration projects, in the case of the India Biomethanation project.

components. A good example is the PVMTI project in India. Off to a slow start over many years without a supportive policy environment, the project did not make much headway initially. However, the advent of a supportive framework in the form of the Jawaharlal Nehru National Solar Mission allowed a number of businesses and business models supported by the GEF project to grow and serve as role models for other businesses. At the time this evaluation was conducted, the four countries covered by the evaluation have set political objectives and targets for using more renewable energy or for becoming more energy efficient.

The sample shows that all projects that demonstrate high progress to impact ratings have included policy components or have resulted in, or were accompanied by, significant work on the legislative level at some stage. In all 12 cases in which replication in the private sector could be found, it was significantly supported by national policies, institutions, or strategies, and declared policy objectives that provided more supportive policy environments for sustainable energy. Examples of policies for the support of GEF-promoted technologies are provided in table 5.4. Two types of activities targeted at policy change are typically incorporated in the design of GEF projects: national support policies, including technical standards, specifications, and certifications for new technologies and high-level support policies (including electricity sector policies and feed-in tariffs); and subsidiary types of policies, such as import tariffs, permitting and licensing, zoning, titling, and insurance requirements.

Broad impact through federal-level support policies was observed in many cases—in fact, in all cases that had a large impact. The most successful project effort in this regard was the China RESP, which helped the government through numerous policy design studies to enhance its renewable energy deployment Mandated Market Policy and become home to the world's biggest wind turbine fleet. Here, GEF support directly helped improve the policy environment and made the overall sectoral growth faster and more efficient. Even in projects with a smaller carbon impact, such as the Mexico Agriculture project, national support policies were decisive in broader adoption of the technology. However, as demonstrated in the India CBM project, simply stating a national target is insufficient for project success or broader impact.

Almost all projects were in line with national priorities when finalized, even if they were not so aligned at their start. In the case of the India Biomethanation project and the China TVE II project, the government began giving greater attention to targeted concerns (e.g., waste management and industrial energy efficiency) only after the start of project implementation. In that respect, general government targets were less influential than whether the legislation to support these objectives was complete and operational, as well as unabatedly supportive of the technological approach chosen by the project. The general foundational activities of the GEF were certainly helpful in the national processes for establishing and formulating these national priorities.

The analysis indicates that non-energy-specific policies often remain a barrier to broader adoption of a piloted technology. For example, in the India CBM, Russia Boilers, and China FCB I and II projects, broader adoption was not possible as the technologies were (and partially still are) not approved for safety according to national standards. The Indian small hydro technology needed to be modernized with new dispatch and regulation technologies, and performance standards had to be introduced in order to ensure its operation. In China, quality assurance of wind and solar technology was a crucial factor in broader impact.

Other gaps in the legal framework that have frequently hampered project effectiveness are land title and ownership arrangements. Tariffs, taxation, zoning, and grid connection regulations can

TABLE 5.4 **Factors for Broader Adoption, Findings, and Examples**

Factor	Finding	Country: project short name
	Product/technology	
Cost-effectiveness	Even highly cost-effective technologies can be difficult to demonstrate	India: CBM, Biomethanation
	Broader impact was achieved through lower-cost technologies and products	China: RED, TVE II, FCB I, RESP India: Alternate Energy, PVMTI, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas
Quality	Broader impact was achieved through higher-quality technologies and products	China: RED, TVE II, RESP India: Alternate Energy, CBM, Biomethanation, Hilly Hydel, Energy Efficiency Mexico: Ilumex, Agriculture, Landfill Gas, Transport
	Quality is important for local acceptance of the product or technology	China: RED India: Biomethanation, Hilly Hydel
	Product quality at international standards can help create internationally successful enterprises	China: RED, RESP
	Stakeholders: suppliers and institutions	
Technical expertise/ more and better suppliers	Without a significant pool of local experts, no project has been able to reach broader impact; GEF projects have provided various types of assistance and enhanced local expertise	China: RED, RESP India: Alternate Energy, PVMTI, Hilly Hydel, Energy Efficiency Mexico: Ilumex
Build-up of a local industry/supply chain	A local supply chain can stabilize and broaden impact	China: RED, RESP India: Hilly Hydel
Reaching the target group (households)	Projects targeting the household sector were not able to stimulate demand for energy-efficient or renewable energy products without subsidies	China: RED India: PVMTI Mexico: Ilumex Russia: Boilers, Education
Reaching the target group (businesses)	Specialized ("nodal") agencies have high credibility with industrial target groups and might be able to function well as knowledge centers for their constituency	China: TVE II India: Biomethanation, CBM
Networks of agencies	Likelihood of broader adoption increased with effectiveness of interplay among businesses and research and national institutions	China: TVE II India: Biomethanation, CBM Mexico: Landfill Gas
	Consumer demand	
Users/consumers	Most projects targeted businesses or public services, in line with GHG mitigation potential	
Cognitive and financial barriers	In almost all projects, there were critical cognitive or financial barriers on the part of prospective users of the technology	Only exceptions: China RESP and China FCB I and II projects
Principal-agent dilemma	Broader impact is difficult if the target group does not benefit from a reduction of its GHG emissions	Russia: Boilers, Education
Stimulating demand	It is possible to stimulate demand by highlighting the attractiveness of sustainable energy solutions, but it takes a long time	India: Alternate Energy, PVMTI, Biomethanation, Hilly Hydel, Energy Efficiency China: REDP Mexico: Ilumex, Agriculture, Landfill Gas, Transport

(continued)

TABLE 5.4 Factors for Broader Adoption, Findings, and Examples *(continued)*

Factor	Finding	Country: project short name
Finance		
Availability of finance from commercial banks	Availability of finance was often a function of policy environments and the soundness of the projects	China: RED, RESP India: PVMTI
Investment subsidies	In many cases, countries continued subsidy schemes, which led to broader adoption	China: RED, RESP India: Alternate Energy, Biomethanation, Energy Efficiency, Hilly Hydel, PVMTI Mexico: Agriculture
Policy		
Policy framework	All projects with high progress to impact ratings take place in situations with supportive policy frameworks	China: RED, TVE II, RESP Mexico: Ilumex
National targets for deploying renewables, enhancing energy efficiency, or reducing emissions	Stated national targets are insufficient to ensure broader adoption	India: CBM
Non-energy-specific legislation	Lack of subsidiary legislation (such as safety standards, grid regulation, or tariffs) can be an important brake on broader adoption	China: FCB I and II India: CBM Russia: Boilers
Technical certification, energy efficiency standards	Co-evolution of technical development and standards setting, as well as quality assurance, maximizes broader impact	China: RED, TVE II, RESP Mexico: Landfill Gas

also hamper progress.[9] For example, in the Russian building sector, the distribution of responsibilities for maintaining buildings and heating systems among municipalities, apartment owners, and management companies of privatized multifamily blocks remained unclear for a long time. To this day, the fact that homeowner associations are voluntary in Russia makes significant investments in energy efficiency in residential buildings difficult.

5.6 Other Factors: Project Strategies and Mechanics

Project strategies and the mechanics of project delivery also affect project results. A number of aspects internal to the GEF appear to facilitate broader adoption. The first such aspect is latitude for **adaptive management**. Several projects demonstrate that without some flexibility for adaptive management, direct and indirect impacts would be much smaller. In the China TVE II project, the pilot enterprises had been selected in the preparation phase. Just before the start of project implementation, the national catalogue for technologies to be phased out was adjusted, which required reconsideration of the technologies best suited for this project and changes in the pilot companies. Technical and locational details are best assessed locally; this requires adaptive management.

Another aspect of GEF projects mentioned repeatedly by stakeholders is the high level of **documentation** they require. This may raise the costs of project implementation for GEF Agencies; however, it may have some benefits as well. Consistent monitoring and evaluation lead to a knowledge base that allows for faster and more effective replication. Such a knowledge base has been utilized,

[9] Not all evaluations provided details on potential challenges.

for example, in the case of Mexico's Ilumex project, which was replicated in several other Latin American countries.

A third attribute is the **prolonged and reliable nature of GEF support**. Many of the projects in the sample had long durations from pipeline entry to approval and implementation. The average duration was around 80 months, but the longest was 152 months, and 26 percent of the projects in the sample were implemented over more than 100 months. During this time, even as policy trends in countries changed, the local stakeholders supported by the GEF project knew they could continue their work on the GEF-supported approach. This assurance allowed a significant number of projects and climate mitigation champions to maintain their focus on a less-carbon-emitting world, even when the surrounding political environment was not entirely supportive of this vision. The level of assurance provided through GEF support has been very important in maintaining an overall trend toward energy efficiency and renewable energy.

A downside of long project lead times is that project design and expectations may need recalibration after implementation start. For example, the India CBM was downsized during implementation because of technical constraints in the selected project sites. In another case, the China RED was strongly reduced in its wind component and the associated expectations in terms of GHG emissions reductions when local interest in wind energy seemed low, but was afterwards included in the RESP. In other projects—Mexico Agriculture and Mexico Wind—the expected GHG savings were erroneously estimated. In the Mexico Wind case, this came about because of a lack of a prescribed GHG accounting methodology. In the two other cases—India CBM and China FCB II—technical, stakeholder, or legal conditions were misjudged at the project design stage so that the projects could not be implemented as planned. In general, the indirect impacts of projects such as jobs or adoption of new environmental regulations were typically not considered as very relevant during project approval.

5.7 Summary: Factors That Affect Broader Adoption

The specific promoted technology or approach is a determinant of the degree to which other supportive factors come into play in facilitating its broader adoption. The cost-effectiveness of all technologies is not necessarily equal. Some technologies are highly profitable to implement, while others are only cost-effective if there are subsidies or incremental cost payments involved (e.g., through the CDM). Typically, this concept of cost-effectiveness is expressed through the marginal abatement costs of the technology. However, several types of costs that are important may not show up in the classic marginal abatement cost curve discussion. For example, even though the marginal abatement cost curve of a technology may make it viable in a given market, the removal of entry and other barriers may be costly.

The GEF projects triggered significant changes in many areas (e.g., the Mexico Landfill Gas, India Biomethanation, and India CBM projects). Table 5.4 summarizes the examples of the relevant intervention areas that were targeted through the GEF projects. Several of these address barriers hindering market change.

Most of the projects with a high progress to impact rating adopted a comprehensive, multicomponent approach to addressing market barriers and promoting market change, analyzing all stakeholders and barriers a technology might face and having an overall higher likelihood of reaching large-scale impact. The most multipronged approach was taken by the China RED and RESP initiatives, which included policy, financing of investments and manufacturing, quality assurance, and other aspects of technical assistance.

6. Implementation and Related Factors Influencing Broader Adoption

This chapter looks at how implementation and other operational elements of GEF projects may influence broader adoption, specifically focusing on the challenges of measuring and attributing GHG benefits, and of counterfactual establishment.

6.1 GHG Measurement Methodology and Attribution Challenges

LACK OF GUIDANCE AND STANDARDIZED METHODOLOGY

At the time most of the projects in the sample were approved, no harmonized methodology for GHG assessment had been issued. Consequently, projects did not necessarily differentiate between direct and indirect GHG emissions reduction impacts. For example, the intended GHG emissions reduction of the Mexico Wind project at project approval had been specified as 80 Mt of GHGs per year, which was almost a fifth of overall Mexican emissions at the time. The project had no investment component and intended to contribute this objective through a limited set of scientific studies and policy advice.

The lack of guidance on how causal links between project activities and project impacts should be described and how GHG impacts could be quantified during project approval was addressed in GEF-3 with the publication of the GEF GHG methodology (GEF 2008). In particular, attribution and treatment of indirect impacts had to be harmonized across projects. The methodology clearly specifies that direct GHG impacts are "calculated by assessing the fuel savings attributable to the investments made during the project's supervised implementation period"—that is, it attributes those GHG savings directly to the project and claims full causality for them.

Considerable divergence was observed in lifetime GHG emissions reduction/avoidance benefits expected at the project start and estimated at project completion. For just under half of the projects (43 percent) covered in the sample, the direct GHG impact had been overestimated at the beginning of the project. In addition, final project reports typically do not fully disclose all parameters that were used for the GHG analysis. Other reasons for divergence lie in the methodology itself. As table 6.1 indicates, the GHG measurement calculations are highly sensitive to certain assumptions and parameters. First, at the point of a project's completion, not all of its attributable impacts have manifested. For example, at implementation completion of a project focused on promoting replication of energy-efficient systems, not all of the energy systems that could be attributed to the project are known or can only be estimated with limited accuracy. As a result, estimates at the point of project completion are likely to vary substantially from actual impact.

Second, very few projects include arrangements that allow monitoring of energy service

TABLE 6.1 Types of Errors Encountered in GHG Calculations among Projects Included in the Evaluation

Area	Type of error	Example
Installed capacity	Over- or underestimation	China RESP: Sometimes 28 MW small hydro, sometimes 24 MW small hydro
Capacity factor (power that can be generated from a MW of installed capacity)	Over- or underestimation	China RED: Assumed average capacity factor of solar PV systems of 35%; 14% would be more realistic
		China RED and RESP: Assumed average of 2,500 hours of full load operations of wind systems; 29% of full (100%) load is more realistic Full load hours within the same project for small hydropower varies from 2,000 to 8,100
Operating hours	Calculation errors	Mexico Agriculture: Pumps would have to be on average over 70 kW if they are under operation 3,000 hours/year
System size	Using wrong number of digits or decimal places	Mexico Agriculture: Typical irrigation pumps are < 10 kW
Emission factors: CO_2 emission reduced per unit of fuel/electricity	Using marginal or average emission factors	Marginal: Can, e.g., be coal with 1,000 g/kWh or gas combined heat and power with 350 g/kWh versus average can be anywhere lower or higher
	Using outdated emission factors	China and India emission factors were reduced from 2003 to 2012; this change was not factored in
Benefit period	Inconsistent with methodology or comparison between technologies	India Energy Efficiency: 20-year benefit period for all promoted technologies

delivery through product life, so there is a need to rely on estimates. In some cases, estimates have been found to be out of line with general experiences on performance from other countries. For example, for the China solar PV systems, it was assumed that all would generate power at full rated capacity for 3,000 hours per year—which would be technically feasible only for highly sophisticated (tracking) solar PV systems in completely cloudless desert situations under perfect operating conditions.

A third major aspect that can distort GHG benefit calculations is the time-boundedness of the emission factors.[1] Particularly for electricity, some emission factors have changed substantially over recent years. The methodology does not specify which factors have to be used. Depending on whether the emission factors before or after the project are used, expectations—as well as achievements—can vary by as much as 15 percent. Cumulative GHG savings over the lifetime of the equipment depend on the benefit period, that is, the emissions-reducing lifetime of a system. Before the introduction of the methodology, projects were free to choose these benefit periods, and did so. Table 6.1 attempts to describe the possible variations introduced by each of these errors, which can add up to significant uncertainties. Overall, the methodology has proved to be insufficiently robust.

CHALLENGES IN CALCULATING DIRECT IMPACTS

The methodology clearly specifies what should be included as project impacts and what should not. In reality, however, the extent to which the impacts of GEF activities may be distinguished with or isolated from those of other stakeholders differs from one context to another. For example, in the Mexico

[1] Emission factors express how much CO_2 is emitted from each fuel.

Transport project, the GHG impacts can be very closely linked to project activities. In this case, the GEF project financed feasibility studies and preparations for a bus rapid transit scheme along one of the two major transportation axes in Mexico City. The construction was financed by a follow-up project of the International Bank for Reconstruction and Development (IBRD) and the City of Mexico. The utilization of the rapid transit system led to emissions reductions of 35,000 tCO_2eq per year—which, according to the GEF methodology, need to be classified as indirect emissions reductions. Still, the emissions savings would not have taken place without the planning work conducted with the help of the GEF grant, so the causal link is rather strong.

In most other cases, the actual investments were part of the project cofinancing (e.g., a significant number of wind or solar PV investments in various renewable energy projects); thus, they were included in the direct impacts. While the methodology objectively clarifies the attribution of impacts to GEF projects, direct GHG impacts are not necessarily comparable between projects, as there are no hard rules to determine project boundaries.

A very interesting example in this respect is the China TVE II project. Its enormous GHG emissions reductions result, among other factors, from the inclusion of a replication mechanism into the project logframe. This enhanced the emissions reductions that could be tracked through the project monitoring and evaluation system and led to this being the project within the sample with the highest overall avoided emissions. In most other cases, replication activities—including if they are supported by GEF (revolving) funds but take place after the project has closed—cannot be counted toward the direct impacts of a GEF project. Thus, by including replication components in the project logframe, direct impacts can be increased, while equally effective replication mechanisms could complement and build on the GEF project but be counted as indirect emissions reductions. This should give rise to a re-evaluation of the value of direct GHG impact as the seemingly most important result of GEF projects. It is easier to attribute direct GHG impact to the respective GEF-supported project. The installations and behavior that cause direct impacts are part of a project's outputs or outcomes; that means they are formulated and tracked as part of the logframe and project results. However, the GHG impacts of these outputs or outcomes may be low, and the major GHG impact of several projects may be in the form of indirect GHG reduction. The "Manual for Calculating GHG Benefits of GEF Projects" notes:

> Because GEF projects emphasize capacity building, innovation, and catalytic action for replication, their largest impacts typically lie in the long-term GHG savings achieved after the GEF project's completion. These investments are strongly affected by the long-term outcomes of the GEF activities that remove barriers; for example, those that build capacity, improve the enabling environment and stimulate replication. (GEF 2008, 4)

CHALLENGES IN ESTIMATING INDIRECT IMPACTS

While this evaluation found that indirect impacts are substantial (see table A.3), their calculation is more difficult and the attribution to GEF projects is not clear. Indirect impacts are not under the control of a project, they are uncertain, and they can neither be attributed to nor validated as a consequence of GEF projects with a high degree of certainty. Achievement of indirect impacts is usually a result of several factors that are often beyond what may realistically be determined by a given GEF project. These factors may include governance-related dimensions, the policy environment, and political leadership, among others.

The methodology allows the use of a GEF contribution factor that is adjusted to the characteristics of the project and its outcomes, but its use is not homogenous across all cases. In some cases, all developments in the sector are counted toward the indirect impacts of the GEF project. So, in the case of the China RED project, the implementation completion report fully counts all Chinese wind farms and their emissions reductions toward GEF impacts. For the related China RESP, the implementation completion report randomly attributes half of the impact of the Chinese wind farms to the GEF World Bank project.

For some of the projects in this analysis, GEF contribution factors have been estimated. For the India Alternate Energy project, the contribution to the current state of the PV sector in India was estimated to be 25 percent, and to the wind sector 50 percent. The contribution of the India PVMTI project to the country's PV sector was also estimated to be 50 percent. These assessments are very rough and potentially dependent on the scope of the analysis (and thus very specific to the context and central questions of the evaluation). They are based on comparisons with a plausible counterfactual and are hard to support with solid evidence. While the results were plausible, equally plausible lines of argument would have led to vastly different results.

Indirect effects might look very different during the completion of a project and in a postproject evaluation. For example, the implementation completion report of the China Efficient Industrial Boilers project (GEF ID 97) assumed in 2005 that the project would lead to indirect cumulative impacts of 140 $MtCO_2eq$. Because of changes in the Chinese boiler market, however, the GEF Secretariat in 2010 recalculated the emissions impact to 40 $MtCO_2eq$ by 2019, based on a World Bank Independent Evaluation Group postproject evaluation that found that only two of the boiler companies that had originally participated in the project were still in existence. Moreover, these companies reported that their products had been illegally copied, which would lead to higher GHG benefits.

While all this shows that the indirect impacts are important intended results according to GEF programming logic, it also illustrates that it is easier to define a causal chain for indirect GHG effects ex ante than to identify them ex post. A large number of contextual factors influence indirect GHG effects and, for a given project, one or more factors may be critical in determining the extent of indirect benefits. For ex ante effects, they need to be formulated in the abstract, albeit based on actual research to the degree possible. The GHG accounting methodology accepts that they can be formulated in an abstract manner. But in order to reconstruct ex post how a GEF project actually influenced broader adoption, detailed and triangulated reports on local processes of broader adoption and market change are needed. This process is subject to limitations—particularly as most of these reports are based on personal impressions from interviewed stakeholders, who may find it difficult to assess causality objectively.

It is not always clear that even careful triangulation can lead to unequivocal and quantifiable assessments of the GEF contribution. This effect is compounded for projects that were completed a long time ago, as GEF-funded activities and their impacts become more and more indistinguishable from non-GEF activities. This phenomenon is stronger the more successful a project was, the longer ago a project was completed, and the more pervasive market change has been since project design. For example, the India Alternate Energy project was part of a national initiative. In the China RESP, the evaluator was not able to assess whether the project added value to addressing the given environmental concern.

The GEF GHG emissions methodology is an attempt to solve the attribution challenge that is only functional for ex ante assessments. Quantitative ex post assessments necessarily rely on expert judgment and are not very robust. The GEF Secretariat, working with the GEF Scientific and Technical Advisory Panel, has developed methodological guidance for energy efficiency and transportation projects since 2008, introducing benchmarks and criteria to integrate consistency across this type of project, but these methods continue to focus on ex ante analysis and have many limitations for ex post evaluation.

Recent methods developed by the United Nations Environment Programme attempt to address the identified methodological challenges and limitations. As of this writing, the Agency has developed tools for measuring and monitoring the carbon benefits of land use, land use change, and forestry projects.[2] It seeks to provide tools for forecasting at the planning stage, monitoring and verification at the implementation stage, and long-term assessment of future project impacts.

In sum, the GEF GHG methodology is logical but complicated and thus error-prone and not very robust. It requires significant understanding of the specifics of GEF projects and the overall GEF strategy, as well as technical knowledge. While the methodology is consistent and provides stringent guidelines, some project proponents and evaluators who have used it may have made errors because they did not have a sound understanding of the underlying conceptual issues. The methodology clearly has been designed for ex ante assessment. Ex post assessment can only be made with significant research into the local context—which, while methodologically appropriate, is operationally inefficient.

6.2 Counterfactual Analysis: What Would Have Happened in the Absence of GEF Support?

The evaluation established that the GEF has contributed to the progress made by confirming the causal links between GEF support and the observed impacts and broader adoption. But impact and progress to broader adoption cannot be attributed to the GEF alone. In most cases after GEF projects ended, national momentum toward broader adoption was continued, largely supported by country government and private sector agents. Overall, the last 15 years show a global trend toward more energy efficiency and more systematic use of renewable energies. The efforts of the GEF go hand in hand with this global trend, and the efforts of many other agents. In consequence, the distinction of the effects between the GEF projects and other activities or factors is somewhat blurred. This makes it harder to answer the counterfactual question: What would have happened without GEF support?

The markets targeted by GEF projects are unique, and randomized studies are not possible. Therefore this question was addressed by posing it to diverse stakeholders and experts who were familiar with GEF projects and with the projects' broader contextual conditions and by cross-referencing these perspectives with other evidence obtained during the evaluation. The evaluative work in the four countries resulted in assessments of how likely it was that the same activities would have been triggered without the GEF projects.

Of the 18 projects covered, the evaluation assessed that it was very unlikely or unlikely that 8 of these would have taken place without GEF support. Of the remainder, the evaluation determined that nine projects were likely to have taken place even without GEF support; it was difficult to make this determination for the remaining project (table 6.2).

Among the eight projects that were very unlikely or unlikely to have taken place without GEF support, two—the Mexico Transport and Agriculture projects—were very unlikely to have occurred otherwise, meaning the full direct and indirect impact can be attributed to GEF support. In the six remaining cases, the GEF played a significant role in triggering the projects. While the countries already had an interested and engaged

[2] http://www.stapgef.org/carbon-benefits-project-review-meeting/.

TABLE 6.2 Added Value of GEF Financing

Question	Classification based on assessment
How likely is it that the project (or comparable activity) would have taken place without GEF support?	Very unlikely or not likely: 8 projects Very likely or likely: 9 projects Unable to assess: 1 project
For nine projects that were assessed to be "very likely or likely" to take place without GEF support, if the project would have taken place anyway, what was the added value of GEF financing?	Would have taken place more slowly: 6 projects (enhanced speed) Would not have been implemented as per international standards: 1 project (enhanced quality) Would have taken place more slowly and would not have been implemented as per international standards: 1 project (enhanced speed and quality) Added value difficult to determine: 1 project

community of agencies and players, this alone was not likely to be sufficient for action to occur. It is worth considering at this point that the sample only contains emerging markets that typically have significant fiscal means: probably these activities could have been financed by the public budget, but they would not have been financed without GEF support.

In nine instances, the projects are likely to have taken place even without GEF support. In at least seven of these cases, the change would have been achieved, but at a slower pace without the GEF. Successful implementation of these seven projects helped accelerate national progress toward climate mitigation by assisting in the removal of barriers to adoption of the promoted technologies earlier than they otherwise would have been. The analysis shows that this acceleration impact can be tracked in most parts of the portfolio; in some cases, the contribution of the GEF to this market acceleration was much stronger. Examples of such acceleration include the India Hilly Hydel, CBM, Biomethanation, and PVMTI projects. These projects illustrate how combating climate change is a long-term, generational effort and that, under the right conditions, the GEF can contribute significantly to shortening the time required. In at least two cases—the China RESP and the Russia Education project—the evaluation found that GEF involvement led to an improvement in the standards adopted by the project, thus raising it above what national stakeholders asked from the targeted technologies. In the China case (RESP), the GEF project was concerned with product quality issues. Ignoring these would have prevented the Chinese renewable energy manufacturers from attaining the global leadership they have today, and poor performance by the renewable energy systems would have led to much lower deployment numbers and GHG mitigation impacts.

7. Summary: Impact of GEF Projects

Global investment in renewable energy during 2010–12 was higher than in fossil fuels (REN21 2013). Modern renewables now account for a greater share of global energy consumption than traditional biomass—9.7 percent versus 9.3 percent (REN21 2013). In terms of their influence on global energy trends, emerging markets are now at least as important as established economies (REN21 2013). The GEF's attention to interventions involving energy efficiency and modern renewables, and its emphasis on actions in emerging economies, is consistent with the aforementioned trends in the broader context. Also, the experiences covered by this evaluation show that the GEF has played an important role in laying the groundwork for the broader adoption of several technologies and approaches in which investments are now being made.

All countries with emerging markets have formulated policy targets on either renewables or energy efficiency, or both. This is a global trend, as illustrated in table 7.1.

Some countries have experienced very strong economic growth and growth in their sustainable energy sectors in the last 10 years. This is particularly true for China and India. Both countries have made systematic efforts to deploy renewables: India since the late 1980s and China since the 1990s. Growth in the last decade was so explosive—particularly in China—that the targets had to be corrected upward repeatedly (box 7.1).

In the Chinese case, sectoral development has been much more expansive than envisioned in the late 1990s when the RED and RESP efforts were initiated. In addition, wind sector development in particular has been accelerated as compared to the government's own plans. While these accomplishments cannot be attributed to GEF support, the GEF made important contributions to the process. For example, during the preparation of the China RESP, the project team had expected approval of the Renewable Energy Law to take three to five years. In fact, the law was approved within one year, and without direct GEF influence. On the other hand, in order for the law to have so much impact so rapidly, a large number of additional preconditions needed to fall into place; these were specifically targeted by the GEF project, which changed its focus from piloting policies in four provinces to making the law a success. The project emphasized subsidiary legislation, standards, testing, and certification. Thus, the GEF intervention helped create these preconditions in a timely fashion through policy advice, systems quality control, and systematic improvement of local products so that potentially expensive challenges could be avoided—for example, those related to poor product quality and lack of local capacity and expertise. Without the GEF, market development would most likely have been slower than government plans had predicted.

TABLE 7.1 Climate Mitigation, Energy Efficiency, and Renewable Energy Targets in the Sample Countries

Country	GHG reduction targets	Energy efficiency targets	Renewable energy deployment targets
China	GHG intensity reduction: • 17% by 2015 compared to 2010 (Ni 2012) • 40–45% by 2020 (Climate Action Tracker n.d.)	Energy intensity reduction • Overall: 16% by 2015 compared to 2010 (China Briefing 2012; REN21 2012) • Energy-intensive industries: 20% by 2015 compared to 2010 (China Economic Review 2012)	Share of final energy consumption • 11.4% by 2015 (Ni 2012) • 15% by 2020 (REN21 2012) Technology-specific targets (REN21 2012) • Wind on-grid: 100 GW by 2015 • Wind offshore: 5 GW by 2015; 30 GW by 2020 • Solar: 15 GW by 2015 (1 GW concentrated solar power) • Hydro: 284 GW by 2015 • Biofuels: 5 Mt of ethanol fuel used 2011–15
India		Energy intensity reduction: 20–25% by 2020 (India Climate Portal 2009) Energy saving: 23 Mt oil equivalent annually by 2014–15 (Enerdata n.d.)	Renewable energy share of electricity production • 10% till 2012 (REN21 2012) • 15% by 2020, excluding hydro energy (BMI 2013a; REN21 2012) • 35% by 2020, including hydro generation (BMI 2013a) Total deployment target: 3.5 GW new renewables by 2011–12 (REN21 2012) Technology-specific targets (REN21 2012) • Wind: 9,000 MW by 2012 • Solar, grid connected: 20 GW by 2022 • Solar, off-grid: 2,000 MW by 2020 • Solar lighting systems: 20 million by 2022 • Solar thermal collector area: 14 GW (20 million m^2) by 2022
Mexico	Total emissions reduction 30% below business-as-usual by 2020; 50% by 2050 compared to 2000 (BMI 2013b)	Overall energy saving of 15% (2,472 TWh) by 2026 compared to 2012 (Enerdata n.d.)	Renewable energy share of electricity production of 35% until 2025 (BMI 2013b)
Russian Federation	Total emissions reduction of 15–25% by 2020 compared to 1990 (UNFCCC 2013)	Energy intensity reduction of 50–56% by 2030 compared to 2005 (ABB 2011; Enerdata n.d.)	Renewable energy share of electricity production (IFC 2011; REN21 2012) • 2.5% in 2015 • 4.5% in 2020

BOX 7.1 Drastic and Unexpected Changes within 10 Years: China's Wind Energy Sector

China has had renewable energy plans for many years. In 1995, the government created the New and Renewable Energy Development Plan 1996–2000, which set a target for wind power capacity at 1 GW for 2020. Even though the Riding the Wind Program tried to deliver a development push to domestic manufacturers, the target was lowered in 1998 to 620 MW—in recognition of the fact that, between 1993 and 1997, cumulative installations had only grown from 17.1 MW to 167 MW, far shy of the target. And China's 9th Five-Year Plan (1996–2000) fully reflected the continuing dominance of coal, oil, and gas.

However, the 10th Five-Year Plan (2000–2005) highlighted a change in objectives. By the end of the plan's period, lending to renewable energy grew in strategic importance. Renewable energy was supposed to cover 5 percent of electricity consumption. On-grid wind projects were included in the national technology programs that provide significant public funding for research and development (R&D) efforts of national importance. The New and Renewable Energy Industry Development Plan 2000–2015 articulated the target of "establishing famous trademarks with own intellectual property rights and strengthening wind technology R&D." Notwithstanding this prediction, *World Energy Outlook 2002* (IEA 2002) expected that all Chinese renewable (primary) energy consumption (excluding hydropower but including all renewables based on heat and biomass) would total 4 Mt of oil equivalent (168 PJ) in 2010.

In 2005, China's Renewable Energy Law came into force, much sooner than observers and stakeholders had expected. The 11th Five-Year Plan (2005–2010) set a wind energy target for 5 GW by 2010. This target had been exceeded by the end of 2007, and needed to be revised upward. By the end of 2010, China had 44.7 GW of wind power—the largest wind power capacity in the world, according to the Global Wind Energy Council. Energy output from wind in China in 2010 was estimated at 60 TWh (216 PJ). This massive growth over 2002 International Energy Agency expectations demonstrates how much quicker this renewable energy sector was developed than had been expected.

Annex A: Project Data

TABLE A.1 Projects Included in This Study

GEF ID	Name	Short name	Country	Start	End	GEF Agency	Executing agency	Financing at completion (million $) GEF	Total
76	Alternate Energy	Alternate Energy	India	11/92	12/00	IBRD	IREDA	26.00	284.00
112	Photovoltaic Market Transformation Initiative	PVMTI	India	6/98	6/10	IFC	IFC	10.73	UA
292	Capacity Building to Reduce Key Barriers to Energy Efficiency in Russian Residential Buildings and Heat Supply Based on the Example of the City of Vladimir, Russia	Boilers	Russia	2/98	12/04	UNDP	Ministry of Industry, Science and Education	2.98	3.19
325	Coal Bed Methane Capture and Commercial Utilization	CBM	India	6/98	9/08	IBRD	Ministry of Coal	9.20	19.11
370	Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions	Biomethanation	India	3/94	8/00	UNDP	Ministry of New and Renewable Energy	5.50	11.00
386	Optimizing Development of Small Hydel Resources in Hilly Areas	Hilly Hydel	India	1/95	12/03	UNDP	Ministry of Environment and Forests	7.50	14.64
404	Energy Efficiency Project	Energy Efficiency	India	6/00	3/06	IBRD	IREDA	5.00	47.23
446	Renewable Energy Development	RED	China	6/99	6/08	IBRD	State Economic & Trade Commission	27.00	UA
575	Highly Energy Efficient Lighting Pilot	Ilumex	Mexico	3/94	12/97	IBRD	Comisión Federal de Electricidad (CFE)	10.70	25.95
622	Energy Conservation and GHG Emissions Reduction in Chinese TVEs—Phase II	TVE II	China	12/00	7/07	UNDP	UNIDO and Ministry of Agriculture	7.99	55.60
643	Renewable Energy for Agriculture	Agriculture	Mexico	12/99	6/06	IBRD	FIRCO	8.90	21.70
784	Methane Gas Capture and Use at a Landfill—Demonstration Project	Landfill Gas	Mexico	5/01	6/06	IBRD	Ministry of Social Development	6.53	12.59
941	Fuel Cell Buses, Phase I	FCB I	China	11/02	12/06	UNDP	Ministry of Science and Technology	5.82	13.98
943	Renewable Energy Scale-up Program	RESP	China	6/05	12/11	IBRD	Ministry of Finance	40.22	98.11
1155	Introduction of Climate Friendly Measures in Transport	Transport	Mexico	10/02	3/09	IBRD	City of Mexico/D.F.	5.95	9.74
1284	Action Plan for Removing Barriers to the Full Scale Implementation of Wind Power in Mexico	Wind	Mexico	1/04	12/10	UNDP	Electrical Research Institute (IIE)	4.74	11.81
1646	Cost Effective Energy Efficiency Measures in the Russian Educational Sector	Education	Russia	10/02	9/06	UNDP	Min. of Industry, Science & Education	1.00	2.98
2257	Fuel Cell Buses, Phase II	FCB II	China	5/07	12/12	UNDP	Ministry of Science and Technology	5.77	18.64

NOTE: UA = unable to assess; UNDP = United Nations Development Programme.

TABLE A.2 Activities and Outputs of the Projects Studied in This Evaluation

GEF ID	Short name	Country	Key components[a]	Direct outputs
76	Alternate Energy	India	• Technical assistance: capacity building with IREDA • Investments: wind farms, solar PV market, irrigation-based small hydro	• 87.2 MW wind farms • 78 solar PV subprojects with an aggregate capacity of 2.145 MWp • Small hydro (not GEF eligible): 35 small hydro projects with 117.9 MW
112	PVMTI	India	• Technical assistance: capacity building for solar companies • Financing for solar companies and demonstration projects • Dissemination of business models, lessons learned	10.29 MWp of solar PV installations with five companies
292	Boilers	Russia	• Heat and hot water consumption-based metering and billing software • Demonstration of autonomous boilers • Capacity building with municipal and private stakeholders • Dissemination program for Russia	• Building-level boilers installed for three buildings • Building-level metering has led to reduction in heating bills
325	CBM	India	• Technical assistance: capacity building with public and private stakeholders, universities • Demonstration of three drilling technologies at two sites • Local utilization of recovered methane • Replication action plan, CBM Clearinghouse	Two wells in Moonidih mines, electric power generation (500 kva) using methane gas
370	Biomethanation	India	• National strategy and master plan • 16 demonstration subprojects • Capacity building • Information dissemination	16 subprojects covered under the project had an installed biogas generation capacity of 60,000 m^3/day, 3,749 kW
386	Hilly Hydel	India	• National strategy and master plan • 20 stand-alone small hydel power projects for power generation • Upgrading of 100 water mills • Institutional and human capacity building	20 new and 143 upgraded water mills
404	Energy Efficiency	India	• Technical assistance: capacity building with IREDA, assisting states in promoting end-use efficiency; training; pipeline development for energy efficiency investments • Financial assistance: demand-side management investments, end-user purchase of energy efficiency components, production of equipment, energy management services with performance guarantees	90 MW in avoided peak demand
446	RED	China	• Wind investment (20 MW) • PV investment subcomponent (10 MWp) • PV market development subcomponent • Institutional development for improving quality of PV equipment, certification, and standards • Investment subcomponent for PV manufacturers for innovation, cost reduction, and quality improvement	650,000 systems sold (400,000 verified within the project); aggregate capacity contributed by participating PV companies: 11.1 MWp
575	Ilumex	Mexico	• Acquisition and resale of energy-saving lamps (CFLs) at subsidized prices (by utility) • Market analysis and evaluation	2.5 million CFLs installed; testing lab established quality assurance protocol
622	TVE II	China	• Institutional development, policy implementation committees (PICs), Production Technology and Product Marketing Consortium (PTPMC), revolving capital fund (RCF) • Action plan for TVE market transformation, incentive mechanism • Capacity building with TVEs • Bankable project proposals and implementation of 8 pilot investments • Operational guidelines for PICs/local PICs, PTPMC, and RCF; PTPMC operating commercially	9 industrial efficiency pilot companies in 8 provinces; 118 built-in replications

GEF ID	Short name	Country	Key components[a]	Direct outputs
643	Agriculture	Mexico	• Dissemination, market development • Institutional capacity and certification • Demonstration investments • Technical assistance • Vendor financing	1,439 systems have been installed and were still operating at project end
784	Landfill Gas	Mexico	• Engineering and construction of methane capture and use plant • Capacity building with Ministry of Social Development • Policy and regulatory reform for landfill gas management • Regional dissemination in Latin America	A landfill gas–based power generation plant with total power generation capacity of 12.72 MW
941	FCB I	China	• Demonstration of technical feasibility of FCBs and refueling • Technical studies • Bus company staff and operator training and certification program • Capacity building among public transport policy makers • Capacity building for manufacture of FCBs and fuel supply systems • Information dissemination	Proof of concept
943	RESP	China	• World Bank loan financing (200 MW wind, 25 MW biomass, 28 MW small hydel power) • Mandated market policy • Technical assistance for solar companies • Demonstration projects • Renewable resource assessments for pilot provinces • Support for investment scale-up • Institutional development and capacity building	• 100 MW wind farm in Fujian • 100 MW wind farm in Inner Mongolia • 25 MW straw-fueled biomass power plant in Jiangsu • 28 MW from new and rehabilitated small hydropower plants in Zhejiang
1155	Transport	Mexico	• Sector strategy harmonization • Studies on enabling environment • Field test of vehicles • Technical assistance for integration of air quality considerations in transit strategies • Public awareness and dissemination	Metro bus currently has 3 lines that cover 50 km of bus rapid transit corridors, with 82 stations that provide public transportation services to 9 of the 16 districts of Mexico City
1646	Education	Russia	• Education program on energy efficiency in secondary schools • Demonstration of energy saving and financial models in schools and universities • Dissemination of results of the demonstration activities and the curriculum	Hardware components costing $1,097,600 have been installed under the project
1284	Wind	Mexico	• Enhanced institutional, legal, and regulatory framework for wind energy • Capacity building • Wind energy resource assessment • Feasibility studies for 3 wind power plants	Test wind farm
2257	FCB II	China	• Demonstration of technical feasibility of FCBs and refueling • Technical studies • Bus company staff and operator training and certification program • Capacity building among public transport policy makers • Capacity building for manufacture of FCBs and fuel supply systems • Information dissemination	Proof of concept

a. From Question 2.3 in annex B.

TABLE A.3 GHG Emissions Reduction and/or Avoidance Benefits

GEF ID	Short name	Country	Direct GHG emissions reductions: Expected at project start ($MtCO_2eq$) Total	Expected at project start ($MtCO_2eq$) Annual	Estimated at project completion Total ($MtCO_2$)	Estimated at project completion Annual ($MtCO_2eq$)	Estimated at point of evaluation Total ($MtCO_2$)	Estimated at point of evaluation Annual ($MtCO_2eq$)	Indirect GHG reduction/avoidance impact at point of evaluation (Mt eq) Total	Indirect GHG reduction/avoidance impact at point of evaluation (Mt eq) Annual
76	Alternate Energy	India	5.75	—	6.594	—	6.594	0.65	457.9	5.22
112	PVMTI	India	1.2	0.12	0.2	0.02	0.266	0.0266	0.396	1.2
292	Boilers	Russia	—	—	0.0346	0.0025	0.00173	0.000125	0	0
325	CBM	India	1.701	0.3402	0.0715	0.0143	0.0715	0.0143	5	0.5
370	Biomethanation	India	—	—	3.545	0.2364	3.545	0.2364	1.102	0.551
386	Hilly Hydel	India	0.032	0.0032	0.01887	0.001887	0.01887	0.001887	90.125	0
404	Energy Efficiency	India	0.76	0.076	4.815	0.4715	9.78	0.978	44.77	0
446	RED	China	6.2	0.31	6.2	0.31	6.2	0.31	11	1.1
575	Ilumex	Mexico	0.71	0.0789	0.764	0.0849	0.764	0.0849	—	3.4
622	TVE II	China	0.95	0.85	10.836	1.548	10.836	1.548	180	31
643	Agriculture	Mexico	0.45	0.03	0.544	0.363	0.544	0.363	0.53	0.015
784	Landfill Gas	Mexico	1	0.1	1.6	0.16	1.6	0.16	0	0
941	FCB I	China	—	—	—	—	—	—	0	0
943	RESP	China	23	1.15	128	6.4	128	6.4	0	32
1155	Transport	Mexico	—	—	0.8934	0.03575	0.8934	0.03575	—	0.035
1284	Wind	Mexico	80	4	—	—	—	—	0	0.028
1646	Education	Russia	0.06	0.003	0.06	0.003	0.0198	0.0022	0.028	0
2257	FCB II	China	0.00035	0.00018	0.00001	0.000005	0.0	0.0	0	0

NOTE: — = not available or unable to assess.

TABLE A.4 Sustaining Project Products

GEF ID	Short name	Country	Sustaining
76	Alternate Energy	India	The project doubled Indian installed wind capacity and led to significant installations in the solar PV and small hydro domains.
112	PVMTI	India	Four companies and a large solar installation.
292	Boilers	Russia	All boilers have been mothballed; consumption-based billing system was never implemented.
325	CBM	India	Only one of the three drilling technologies was successful.
370	Biomethanation	India	—
386	Hilly Hydel	India	Capacity building of key technical and financial institutes was an intended objective of the project.
404	Energy Efficiency	India	—
446	RED	China	At least 500,000 PV systems are now providing power to rural households.
575	Ilumex	Mexico	Lamps were tested, and their quality convinced consumers to use them. At a higher level, the project-supported technologies and approach have continued to receive government support. As a result, the technology has become widespread.
622	TVE II	China	Pilot projects are up and running; support mechanism for energy efficiency efforts have been institutionalized through establishment of the Hongyuan Company.
643	Agriculture	Mexico	Systems should still be operating.
784	Landfill Gas	Mexico	Through operation of this plant, 181,216 MWh of electricity had been generated as of October 1, 2006, benefiting the population of 7 municipalities in the Monterrey metropolitan area with clean and cheaper energy.
941	FCB I	China	DaimlerChrysler buses are in museums for public awareness purposes and are no longer in use; however, a follow-up project (FCB II) was undertaken.
943	RESP	China	Investments have been sustained; the greatest impact stems from the sustained policy schemes, capacity-building, and quality control mechanisms put in place, which have also been sustained and developed further as needed.
1155	Transport	Mexico	Metro bus currently has 3 lines that cover 50 km of bus rapid transit corridors, with 82 stations providing public transportation services to 9 of the 16 districts of Mexico City.
1284	Wind	Mexico	—
1646	Education	Russia	Classes for students and professionals are still ongoing.
2257	FCB II	China	—

NOTE: — = no sustaining activities, or none reported.

TABLE A.5 Replication Strategies in GEF Projects Leading to Larger Impact

GEF ID	Short name	Country	Replication strategy	Replication mechanism	Linkages with scale-up
76	Alternate Energy	India	Marketing and financing mechanisms for the sale and delivery of alternative energy systems.	Private sector investment	✔
112	PVMTI	India	Additional companies have been created copying the business models.	Private sector role models	
292	Boilers	Russia	No replication could be linked directly to this project.		
325	CBM	India	Vertical drilling has been replicated in India.	Private sector investment	
370	Biomethanation	India	Successful models were taken up in the private sector (around 200 MW).	Private sector investment	
386	Hilly Hydel	India	A national strategy and master plan led to detailed investment proposals for development of small hydel power projects up to 3 MW.	Private sector investment; public-private partnerships	✔
404	Energy Efficiency	India	The project aimed at developing technically feasible and financially viable technology packages for wide-scale replication and promotion of the technologies. During 2011–12, IREDA funded 60 MW capacity energy efficiency and conservation projects.	Private sector; public finance	✔
446	RED	China	A follow-up GTZ project and RESP built on the work undertaken by the RED project.	In other official development assistance projects	✔
575	Ilumex	Mexico	Program was continued with national resources.	Continuation	✔
622	TVE II	China	Project included the identification of 118 formal replication sites and the direct implementation of replication using the project's technical and financial support structures. Pilot enterprises were responsible for actively engaging the broader communication of their achievement as a starting point for sectorwide adoption.	Replication mechanism	✔
643	Agriculture	Mexico	Program was continued with national and World Bank resources.	Continuation	✔
784	Landfill Gas	Mexico	Project is used as a model for other landfills in Mexico.	CDM	
941	FCB I	China	No broader adoption at this point.	Next phase of program	
943	RESP	China	Capacity building with project developers and manufacturers.	Private sector investment	✔
1155	Transport	Mexico	Metro bus has served as a reference for implementation of public transport systems in other cities (Guadalajara, Chihuahua, Juarez, Puebla, Acapulco). In 2009, the federal government created the first federal support program for mass transport, PROTRAM, which provides funding to local governments to cover up to 100% of the cost of studies and up to 50% of infrastructure for public transport projects.	Other cities; public finance	✔
1284	Wind	Mexico	No broader adoption at this point.		
1646	Education	Russia	Replication strategy not clear.		
2257	FCB II	China	Technical regulation and safety standards as well as costs remain a barrier to replication.	Next phase of program	

NOTE: GTZ = German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit).

TABLE A.6 Scale-Up of Project Activities on a Larger Geographic Scale or Expansion to Other Thematic Areas

GEF ID	Short name	Country	Scale-up	Channel
76	Alternate Energy	India	Capacity building for IREDA, marketing, and financial mechanisms allowed the organization to expand work to other areas, including disenfranchised groups, other technologies.	Capacity building/ agency
112	PVMTI	India	Some of the supported businesses have expanded their product portfolio to include new products.	Suppliers, government program
292	Boilers	Russia	The market has scaled up significantly but not necessarily because of this project.	
325	CBM	India	To scale up CBM recovery in India, it would be necessary to demonstrate the other two technologies.	
370	Biomethanation	India	Capacity building with technical institutes and nodal agencies enabled them to help adopters in bigger and more complex projects.	Capacity building/ agency
386	Hilly Hydel	India	A national strategy and master plan with detailed investment proposals for development of small hydel power projects with a total capacity of 1,200 MW over a period of 15 years and state-specific strategies have been developed in the project. Having gained experience in the project, project developers expanded their activities to other states.	Suppliers, government program
404	Energy Efficiency	India	The market has scaled up significantly, but the contribution of this project is unclear.	Capacity building
446	RED	China	With government support, Chinese rural electrification efforts have broadened to include minigrid and grid-connected systems and more remote areas. Eighteen PV manufacturers, benefiting from technology improvement support within the project, invested in technology improvements and attained international certification for their products, ultimately leading to the emergence of China as a global PV manufacturer.	Government program, international role model
575	Ilumex	Mexico	Because of the bulk sales generated by Ilumex and FIDE, manufacturers and distributors became confident about the market and invested in distribution channels and marketing. There is now healthy competition from numerous manufacturers, providing a range of CFLs of differing quality and price.	Suppliers
622	TVE II	China	Some of the pilot enterprises actively engaged in cooperative structures on research and development (e.g., with universities) on new technologies that would further improve energy efficiency beyond the technologies introduced by the TVE project. In addition, international business-to-business dialogues formed between some of the particularly successful project sites and international counterparts, especially from Bangladesh and India.	Suppliers, capacity building/agency, international role model
643	Agriculture	Mexico	It is likely that the system vendors expanded their business to areas of Mexico that were not covered initially by the project. Nevertheless, system cost is still a barrier to broader adoption.	Government program, suppliers
784	Landfill Gas	Mexico	The project has become a reference not only for Mexico, but for Latin America in general.	International role model
941	FCB I	China	Phase II of the project.	
943	RESP	China	Chinese wind turbine industry is globally competitive and exports turbines as a result of the project's quality assurance and technical improvement components.	Suppliers
1155	Transport	Mexico	Program also finances light rail systems.	Government program
1284	Wind	Mexico	The market has scaled up significantly, but not necessarily because of this project.	
1646	Education	Russia	Classes are also taught in other areas.	Schools in other areas
2257	FCB II	China	In 2012 the Ministry of Finance promulgated FCB taxation preferential policies, which give a subsidy of RMB 600,000 (roughly $100,000) to each FCB buyer. Project has a South-South cooperation aspect.	Government program

NOTE: FIDE = Fideicomiso para el Ahorro de Energía Eléctrica.

Annex B: Project Review Questionnaire

B.1 General Information

1.1 Project Identification

Q. No.	Question	Response
1.1.1	GEF Project ID	
1.1.2	Project name	
1.1.3	Actual date of start of project implementation	
1.1.4	Actual date of project completion	
1.1.5	Date when this form was completed	
1.1.6	Reviewer	

1.2 Financing (in US$; else note the currency)

Q. No.	Financing	Approval	Completion
1.2.1	GEF project grant		
1.2.2	Total GEF grant for project (including PDFs/PPGs)		
1.2.3	Cofinancing		
1.2.4	Total project cost		
1.2.5	**Incidence of fiduciary irregularities:** Do the documents reviewed and the interviews conducted for this evaluation provide specific information that may require follow-up? Include findings on incidence of corruption, reallocation of GEF funds, mismanagement, etc. Explain.		

B.2 Project Objectives

Q. No.	Question and response
2.1	List the global environmental objectives of the project; in case changes were made during course of project implementation, note the changes.
2.2	List development objectives of the project; in case changes were made during course of project implementa-tion, note the changes.
2.3	Describe key components of the project noting changes, if any, made during the course of project implementation.
2.4	If there were changes in the global environmental objectives, development objectives, or project components/ activities during implementation, describe the reasons for them.
2.5	Describe and list the important preceding interventions that were taken up in the country and are relevant to the given activity/demonstration and the environmental concern being addressed. Describe the extent to which this activity/demonstration builds on them or replicates those interventions.

B.3 Project Approach

Q. No.	Description	Response
3.1	Did the project develop and propose legal and regulatory measures to address CCM?	Yes....1 No....2
3.2	Did the project promote certification, labels, and standards?	Yes....1 No....2
3.3	Did the project support enforcement measures to ensure better compliance?	Yes....1 No....2
3.4	Which of the following financing approaches did the project support?	ESCO....1 Bank financing....2 Others (specify)....3
3.5	Project primarily targeted which of the following GHG-producing sectors of the economy?	Waste management....1 Forestry....2 Agriculture....3 Industry....4 Building....5 Transportation....6 Energy supply....7 Others (explain)....8 a, b, c
3.6	Which of the following generic strategies for CCM has the project adopted? (Check all that apply)	Energy-efficient buildings....1 Industrial efficiency....2 Renewable: solar energy....3 Renewable: wind energy....4 Renewable: biogas....5 Sustainable: transportation....6 Others (specify)....7 a, b, c
3.7	Which specific market or markets (or submarkets) have been targeted by the project? What are the realistic technology-specific geographic bounds of the market(s) that may have been influenced by the project activities?	

B.4 Technologies

Q. No.	Description	Response
4.1	Did the project promote specific CCM technologies?	Yes....1 No....2
4.2	List the specific technologies promoted by the project. (Where more than one CCM approach has been promoted by the project, clarify the approach a given technology was linked with. The technical information on the technology should also be noted so that different generations of technologies may be distinguished. Where this is not possible, please note that as well.)	a. b. c. d. e.
4.3	For each of the technologies listed in Q. 4.2, at which stage(s) of the technology development cycle and innovation chain did the GEF project provide support?	see table below

Technology	a	b	c	d	e
Basic research & development	1	1	1	1	1
Applied research & development	2	2	2	2	2
Demonstration	3	3	3	3	3
Technology deployment	4	4	4	4	4
Technology diffusion	5	5	5	5	5

Q. No.	Description	Response
4.4	To what extent have the technologies promoted by the project been adopted? Compare actual adoption at project completion and at the point evaluation was conducted with expectations laid out in the project document. If more than one technology has been promoted, which of these are getting more traction and why?	

B.5 Barrier Removal and Market Transformation

(This section needs to be filled out separately for each market if multiple markets have been targeted as listed in response to Q. 3.7; when required, replicate this table.)

		GEF project		Other actors			Changes and GEF contribution		
	Status of barrier at time project started	Intensity of barrier removal activity within GEF project framework	List key GEF-supported activities focused on addressing the barrier	Outside the framework of the GEF project, which other key actors have been addressing this barrier?	Intensity of barrier removal activity *independent of the GEF project*	Intensity of the barrier removal activity by other actors *influenced by the GEF project*	Intensity of barrier at project completion	Present intensity of barrier	If there has been a change in barrier status (g–a), how much could be attributed to the GEF project, taking into account what may be attributed to other actors and other factors?
Barrier related to	a	b	c	d	e	f	g	h	i
Consumers/users[a]									
Consumer ignorance									
Lack of interest/motivation									
Lack of expertise									
Lack of access									
Lack of affordability									
Lack of cost-effectiveness									
Supply chain/infrastructure[a]									
Ignorance									
Lack of expertise									
Lack of affordability									
Lack of cost-effectiveness									
Lack of a business model									
Local financers									
Ignorance									
Lack of expertise									
Lack of cost-effectiveness									
Lack of business model									
Policy makers									
Lack of interest/motivation									
Ignorance									
Lack of expertise									

NOTE: **Columns a, g, and h:** no barrier = 1; present but not important = 2; significant barrier = 3; show-stopping/critical barrier = 4. **Columns b, e, and f:** low intensity = 1; moderate intensity = 2; significant intensity = 3; high intensity = 4. **Column c:** low attribution = 1; moderate attribution = 2; significant attribution = 3; high attribution = 4.

a. Information on affordability-related barriers was requested separately from information on cost-effectiveness barriers.

B.6 Market Transformation

Q. No.	Question and response
6.1	In order to bring about market transformation, what explicit or implicit assumptions have been made in the project's causal chain? To what extent do these assumptions still hold?
6.2	To what extent was lack of appropriate policies, laws, and regulations a barrier at project inception? Where applicable, also discuss adequacy of institutions and arrangements to ensure compliance. If these barriers were present, to what extent were these addressed as part of the project and with what results?
6.3	Compared to the expectations at the project start for changes in the status of the targeted barrier at project completion and during the postcompletion period (i.e., now), what have been the actual changes? Explain, specifying the changes and how these were achieved for each of the targeted markets.
6.4	To what extent could the changes in market barriers to CCM evident in each of the targeted CCM-relevant markets be attributed to the GEF-supported project? When discussing the GEF influence, also address the level of change that may be attributed to **other actors** and also **other factors** that were independent of the GEF project but affected market transformation. Give separate responses for separate markets.
6.5	Where applicable, what have been the consequences of the evident changes in function and structure of the targeted markets? To what extent has this led to behaviors that result in CCM compared to the business-as-usual scenario?

B.7 GHG Reductions (tCO_2eq)

7.1 GHG calculations provided by executing agency/Implementing Agency

	Type of activity or technology	GHG emissions reductions due to the project expected at project start	GHG emissions reductions realized during project implementation period	Estimated total GHG emissions reductions during entire benefit period		Length of entire benefit period (years)	Key assumptions
				As of project completion	At time of this evaluation		
Type of reduction	**a**	**b**	**c**	**d**	**e**	**f**	**g**
Direct reduction[a]							
Total direct							
Indirect reduction[b]							
Total indirect reductions							
Grand total							

NOTE: **Columns a, b, and c:** self-explanatory. **Column d:** estimated total emissions reductions (both realized emissions reductions during implementation and expected reductions during the remaining benefit period) at the point of project completion. **Column e:** where applicable, this would have updated estimates for Column d provided by the executing agency based on additional information that became available after project completion. **Column f:** length of the benefit period used in calculation of Columns d and e. **Column g:** assumptions made in calculation of GHG emissions reductions benefits; it is very important to list these.

a. Direct result of activities/use of advanced CCM technologies funded through the GEF project.

b. Influenced by project activities through broader adoption processes such as replication, scaling-up, mainstreaming, and market change; excluding direct reductions.

7.2 Comments on GHG emissions calculations and additional calculations

Q. No.	Question and response
7.2.1	To what extent are the GHG emissions reduction calculations in Columns c, d, and e realistic? Why? Given the nature of GHG emissions reduction activity and/or technologies promoted, are the assumptions made for calculation of GHG emissions reductions realistic?
7.2.2	In case the calculations provided by the executing agency/Implementing Agency are not realistic, is it possible to calculate more realistic estimates of the CO_2 emissions reduction benefits based on the available information and plausible assumptions (explain)? If yes, then the evaluator should make these calculations and include them as an annex to this form.

B.8 Progress to Impact

8.1 Factors that may influence achievement of long-term impacts

Q. No.	Dimension/question	Response	Rating scale/states (retain the rating option that applies)
8.1.1	Was project linked to an ongoing process supported by other stakeholders?		• Strong linkage • Weak linkage • No linkage • Unable to assess
8.1.2	Robust arrangements for continuation of activities are (were) in place after GEF support has ended?		• Robust arrangements in place • Weak arrangements in place • No arrangements in place • Not applicable • Unable to assess
8.1.3	Has the project included adequate arrangements within its project design to facilitate replication, mainstreaming, scaling-up?		• Robust arrangements • Weak arrangements • No arrangements • Unable to assess
8.1.4	Are contextual conditions that are beyond the control of the project but enable progress to impact (in the chain of causality) present?		• Yes, most enabling contextual conditions are present • Some enabling contextual conditions are present • None of the enabling contextual conditions are present • Unable to assess
8.1.5	List the key assumptions—explicit or implicit—in project's causal chain. Are the key assumptions of the project for causal chain of impact achievement realistic?	List of the key assumptions:	• Realistic assumptions were made and these still hold • Realistic assumptions were made but these do not hold anymore • Unrealistic assumptions were made
8.1.6	At the point of project start, to what extent was the project linked to national priorities?		• Strong linkage • Weak linkage • No linkage • Unable to assess

8.2 Impacts related to knowledge and information sharing

Q. No.	Question and response
8.2.1	Evidence of enhancement of knowledge of key stakeholders on relevant critical issues. Explain.
8.2.2	Evidence of development of databases and information-sharing arrangements. Explain.
8.2.3	Evidence of behavior changes due to awareness building among people and communities. Explain.

8.3 Impacts related to legal, policy, and regulatory environment and government structures and arrangements for regulation and enforcement

Q. No.	Question and response
8.3.1	Where relevant, provide evidence on development of legal, policy, and regulatory framework due to project activities. List the changes that could be attributed to the project.
8.3.2	Where relevant, provide evidence on development of institutional and administrative systems and structures and improved arrangements for stakeholder engagement due to project activities.

8.4 Demonstration of technologies and approaches

Q. No.	Question and response
8.4.1	Evidence on replication of the promoted technologies, and economic and financial instruments (which, where, and the extent).
8.4.2	Evidence on scaling-up of the promoted approaches and technologies by the government or private sector (which, where, and the extent).
8.4.3	Evidence on mainstreaming of the promoted approaches and technologies by the government or private sector (which, where, and the extent).
Other environmental impacts	
8.4.4	Other than CO_2 emissions reduction, what other environmental impact has the project achieved? Explain.

8.5 Socioeconomic impacts

Q. No.	Question and response
8.5.1	Evidence on intended socioeconomic impacts at the local level.
8.5.2	Evidence on intended socioeconomic impacts at the systemic level.
8.5.3	Evidence on unintended socioeconomic impacts at the local level.
8.5.4	Evidence on unintended socioeconomic impacts at the systemic level.

8.6 Progress to impact rating (which of the following four stages in progress to impact does the project correspond to and why?)

Rating			Explanation (for the given rating)
High progress to impact (intended global environmental benefits)	4	Either a or b (or both) are being met: a. Removal of threats or/and improvement of environmental status, at the highest level targeted by the project. b. There is evidence that all of the following three conditions have been met: • Threat removal at the highest level targeted by the project has begun. • Intermediate states (usually associated with medium-term outcomes) in the impact chain of causality have been reached and are durable. • Effective and lasting mechanisms for stress reduction are in place.	
Significant progress to impact (intended global environmental benefits)	3	There is evidence that there has been significant movement to achievement of following conditions: • Threat removal at the highest level targeted by the project has begun. • Intermediate states (usually associated with medium-term outcomes) in the impact chain of causality have been reached and are durable. • Effective and lasting mechanisms for stress reduction are in place.	
Moderate progress to impact (intended global environmental benefits)	2	There is evidence that short-term outcomes of the project in the impact chain of causality have been achieved fully or significantly.	
Low or negligible progress to intended global environmental benefits	1	There is evidence that achievements in terms of short-term outcomes are low. Major expected short-term outcomes have not been achieved.	
Unable to assess	UA	Available evidence is not sufficient to determine progress to impact.	

B.9 Synthesis

Q. No.	Question and response
9.1	What are the key impacts of this project on capacity building at the personal, institutional, and systemic levels? What is the significance of the project's achievements on capacity building?
9.2	What are the key impacts of this project on knowledge generation and information sharing? What is the significance of the project's achievements on capacity building?
9.3	What are the key impacts of this project on the legal, policy, and regulatory environment, and on government structures and arrangements for regulation and enforcement? Where applicable, list the laws and regulations that have changed as a result of this project and their significance.
9.4	How likely is it that this activity would not have taken place or would not have taken place in its present form without GEF support?
9.5	Net added value of GEF contribution through this project?
9.6	To what extent have the country counterparts and other actors performed their expected role?
9.7	If barriers to market transformation still persist, what additional measures from country counterparts, other actors, and the GEF may be required to mitigate these barriers? Who should do what?
9.8	

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