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CLIMATE CHANGE SERIES

Monitoring and Evaluation of Market Development in World Bank-GEF Climate Change Projects

Framework and Guidelines

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Acronyms

CFL	Compact Fluorescent Light
DSM	Demand-Side Management
GEF	Global Environment Facility
GHG	Greenhouse Gas
ICR	Implementation Completion Report
IPP	Independent Power Producer
M&E	Monitoring and Evaluation
MGO	Non-governmental Organization
PAD	Project Appraisal Document
PCD	Project Concept Document
PIR	Project Implementation Review
PPF	Project Preparation Facility
PV	Photovoltaic

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Executive Summary

The Global Environment Facility (GEF) strategy for climate change encompasses three operational programs that are designed to promote energy efficiency and renewable energy by reducing barriers, implementation costs, and long-term technology costs. The goal of projects under these operational programs is to catalyze the sustainable development of markets for specific technology applications considered particularly desirable from a climate-change-mitigation perspective.

GEF projects have both direct and indirect impacts on markets. Direct impacts occur during the project itself in the form of specific project outputs. Indirect impacts occur as the direct impacts of the project "ripple out" in space and time, or among institutions to affect the market in a geographically broad, long-term, and/or institutionally diverse manner. Indicators of avoided greenhouse-gas emissions can mark how successfully a project achieved its expected outputs and can promote accountability of project agencies. But in the context of assessing overall GEF effectiveness in mitigating climate change, direct project outputs are much less significant than indirect impacts and sustainability.

Indirect impacts and sustainability are evaluated by measuring changes in markets. Measuring changes in markets is not simple because markets have many dimensions. The most common quantitative dimensions of a market are sales volumes, investment volumes, prices, technical characteristics of products, number and size of market participants (producers, distributors, financiers, and service firms), and purchaser demographics. But there are also many qualitative dimensions to a market, such as access to information, awareness and attitudes, capabilities, financing mechanisms, codes and standards, and institutional dimensions of many forms. Measurement of changes in markets can focus on all of these dimensions.

Projects can employ three types of indicators to measure their success: *market intervention indicators*, *market development indicators*, and *market sustainability indicators*. Market intervention indicators measure the most direct impacts—those that typically occur during a project (project output indicators) and that will generally be known by the time of the project's completion. Market development indicators reflect a project's indirect impacts (outcome/impact indicators), and significant changes in these indicators may not be seen until some years after project completion. Market sustainability indicators, which reflect the degree to which a developing market is sustainable without further intervention, take even longer to observe and verify. Market sustainability could also be interpreted in terms of the degree of permanence of barrier removal—whether barriers will reemerge or not. GEF project evaluation must go beyond market intervention and also focus on market development and market sustainability.

Each of these three types of market change indicators can measure investments or sales ("physical changes"), or changes in the institutions, capabilities, knowledge, transaction rules, and available goods and services that define markets ("market structure/function changes"). Proxy indicators for physical changes can also include energy

savings or energy production. Investments and sales are trailing indicators and take longer to obtain than indicators of market structure/function, which are leading indicators because they are precursors to changes in investments or sales. Data oninvestments and sales may be difficult to obtain because of its proprietary nature. Measurement of changes in market structure/function presents a challenge because of the need for qualitative or survey-oriented data collection and ratings, particularly for capability and institutional development changes. Despite the difficulties and costs, more emphasis in GEF project evaluation needs to be placed on measuring changes in market structure/function because of the need for leading indicators to give an earlier indication of project impacts.

Project design must clearly distinguish between what are expected outputs (market interventions) and what are anticipated indirect impacts/outcomes (market development and market sustainability). The bank's current project design approach using logical frameworks is consistent with distinguishing market interventions from market development and market sustainability.

Market development should be an integral part of the entire project cycle, starting during project design and continuing past project completion. Attention to market development objectives and indicators during project design will result in well thought out and well-designed projects that are consistent with GEF goals and thus easy to justify. Attention to monitoring market development during project implementation can indicate whether projects are having their intended impact and thus guide mid-course corrections. Monitoring and evaluation of market development and sustainability at project completion and two to four years after completion will provide critical information for judging the success and effectiveness of GEF resources and for improving future project designs.

Project preparation should define the affected market and the expected types of direct and indirect impacts on that market, define market sustainability, select indicators, establish sources of data, measure and establish baselines, and assign responsibilities for monitoring and evaluation. The quality of indicators and monitoring and evaluation planning can be improved by directly involving client counterparts. During project implementation, the executing agency should monitor market intervention indicators. At project completion, the executing agency and Implementation Completion Report (ICR) consultants should evaluate the final market intervention indicators, calculate avoided CO_2 emissions resulting from direct project outputs, and monitor and evaluate market development indicators.

A key concern is the need for post-project evaluation (typically two to four years after project completion) to monitor and evaluate market development (outcome/impact) indicators and market sustainability indicators. It is not yet clear how responsibility and resources should be allocated for conducting systematic post-project evaluations that measure changes in markets from World Bank/GEF projects. Discussions with clients should identify appropriate agencies and incentives for post-project monitoring and evaluation.

A strategy for assessing changes in markets should focus on key indicators of market changes and reductions in market barriers, provide a complete and credible story with supporting evidence about what existed before and what happened during a project to change the market, and employ a systematic framework for analysis before and after the project. To conserve evaluation resources, in-depth retrospective analyses can be conducted for selected key initiatives. In any strategy, causality between market interventions and market development and sustainability is difficult to establish; thus evaluation can show market changes and the influence of the GEF on those changes, but may not allow direct attribution.

1 Introduction

The Global Environment Facility (GEF) strategy for climate change encompasses three operational programs that are designed to promote energy efficiency and renewable energy by reducing barriers, implementation costs and long-term technology costs. The goal of projects under these operational programs is to catalyze the sustainable development of markets for specific technology applications considered particularly desirable from a climate-change-mitigation perspective. The basic presumption is that project interventions will result in greater and more accelerated replication and adoption of the technology applications than would otherwise occur. Thus, market development and market sustainability are at the core of GEF objectives and goals and require substantial scrutiny before, during, and after project implementation.

GEF project design must clearly distinguish between what are expected outputs (market interventions) and what are anticipated indirect impacts/outcomes (market development and market sustainability). Early attention in the project cycle to market development and market sustainability will result in good project designs that are consistent with GEF goals. This task is straightforward because the bank's logical framework approach to project design facilitates the distinction between market interventions and market development and sustainability. Additional attention to market development and market sustainability later in the project cycle, for example in the post-project phase, will provide critical information for judging the success and effectiveness of GEF resources and for improving future project designs.

How should market development be monitored and evaluated for specific GEF projects? This document provides a conceptual framework, some practical guidance, and specific project examples to help answer this question. This document is intended to assist World Bank task managers, staff, and consultants engaged in the design and implementation of monitoring and evaluation components of climate change mitigation projects funded by the GEF. The guidelines can also serve as a useful reference for client government agencies, nongovernmental organizations (NGOs), and others involved or interested in the design, implementation and evaluation of climate change mitigation projects.

Section 2 presents a framework for measuring changes in markets, defines several categories of indicators, discusses what each type of indicator is supposed to measure, and provides a set of generic indicator examples. Section 3 shows at what point in the project cycle the different types of indicators and monitoring and evaluation tasks are relevant. Section 4 discusses several issues associated with the design of a monitoring and evaluation approach, including trailing (physical) vs. leading (nonphysical) indicators, causality, establishing a project baseline, measurement sources, selection of monitoring and evaluation agencies, and the costs of market assessments. Finally, Section 5 provides a set of examples to illustrate the various types of indicators and how they fit within the project logical framework (Project Planning Matrix). A few of the project examples are of early pilot-phase GEF projects that have recently been completed

(Mauritius, Poland, India, and Thailand); these examples also contain illustrative narrative evaluations of market changes.

Three annexes follow the text. Annex A discusses general technical considerations for determining avoided CO2 emissions from projects. Annex B gives sample terms of reference for a consultant responsible for monitoring and evaluating market development. Annex C reviews literature that is relevant to assessing markets changes.

Further information about GEF programs, World Bank practices for monitoring and evaluation, renewable energy, and energy efficiency can be found in other existing World Bank and GEF documents (see GEF 1996 and 1997; Mosse and Sontheimer 1997; World Bank 1993, 1996, 1997a, 1997b).

2 Measuring Changes In Markets

GEF projects have both direct and indirect impacts on markets. Direct impacts occur during a project itself in the form of specific project outputs. Indirect impacts occur as the direct impacts of the project "ripple out" in space and time or among institutions to affect the market in a geographically broad, long-term, and/or institutionally diverse manner. Although traditional project performance monitoring usually captures direct impacts, it falls short of understanding how projects have a broad, long-term impact on market development and market sustainability. In the context of GEF projects, indirect impacts are much more significant than direct impacts in terms of avoided greenhouse gas emissions; however, indirect impacts are also more difficult to measure precisely. The problem of measuring indirect impacts is fundamentally one of measuring changes in markets.

The Challenge of Measuring Changes in Markets

Measuring changes in markets is not simple because markets are complex phenomena. Although no overarching theory or framework has become widely accepted yet, research and practice have produced useful insights. According to Feldman (1994), the three key defining dimensions of a market are: (1) the number and nature of participants, (2) the variety and characteristics of the products and services available, and (3) the rules governing exchanges in the marketplace. These dimensions represent the different components of a "snapshot" of the market for a particular technology application at any given time. Changes in these dimensions can be tracked over time to provide a dynamic picture of market development. These dimensions also will vary spatially—even neighboring regions can exhibit quite different market characteristics. The most common quantitative measures of a market are:

- Sales volumes of the target technology to different groups of purchasers
- Stock of the target technology already existing among different groups of purchasers
- Prices, technical characteristics, and quality of the target technology available in the market
- Number, size, and characteristics of producers, distributors, or service firms in the market
- Demographics and other characteristics of different groups of purchasers in the market

There are also many qualitative measures of a market, such as:

- Accessibility of technology information, financing, purchase opportunities (stores, catalogs, and maintenance and repair services
- Awareness of and attitudes towards the target technology
- Motivations and incentives to purchase and install the target technology
- Programs and plans to produce, market, or purchase the target technology
- Distributors' and dealers' practices for stocking and promotion of the target technology
- Momentum of standard practices or habits with already-established technology

- Skills and capabilities of purchasers to assess, choose, specify, and use the target technology
- Skills and capabilities of producers to develop, produce, and market the target technology
- Skills and capabilities of distributors and service firms to market and service the target technology
- Existence of opportunity information like renewable-energy geographical-resource assessments and engineering estimates of energy-efficiency potential
- Existence and use of standard contractual models (independent-power-purchase contracts and non-negotiable power-purchase tariffs)
- Existence and use of financing (dealer or producer credit, revolving funds, commercial loans)
- Existence of formal or informal industry codes of conduct for market actors (and degree of compliance with these codes)
- Existence of technical codes and standards for the target technology (and degree of compliance with these codes and standards)
- existence of institutions that allow groups of individual purchasers to make collective decisions (condominium associations)
- Relevant legal institutions, regulatory frameworks, taxes, duties, and other macroeconomic and legal conditions

Measuring changes in markets requires thinking beyond measuring direct energy savings or energy production. An example of such a change in thinking is occurring for energy-efficiency programs in the United States: "Regulators and corporate managers must totally rethink conventional [energy efficiency] program designs and evaluation techniques....evaluation may not be viewed as simply an exercise in counting kWh but as a serious examination of the marketplace before, during, and after program intervention.... It may be more important to focus on indicators such as dealer stocking patterns than actual kWh savings" (Saxonis 1997, p.171).

Transaction costs can provide one way to look at changes in markets, particularly in how transaction costs are decreasing or increasing over time. Measuring transaction costs essentially means measuring barriers, some of which are created by the presence of high transaction costs. Feldman (1996) explains:

> Increased sales are simply indirect evidence that transaction costs have been reduced....The effectiveness of market transformation programs should *not* be judged only by savings achieved or by surrogate measures such as sales of efficient products and services. Instead, evaluation of market transformation programs should also focus on the identification and measurement of transaction costs. Among the transaction costs that can be identified are hassle, lack of information, and avoidance of risk [concern over potential product failure or premature wear-out]. Marketers and analysts can readily specify proximate indicators of each of these costs(p.ii).

Also important to understanding changes in markets is knowing what suppliers of technologies are thinking, the decisions they are making, and why. Because of the commercial nature of such data, however, understanding the supply side is more difficult, as Feldman (1995) and others have pointed out. Still, it is important to understand the business plans of suppliers or potential suppliers: how they see the future market and how they plan on participating in a market. Similarly, it is important to understand the plans and views of financiers, dealers, and other market participants. For before-after comparisons associated with specific project interventions, suppliers' views are also key. For example, in comparison with the preproject situation, do suppliers see a significantly enlarged segment of potential customers with access to nonconcessional finance and continued adequate technical and maintenance support organizations even in the absence of project interventions? Suppliers' views regarding market segments, consumer willingness to purchase products or services, banks' willingness to extend credit, price trends, after-service networks, and competition are likely to be valuable for any market evaluation.

Finally, the sustainability of a market means the sustained adoption of a particular technology application over time up to the technology's economic potential (the top-most point of the technology diffusion curve; see Annex C). Key to measuring whether specific project interventions result in sustainable markets is the "market response" after a project is completed. Does a market return to its prior state? Does it undergo a "transient" response for some number of years after the project, or does it continue to grow faster than would have been the case in the absence of the project? The type of project could be a factor. For example, if subsidized equipment is sold as a project intervention and then subsidies are abruptly removed, there is likely to be some transient response before a "true" market response can be observed. If specific institutions or practices remain in place after the project, then the transient response is likely to be smaller and the final phases of the project and immediate post-project period are more likely to reflect the beginning of a "true" market response.

Three Types of Indicators to Measure Project Impacts

We can define three types of indicators to measure project impacts: *market intervention indicators*, *market development indicators*, and *market sustainability indicators*. These indicators measure three different ranges of "directness" or "proximity" of market impacts from the project (see Table 1). Directness and proximity can be in terms of time, space and/or institutions. Market intervention indicators measure the closest, most direct impacts on markets, corresponding to project outputs. These impacts typically occur during the project itself and will generally be known by the time of a project's completion. Market development indicators reflect a project's indirect impacts at project completion or at a point in time after project completion. Significant changes in market development indicators may not be seen until some years after project completion. Market sustainability takes even longer to observe and verify. Market sustainability indicators measure the "furthest", most indirect influence on markets. Market sustainability reflects the degree to which a developing market is sustainable without further intervention—the degree to which market functions are performed by those who profit from the market. Another way to think about market sustainability is the degree of permanence of barrier removal—whether barriers will reemerge or not. Examples of all of these indicators are given in Tables 2 and 3. In addition, Section 5 provides illustrations of indicators for specific GEF projects under implementation or preparation. Indicators generally can be grouped into the Project Planning Matrix as shown in Table 4.

All three types of indicators (market intervention, market development, and market sustainability) can measure different degrees (in space, time, and institutions) of "barrier removal." For example a project output might be a pilot financing mechanism among a certain set of institutions or in a specific region of a country, measured by market intervention indicators. This project reduces the financing barrier by demonstrating a viable financing mechanism in a specific region or among specific institutions. After the project, if it is proven successful, the pilot financing mechanism could be replicated on a larger scale or among other regions or institutions. These changes would be measured by market development indicators. Finally, the long-term sustainability of such a mechanism (for example, repayment rates and reinvestment rates of revolving funds) or its ultimate viability among other institutions or regions would be measured by market sustainability indicators. At each stage, the financing barrier is being reduced, but in a different way—at a different temporal, geographic, or institutional proximity and scale relative to the original intervention.

The China Efficient Boilers Project (see Section 5) further illustrates the concept of "proximity." A large group of boiler manufacturers was invited to participate in a project to upgrade the efficiency of their products. Nine manufacturers were selected. Their performance in designing, producing, and marketing more efficient boiler models through the project could be measured using market intervention indicators. Through replication and dissemination efforts (especially by the Ministry of Machinery), other manufacturers (i.e., those that were involved in the initial project stages and submitted proposals for participation) would be better able and more motivated to upgrade and market their boiler models as well. These indirect impacts would be measured by market development indicators, for example through surveys and monitoring of these manufacturers. Finally, market sustainability would be measured by sustained market share of more efficient boilers industry-wide (almost 100 manufacturers) at a level commensurate with the economic potential in the Chinese economy.

Each of the three types of indicators can measure investments or sales ("physical changes") or (often less tangible) changes in the institutions, capabilities, knowledge, and transaction rules that underlie markets ("market structure/function changes"). Physical changes refer to changes in a market in terms of sales, investments, and other physical consequences of transactions. Market structure/function changes reflect conditions or characteristics of a market that determine what market transactions occur. Examples include increases in awareness, changes in perceptions of risks and benefits, adoption of standards, adoption of new contractual models, reductions in costs, and greater availability of products at dealers.

Physical changes in markets (sales and investments) could also be measured by proxy indicators of energy use, such as the quantities of energy saved through investments by energy-service companies or the quantities of energy produced from installed renewable energy systems. Proxy energy indicators have the advantage of focusing attention on measurable outcomes that can be specified in contracts and used to promote and manage project performance. Proxy energy indicators also more closely reflect the performance of a project in terms of the GEF's strategic goal—reducing greenhouse gas emissions. But proxy energy indicators "confound" the measurement of physical changes with other variables such as the effectiveness of technology choice and the quality of installations, equipment, or maintenance. Directly measuring sales or investments and measuring these other variables separately provides more information. Proxy energy indicators are also subject to analytical manipulation even if they are based upon metered data. Further, proxy energy indicators take longer to obtain than sales and investment data because measure-

Table 1: A Framework for Measuring Changes in Markets

	Time, Space, and/or Institutional Proximity to Project <<<---- Closer -- Further --->>>		
Type of change	**Market intervention indicators**	**Market development indicators**	**Market sustainability indicators**
Physical: • investments • sales	Direct investments or sales supported by the project: • direct subsidies • direct financing • direct financing through private-sector entities	Indirect investments or sales not financed or subsidized by the project	Evolution over time of investments and sales to a sustainable level appropriate to economic potential
Market structure and function: • institutions • capabilities • knowledge • transaction rules • types of goods and services	Direct results of technical assistance: • institutional development • enhanced capabilities • information dissemination • new contractual mechanisms • new regulations • new codes and standards	Market participants (i.e., producers, dealers, consumers, service firms, financiers): • number of participants • awareness • capabilities • perceptions • plans • decisions • satisfaction Technologies: • prices • characteristics • quality Basis of market transactions: • contract forms • codes, standards, and certification • product labeling • other regulations	Evolution over time of market characteristics that demonstrate market sustainability

ments must be made over an extended time period before results are known. Sales and investment data are available sooner. Engineering estimates of "energy savings capacity" installed, although even more subject to analytical manipulation, are a compromise that provides more immediate data about energy savings. Finally, investment volumes are better indicators of financial sustainability and the degree to which financing and credit barriers, which are key barriers in almost any energy efficiency or renewable energy project, are being overcome.

Monitoring and evaluation efforts of GEF projects to-date have focused on market intervention indicators of direct physical changes and their associated avoided CO_2 emissions. Less emphasis has been placed on market intervention indicators of market structure/function changes and even less on market development indicators of both types. One of the reasons for such a historical bias is that market development indicators are generally more difficult to measure (especially the most intangible ones). This situation should be reversed. Evidence from recent evaluations of GEF projects has suggested that projects are having a large impact on market development indicators (especially in such intangible but important aspects of market structure/function as "outlook" of consumers and producers and the degree to which technologies become "fashionable"). These impacts are occurring even through project outputs themselves did not occur to the extent expected (especially physical changes, like the number of installations). This experience confirms what many believe: the main value of direct investments or sales in GEF projects is not in the direct hardware installed (and associated avoided CO_2 emissions). Instead, the main value of an installation is the degree to which it demonstrates technical, economic, financial, social, institutional, and/or operational viability of the technology and sustainable market mechanisms for its continued dissemination. The value of hardware installed in GEF projects also comes from creating a "critical mass" of market volume to attract further capital, production, demand, and distribution. It is, however, very difficult to predict the level of installations required to achieve these "demonstration" and "critical mass" effects.

When measuring market development, it is important to measure market structure/function changes in addition to physical changes because physical changes are "trailing indicators" of market development; they take longer to appear and discern than market structure/function changes. By contrast, indicators of market structure/function changes (i.e., reflecting reduced transaction costs) are "leading indicators"; they change first and can be reasonable predictors of future market behavior.

Below are more detailed descriptions of these three types of indicators.

Market Intervention Indicators

Market intervention indicators measure the specific "forcing" effect that a project has on a market. These indicators measure the direct consequences of project activities and correspond to the "project output" level of the Project Planning Framework. Generally, the outputs measured are under the control and responsibility of project management. Many of these indicators measure the conditions created by the project that could be thought of as "reduced barriers" for a specific group of market actors or in a specific location in time or space (dissemination and replication should then reduce barriers for a wider class of actors or locations).

Physical changes are hardware installations that can be directly attributed to the project, which are generally in one of the following three categories: (i) the project procured the hardware; (ii) the project provided financing for installations by private-sector developers or energy-service companies; or (iii) the project provided direct subsidies to producers or consumers.

Market structure/function changes reflect project outputs in terms of, for example, increased awareness and capabilities of specific groups or organizations targeted by the project, specific policies or standards enacted, specific financing mechanisms or credit availability created by the project, and demonstrations of new contractual forms that the project is supposed to develop. Care should be taken that market intervention indicators are not really implementation progress indicators. For example, "training conducted" or even "30 people trained" are more appropriately implementation progress indicators; market intervention indicators would be "ratings of capabilities of group or organization X" or "activities Y undertaken by group or organization X [that demonstrate the desired capabilities]."

Market Development Indicators

Market development indicators measure changes in the broader market beyond direct project impacts. Market development impacts are facilitated by the project but are beyond the immediate control of project management and thus are considered "indirect impacts." Market development indicators correspond to traditional development outcome/impact indicators used by the World Bank and correspond to the "development objective" level of the Project Planning Framework. Most market development indicators measure activity that occurs after the GEF project is completed although some indirect impacts may occur during the project. Physical changes represent sales or investments that are not directly provided, subsidized, or financed by the GEF project. In a purely private-sector approach, these sales or investments should result from private-sector decisions using private financing in a free-market environment. However, government or multilateral financing, special tax incentives, subsidies, or parallel projects may continue after a GEF project. It is always a question of interpretation whether market changes represent true "market development" or are simply further "market forcing" by other intervenors.

Market structure/function changes measured by market development indicators do not result directly from a GEF project. Common indicators are the characteristics of products and services offered in a market, especially prices and costs, but may also may include indicators which measure the number of producers, dealers, or service firms in the market; broad plans, perceptions, and awareness of market actors; and changes in the (either explicit or tacit) rules governing market transactions (through regulations, common contractual forms, standard practice, etc.). Care should be taken that market development indicators are not really market intervention indicators. For example, "standards enacted" or even "number of suppliers adopting standards" are probably market intervention indicators. Market development indicators related to standards would be "volume of equipment produced according to standards," "increased quality or reliability of installations," or "failure, replacement, or maintenance rate of installations."

As the degree of adoption of a technology follows the classical technology diffusion curve (see Annex C), different "adopter groups" that previously resisted doing so may begin to adopt a technology. Tracking these different groups may provide a useful indicator of market development. Adopter groups are categorized as *innovators*, *early adopters*, *early majority*, *late majority*, and *laggards* (Rogers 1995). Market development indicators may also track different groups of market participants (media, government agencies, utilities, consumers, producers, developers, financiers) in different geographical regions through five classical technology diffusion stages: (1) becoming aware of a technology, (2) becoming persuaded to adopt it, (3) deciding to adopt it, (4) adopting it, and (5) verifying the validity of the adoption decision. These types of indicators are difficult to measure in practice and require in-depth social research, so they are not considered in detail here. Nonetheless, an understanding of different adopter groups and progression through the different diffusion stages may help clarify thinking about indicators and their meaning.

Market Sustainability Indicators

Market sustainability reflects the degree to which a developing market is sustainable without the need for further interventions. There are three key aspects to market sustainability indicators: (i) measuring the degree of cost-competitiveness of a technology application in the absence of subsidies or special tax treatment (which affects the asymptote of the technology diffusion curve; see Annex C); (ii) measuring the degree to which essential market functions are performed by those who profit from the market; and (iii) measuring the sustainability of public-sector institutions (including regulations) that provide essential market functions. Another way to think about market sustainability is to assess how permanently barriers have been removed –in other words, whether barriers will reemerge or not. The removal of barriers can be assessed in terms of whether information, intermediation, financing, contractual mechanisms and other "essential" market functions continue to be provided after a project ends.

Table 2: Indicator Examples for Physical Changes in Markets

Market sustainability indicators

- Share of consumers owning a new technology (e.g., compact fluorescent lights (CFLs)) that purchase it again when replacement is required
- Operation and functionality of installed equipment on continuing basis
- Continuation rates of consumers in technology leasing programs
- Utility plans/mandates to contract for future capacity through independent power producers

Market development indicators

- Installed capacity of renewable energy systems
- Number of renewable energy systems installed
- Investment volume in energy-efficiency measures
- Energy savings from investments in energy efficiency
- Floor area or number of buildings constructed according to energy-efficient building codes
- Sales volumes or market shares of high-energy-efficiency products

Market intervention indicators

- Installed capacity of renewable energy systems (project output)
- Number of renewable energy systems installed (project output)
- Investment volume in energy-efficiency measures (project output)
- Energy savings from investments in energy efficiency (project output)

Table 3: Indicator Examples for Market Structure/Function Changes

Market sustainability indicators

- Degree of cost-competitiveness with conventional technologies in the absence of subsidies or special tax treatment
- Share of public vs. private-sector financing of technology investments
- Degree of acceptance of a technology or of a contractual mechanism (ESCOs or IPPs) among mainstream financiers as a commercial-grade investment
- Financial sustainability of market intermediaries (ESCOs or IPPs)
- Budget and staff continuity of public-sector institutions providing market functions
- Continuation rates of dealers or service firms to stock, promote, or service a particular technology

Market development indicators

- Prices and costs of technologies
- New institutional and regulatory frameworks enacted
- Number of producers, dealers, service firms, or intermediaries (like ESCOs) in the market
- Number of independent-power-producer contracts signed
- Market share of equipment produced according to standards
- Business plans of producers or project developers; future expectations for the market
- Performance ratings of existing installations (wind farm capacity factors)
- Financing flows from commercial and/or public sources
- Ratings of understanding and acceptance of the commercial viability of energy performance contracting by potential energy-service companies and by financial institutions

Market intervention indicators

- Standard power-purchase agreement developed with non-negotiable power-purchase tariff
- Number of independent power-production contracts signed
- Number of renewable-energy service contracts signed (concessions for specific regions)
- Ratings of understanding and acceptance by targeted firms, consumers, and/or financiers of the technical, economic, and commercial viability of technologies
- Ratings of satisfaction of project participants (or targeted consumers) with technologies
- Ratings of capabilities of targeted firms to design, produce, market, and service technologies
- Ratings of capabilities of public agencies to promote technologies
- Levels of higher product energy-efficiencies achieved by targeted firms
- Volume of information disseminated and numbers of recipients
- Number of people exposed to technical, institutional, and financial demonstration experience
- Ratings of availability of specific technical information to interested producers or consumers
- Revised or new technology standards issued
- New regulatory mechanisms adopted
- New energy programs or plans adopted
- Technology testing/certification centers established
- Technology intermediation/service centers established
- Number of product certifications
- Ratings of credit availability
- Existence of operating pilot financing mechanisms and credit schemes

Table 4: Indicators in the Project Logical Framework

Narrative Summary	Performance Indicators	Means of Verification	Assumptions and Risks
Project Goal GEF Operational Program Objective	*Market Sustainability Indicators*	Market surveys and research	
Project Objective Develop the market for a specific energy efficiency or renewable energy technology application in a specific country or region by removing barriers and/or reducing implementation costs	*Market Development Indicators*	Market surveys and research by executing agencies, government agencies, and/or independent evaluators	Developments in the market are sustainable over time
Project Outputs Technology demonstrations, critical mass of investments or sales, information dissemination, strengthened institutions, new financing schemes or models, new legal/contractual mechanisms, new capabilities	*Market Intervention Indicators*	Project performance reports by executing agencies	Project outputs are key ingredients for developing the selected market, reducing barriers, and/or reducing costs
Project Inputs (activities)	Implementation Progress Indicators	Project expenditures	Project activities are necessary and sufficient to generate outputs

3 Market Development in the World Bank-GEF Project Cycle

Market development should be an integral part of the entire project cycle, starting during project design and continuing past project completion. Attention to market development objectives and indicators during project design will result in well-thought-out and well-designed projects that are consistent with GEF goals and thus easy to justify. Attention to monitoring market development during project implementation can help determine whether project outputs are having their intended impact and guide mid-course corrections. Monitoring and evaluation of market development and market sustainability at project completion and at some point two to four years after completion will provide critical information for judging the success and effectiveness of GEF resources and for improving future project designs.

Table 5 suggests monitoring and evaluation activities and relevant indicators for various stages of the project cycle. Activities during project preparation should define the market (including specific technology applications, geographic regions, or institutions targeted) and the expected types of direct and indirect impacts on that market. Activities should also include defining sustainability, selecting indicators, establishing sources of data, measuring and establishing baselines for all indicators, and assigning responsibilities for monitoring and evaluation during the project. The quality of these activities can be improved by involving clients directly in selecting specific indicators that are relevant but also cost-effective given existing data sources and availability. Discussions with government counterparts should also identify appropriate agencies for post-project monitoring and evaluation activities and structure effective incentives for continued monitoring and evaluation in the post-project phase.

The completed Project Appraisal Document should contain all of the above elements in both a narrative form and in a completed Project Planning Framework.

During project implementation, market intervention indicators should be continually monitored and evaluated. Monitoring of market development indicators during project implementation serves two purposes. The first purpose is to judge project effectiveness in meeting GEF goals (typically not necessary before project completion). The second purpose is to assist in executing the project effectively and in making mid-project corrections. If indirect market changes are expected to occur before project completion and the project budget allows resources for annual monitoring of market development indicators, then project implementation could be enhanced. However, it does no good to spend resources to "watch the bread rise" when monitoring at project completion will suffice.

At project completion, the project executing agency and ICR consultants should assess the final states of market intervention indicators, determine avoided CO_2 emissions resulting from direct project outputs, and monitor and evaluate market development indicators. If market development indicators were not expected to change during project implementation and thus were not monitored prior to project completion, this may be the first time that data are collected for these indicators since the baseline was established.

Because post-project evaluation is necessary to gain a full perspective on project impacts, a key concern is the need for post-project evaluation (typically two to four years after project completion) to monitor and evaluate market development (outcome/impact) indicators and market sustainability indicators. It is not yet clear how responsibility and resources should be allocated for conducting systematic post-project evaluations that measure changes in markets from World Bank/GEF projects.

Post-project evaluation is similar to the impact monitoring program of the Operations Evaluation Department (OED). However, the demonstration nature of GEF projects calls for increased importance placed on specifying and guaranteeing post-project monitoring and evaluation in project design and negotiations. For example, project implementors may leave after the project is completed, key industry contacts for market surveys may change and their replacements may be unacquainted with the project or its personnel, or governmental agency restructuring may leave the project without a long-term "home" in the government. Because changes in markets are a central concern, preproject baselines must be established and preserved for post-project evaluators, so that similar data sources, contacts, and measurement methodologies can be employed for consistency.

During project preparation and negotiation, specific incentives and disincentives for executing agencies should be considered to encourage post-project monitoring and evaluation (for an example, see the China Energy Conservation Project case study). Post-project monitoring and evaluation requirements for the executing agency or client agencies are probably inadequate if included simply as a disbursement covenant. Once project disbursements have been made, the Bank and GEF will lose influence over the executing agency. Experience suggests that traditional Bank measures such as loan covenants are only partially successful in maintaining ongoing leverage with executing agencies. Projects can budget monitoring and evaluation costs as a separate line item, including project completion evaluations and even post-project evaluations. Initial monitoring and evaluation support in a project preparation facility (PPF), including training for the executing agency in formulating and carrying out the monitoring and evaluation plan, may also help. Disincentives may also be used. For example, for GEF projects blended with World Bank financing, the World Bank's normal covenant arrangement could be expanded to include noncompliance with monitoring and evaluation requirements as a conditional liability of borrowers. For stand-alone GEF projects, legal documents can reflect monitoring and evaluation requirements as a condition of the grant.

World Bank/GEF staff involvement in project design, preparation, and implementation can ensure that monitoring strategies and data collection are appropriate and adequate for evaluation of market development and sustainability. In particular, staff can help ensure that useful and appropriate indicators are used, that adequate baselines are established before the project, and that data sources and methodology are preserved beyond the project life whether through the executing agency or another party.

In any monitoring and evaluation strategy, several important needs must be balanced and addressed: (a) the need for independent and unbiased evaluations; (b) the need for data and experience that only the project executing agency may possess; (c) the need for continuity of evaluation methods and data sources from project preparation to post-completion phases; (d) the need for qualitative data based on surveys and expert ratings that may be resource- and time-intensive to obtain; (e) the need for simple and low-cost monitoring and evaluation activities; and (f) the need for a strategy that decision makers can easily understand.

Table 5: Monitoring and Evaluation in the World Bank/GEF Project Cycle

Project Cycle Phase	Activities Needed and Monitoring Indicator Focus	Potential Agents Responsible	Notes
Project preparation (PCD/PAD)	Define direct impacts (market interventions) vs. indirect impacts (market development and market sustainability) Select indicators and develop logical framework Establish sources of data for all indicators (i.e. executing agency reports, surveys, marketing research to be obtained or commissioned) Measure and establish baselines for all indicators Assign M&E responsibilities (agencies) for all indicators Establish GHG reduction and/or energy savings targets for project outputs	Government project preparation agency Task manager World Bank/GEF Operations staff GEF Secretariat and Council (for guidance and review)	Data sources, methods, survey questionnaires, and other materials associated with baseline measurement should be well documented and preserved for consistency of future measurements
Project implementation (590s and mid-term review)	Monitor *market intervention indicators* Monitor *market development indicators* as appropriate for undertaking mid-project corrections to implementation	Project executing agency Task manager	Ordinary project monitoring and evaluation of project outputs should highlight the emerging linkages between project outputs and broader market changes
Project completion (ICR)	Evaluate direct impacts from *market intervention indicators* Evaluate *avoided CO2 emissions* resulting from direct impacts Evaluate *market development indicators* (maybe for the first time)	Project executing agency ICR consultants Task manager	Plans and resources allocated by government agencies to continue post-project monitoring and evaluation should be determined. For some projects there may be no clear indirect impacts yet.
Post-project (two to four years after project completion)	Evaluate *market development indicators* Evaluate *market sustainability indicators*	Designated government agency Operations Evaluation Department World Bank/GEF Operations staff GEF Secretariat Independent project evaluators	See sample terms of reference in Annex B.

4 Monitoring and Evaluation Approaches and Issues

The lesson so far from market transformation in the United States is to use a four-part strategy to assess the impacts of market transformation programs: (1) focus on indicators of market changes and reductions in market barriers; (2) provide a complete and credible story with supporting evidence about what existed before and what happened during the project to change the situation; (3) use a systematic framework for analysis before and after the project; and (4) conduct in-depth retrospective analyses for some initiatives.

There are six key issues associated with such a strategy: (1) whether to measure physical or structure/function changes in markets; (2) whether and how to explicitly assess causality; (3) how to establish a project baseline; (4) what sources of data to use; (5) how to assign monitoring and evaluation responsibilities; and (6) what costs to budget for retrospective analyses. These issues are elaborated below.

Measuring Physical vs. Market Structure/Function Changes

All of the indicators discussed in the previous section could be used to measure market changes, depending upon the market, sophistication of approach desired, and the resources available. Measuring physical changes, such as from sales data, may provide a more credible estimation of market changes than will be provided by measuring market structure/ function changes. But sales data often lag by a number of years and are sometimes difficult or impossible to get from producers or dealers who consider these data proprietary. Sales and investments are trailing indicators because they measure the market response over time to a reduction in barriers and thus require measurement over extended time frames. Market structure/function indicators, in contrast, may be easier to obtain and are considered leading indicators because they are precursors to changes in investments or sales. Many argue that market structure/function indicators are reasonable proxies for investments or sales if a strong case can be made that market structure/ function changes reflect a reduction in the key barriers that inhibit markets. Measuring market structure/function changes also has the advantage of being directly related to project activities (because these changes are sometimes direct project outputs or closely tied to project outputs) and thus more easily measurable at project completion. Indirect physical changes may require measurement some years after project completion.

If indicators measure physical energy consumption or production, the monitoring and evaluation plan and project budget should consider the issues associated with such measurements, such as: measurement technology; cost versus accuracy of the approach; ability of local staff to conduct measurements and maintain and service measurement instruments; cost of spares and regular maintenance, including calibration costs for equipment; and labor and institutional support costs (see also World Bank 1994). Proper maintenance of monitoring equipment is one of the primary problems in these types of monitoring programs. For dependable data from precise monitoring equipment, maintenance and calibration must be carried out regularly, in many cases as often as every three months. Experience suggests that problems often emerge that should be anticipated in early supervision missions, such as specification of monitoring equipment, intervals at which data should be collected, and the recording medium to be used.

Causality

The problem of assessing causality—the degree to which observed changes in indicators were due to the project—is complex. The farther removed in space, time, or institutions from the project the observed changes are, the more difficult it is to attribute them to the project. Although it may be relatively straightforward to relate measurements of some market development indicators back to the project if there are clear linkages and no confounding or competing influences, attribution of other changes in market development indicators may be considerably less exact and subject to challenge. Nevertheless, causal attribution could be attempted on a selected basis as part of sophisticated monitoring and evaluation strategies.

The most sophisticated strategy is to establish comparison groups. This has been attempted with some success in the United States by comparing market changes in one state that implements an energy-efficiency program against the market in another state without such a program. But even in this case, the "spill-over" from one state to another can be substantial, as experience and ideas are disseminated through national forums. U.S. states are similar in economic, social, and political conditions, which eliminates some sources of comparison bias; however, such comparisons are more problematic among the developing countries and countries in transition in which the GEF operates because of the wide variety of socio-economic conditions.

Surveys can also be taken of market participants. Surveys can ask participants to rate the degree to which specific decisions they have made have been influenced by project outputs. This technique is called "self reporting." Although the validity of self-reporting has been questioned, this strategy has been used extensively in utility demand-side management (DSM) programs in the United States. Other evidence should be presented to support self reporting and provide plausible arguments showing how changes in indicators resulted from the project outputs. Finally, other intervening factors can be identified and analyzed to account for or discount their contribution to changes in the indicators (e.g., bilateral technical assistance or multilateral financing, government policies or programs, private-sector marketing or sales campaigns, new product development and investment by the private sector, and nongovernmental organization activities).

Without a requirement for causal attribution, market development indicators can simply be compared to expected market trends or forecasts. These expectations might be formulated to include larger programmatic efforts that might involve multiple donors, government policy changes, the private-sector, and NGOs. In this case, no credit may be attributed to individual projects; instead, success would be attributed to the overall programmatic effort and the combination of contributions from multiple projects and factors.

Establishing a Project Baseline

Market development indicators must be evaluated against a baseline that describes what would be expected to occur in the absence of a GEF project. A baseline should be established for all indicators prior the start of a project. This baseline should include future projections for the "without-project" scenario to the extent possible. Such projections may come from existing market surveys that measure expectations or plans of market participants or from analyses conducted by government, industry, or independent research groups. Indicators measured at project completion and then two to four years after project completion can be compared with the baseline. Consistent methods and sources must be used to establish the baseline and to measure indicators later. Different approaches could apply to different types of projects, such as projects for consumer markets (CFLs, solar home systems), industrial markets (boilers, wind turbines), innovative delivery mechanisms in target markets (private-sector ESCOs), and specific sectoral applications (energy-efficiency measures in a specific industry).

Many aspects of the baseline may be described in the Project Appraisal Document (PAD) and other supporting documents, particularly in the discussion about current barriers to the targeted technology application. Significant project documents that establish the baseline should be kept readily available for eventual project evaluation. Task managers can facilitate the creation of baseline documentation by ensuring that important source documents are included as appendices to World Bank reports or are archived in project files. Important forms of baseline documentation include:

- The legal, regulatory, and policy framework
- Price information that underlies economic analyses
- Taxes and/or subsidies important to project design
- Institutional capabilities of government agencies
- Market producer and consumer surveys
- Market sales or investment volumes
- Number and nature of market participants and their capabilities and limitations
- Current characteristics of technologies
- Formal or informal relationships between project participants and other market actors.

Typical examples of important price considerations are: power tariff charges including kWh rates and any tariff blocks for demand-side management projects; energy-purchase agreements including avoided cost arrangements for renewable or cogeneration projects that generate electricity; assumed firewood or wood offcut prices in biomass production (forestry) projects; and the imputed values of any byproducts or co-products created in the course of the project (for example, the imputed value of methane captured from landfills). Because private-sector activities in GEF projects will often involve special financial incentives provided by government, the documentation of tax arrangements can be an important element in any post-project evaluation of project performance—including concessionary rates, accelerated depreciation, and tax holidays.

A detailed assessment of an agency's baseline capacity prior to capacity-building activities can be a formidable task; the agency's credibility, experience, and manpower need to be quantified. Three aspects of capacity are particularly important to document: (i) the agency's human resources, including the numbers of staff (field operations, engineering support, planning, finance/administration etc.) by function as well as academic qualifications, area of expertise, and years of experience; (ii) supporting agencies that may be linked to the agency and provide additional capabilities; and (iii) reporting channels within the agency. It also may be important know the interests of different agencies, both formally as expressed in contractual documents or government directives, and informally as determined through personal interviews and other means.

Relationships among project stakeholders may also be relevant to a baseline. These relationships could be documented by knowing which stakeholder group originally conceived a project; which stakeholders are project advocates or opponents; which stakeholders provide political backing for the project; the sizes of the potential communities of stakeholders; and the results of efforts to convince stakeholders of the value of the project. Stakeholder interests could also be classified. For example, participants might have a policy interest, a supervisory interest, a financial or administrative interest, or an executing interest.

Measurement Sources

Gathering data on investments and sales is relatively straightforward if published sources exist, for example from government agencies, business associations, or retailers. Where data sources do not exist, generating these data through surveys and direct contacts with individual market participants may be prohibitively costly for a project. If there are only a limited number of sites where the technology is in use, then site inspection may be a viable method of data collection. Measurement of changes in market structure/function presents a greater challenge than gathering sales and investment data because of the need for qualitative or survey-oriented data collection. Many types of measurements of market structure/function changes will require ratings (for example, producers can be classified in terms of experience size, or market share). The long-standing discipline of marketing research, which attempts to understand characteristics of particular markets, offers insights into measuring the effects of information and persuasion campaigns (Aaker and Day 1986). A variety of research approaches can be used to analyze the market: collection of existing information (studies, journals, customer surveys), focus groups of small numbers of market participants, and surveys of larger numbers of market participants.

Market intervention indicators can generally be measured using reports by executing agencies. However, care should be taken during project preparation and negotiation that executing agencies or private-sector firms participating in the project be required to collect and compile the necessary data (see the China Energy Conservation project example for some examples of contractual agreements). Some market indicators may require compilation of contractual data. For example, the number of independent power producer contracts signed could probably be obtained from an electric utility.

Some indicators require market surveys, for example to measure awareness, understanding, capabilities, plans, decisions, investments, and satisfaction among different categories of market participants. Such surveys can address producers, dealers, financiers, and representative samples of consumers. Surveys of dealers can reveal market prices and sales patterns, and surveys of producers can reveal production costs and production patterns. In both cases, however, the data may be considered proprietary. The proprietary nature of such data is an important issue that may require institutional solutions (i.e., specialized agencies or organizations that collect and aggregate such data with assurances that data will never be revealed about individual firms), or contractual solutions (requirements associated with participating in the project).

Measuring institutional capabilities often requires expert or subjective ratings. Capabilities are probably best measured by having the same expert look at changes over time. If different people assess capabilities over time, a simple protocol, developed as part of the baseline measurement, could help provide consistency in interpretation and rating. Relatively objective measures of capabilities could also be used, such as, ability to enter into contracts (as demonstrated by having done so), or the time it takes a utility to complete a power-purchase agreement.

Assignment of Monitoring and Evaluation Responsibilities

Assignment of monitoring and evaluation responsibilities to one or more agencies should be carefully considered. Ordinarily, a third-party should be assigned both monitoring and evaluation responsibilities. However, assignment of monitoring responsibility to the executing agency may make sense if the agency has the best access to project participants and data. And it may also be adequate for a third party to merely advise the executing agency on good evaluation practice and certify the findings, similar to that of an external accountant who audits companies for shareholder reporting purposes. However, this arrangement could easily be ineffective if the executing agency is hostile to the outside evaluator or doesn't see the need for a third-party advisor. Because project implementors are often concerned about outside parties second-guessing their decisions, there may be resistance to the appointment of third parties to participate in evaluations. Nevertheless, the separation of evaluation activities from project operations is desirable.

Third-party evaluators should be objective, experienced, and independent of project agencies. Evaluators might be from a nongovernmental organization, university, or research institute; an independent policymaking agency of the government; or a semi-autonomous regulatory agency. Historical credibility and reputation of the evaluators is important. In circumstances where no existing local evaluation expertise can be identified, international evaluators could be considered with an eye toward building local capacity during the evaluation process.

Costs of Market Assessments

In the United States and Canada, traditional DSM program monitoring and evaluation typically accounts for between 3 and 5 percent of program costs, and sometimes is as high as 10 percent (World Bank 1994). Assessing market development is more complex than assessing DSM programs; thus, costs for market development evaluation could be even higher than these figures. However, DSM and GEF evaluations differ in one key way–the required accuracy of energy-savings measurements in DSM programs is much higher because the sponsoring utility's financial return is tied directly to these savings. In GEF projects, no financial mechanisms are tied to energy savings or production figures, although some GEF projects have opted to include contractual obligations for specific levels of energy savings to foster attitudes of accountability among project participants (see the China Energy Conservation Project example in Section 5). So the higher costs of assessing market changes may be compensated for by lower costs of measuring physical energy savings or production than are required for DSM programs. Unfortunately, "to date, no one has investigated how much it may cost to perform some of the methods suggested" for measuring market transformation (Wirtshafter and Sorrentino, 1994, p.10.263). Costs will also vary greatly depending on the market, the availability of local expertise, and the number and type of indicators selected. Only after more recent GEF climate-change projects are evaluated will costs become better defined.

5 Project Indicator and Evaluation Examples

The following examples are intended to illustrate the logical framework structure for GEF climate change projects in terms of project objectives, project outputs, market intervention indicators, market development indicators, and market sustainability indicators (see Section 2 for further discussion of these indicators). All the examples reflect the concepts and approaches provided in these guidelines and the evolving understanding of the nature of monitoring and evaluation for such projects. In some cases indicator examples differ from existing project documentation to better reflect this evolving understanding or to provide clarity of illustration.

A few of the project examples are of early pilot-phase GEF projects that have recently been completed or are close to completion (in Mauritius, Poland, India, and Thailand). These examples also contain narrative evaluations of market changes. Evaluation information for these projects is limited, however, partly because the pilot phase did not explicitly target sustainable market development as the primary objective. More recent projects, such as those in China, Sri Lanka, and Argentina, represent a new generation of projects designed under the 1996 GEF Operational Strategy, which targets market development; however, many of these projects are just starting.

Note that the logical framework presentation of indicators reads up; that is, project interventions occur at the bottom and indirect effects occur at higher levels.

Data for the examples come from GEF Project Documents, the GEF Operational Report (most recent, February 1998), Project Concept Documents, Project Appraisal Documents, internal World Bank supervision reports, communications with World Bank staff, and other unpublished material.[1] See also GEF (1997). For a published account of the projects in Mexico, Poland, and Thailand, see Martinot and Borg (1999) and Granda (1997).

1 Project Documents for all projects, the GEF Operational Report, and Project Appraisal Documents for projects approved since 1996 are available from the GEF Secretariat and the World Bank Environment Department.

Project Example 1: Mauritius Sugar Bio-Energy (FY92)

The objectives of the Mauritius Sugar Bio-Energy project are to expand electricity generation from bagasse, to promote the efficient use of biomass fuels from the sugar industry for energy production, and to strengthen the management and coordination of the Bagasse Energy Development Program. To achieve these objectives, the project sought to build a baseload power plant which would provide continuous power to the utility, using bagasse during the crop season and coal in the off season. The plant was to be the first in a series of regional plants, and its output was to depend in part on investments in efficiency improvements of regional satellite sugar mills (financed under the project) to provide surplus bagasse for power generation. The project also included components for technical assistance and technology demonstrations to promote private/public sector cooperation in power plant ventures and evaluate ways to decrease the transport costs for bagasse and optimize the use of sugar cane for power generation.

Direct investments. The Mauritius Sugar Authority provided documentation and data on investments in bagasse and efficiency investments in sugar mills. A bagasse plant planned as part of the project was not completed, and the utility had to invest in additional diesel-fueled plant to make up for the power supply shortfall. Six million dollars were dispersed under the project for efficiency investments in sugar mills to provide surplus bagasse for power generation; these investments were not projected to occur in the baseline.

Indirect investments. Electricity generation from bagasse in Mauritius increased from 70 GWh/yr in 1992 to 118 GWh/yr by 1996. Several sugar mills have completed or embarked upon bagasse power plant investments on their own, independent of the GEF project, including the original mill that was targeted for the bagasse power plant under the project. The European Investment Bank has agreed to finance a bagasse/coal-fired power plant. There was no baseline projection of bagasse power plant development; thus, it is unknown how strongly linked these developments are to the project. The ICR says that "extensive dialogue between the public and private sector on design work, the least-cost power development plan, and power purchasing agreements have directly or indirectly led to the development of other power plants."

Market structure/function changes. Very little data are available in the ICR regarding market structure/function changes, possibly because there was no project completion mission and these types of changes are difficult to analyze from documents alone. The ICR states that there has been "demonstration value" from the project and that the project led to establishment of a framework for independent-power-producer (IPP) development and an administrative focal point for private/public sector partnership in IPP development. The ICR also states that "the project's major accomplishment was progress in helping to establish an institutional and regulatory framework for private power generation in Mauritius and the provision of technical studies and trials to support technologies for improved bagasse production and improved environmental monitoring."

Mauritius Sugar Bio-Energy Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs	**Market Sustainability Indicators** Continued viability of independent power producer contracts Utility plans enacted that depend upon power generation from bagasse Sustainability of bagasse supplies from sugar mills
Development and Global Objectives Expand use of biomass resources in Mauritius. In particular, (a) expand electricity generation from bagasse; (b) promote efficient use of biomass fuels from the sugar industry for energy production; and (c) strengthen the management and coordination of the Bagasse Energy Development Program	**Market Development Indicators** Electricity generated by bagasse power plants (GWh) Capacity of bagasse power plants installed by project developers Volume of efficiency investments in sugar mills by project developers Institutional and regulatory framework enacted for private power generation from bagasse Annual volume of waste bagasse available from sugar mills for bagasse power generation Ratings of capabilities of project developers to design, finance, contract, install, operate, and maintain bagasse power plants and sugar mill efficiency improvements
Outputs 1. Bagasse power plant 2. Sugar mill investments 3. Strengthened capabilities of the Mauritius Sugar Authority and the Central Electricity Board 4. Policy advice and development 5. Biomass energy technology study 6. Bagasse transport study	**Market Intervention Indicators** 1.1 Capacity of bagasse power plant installed under project (MW) 2.1 Volume of efficiency investments in sugar mills under project 3.1 Ratings of capabilities of the Mauritius Sugar Authority and the Central Electricity Board to develop the Bagasse Energy Development Program, to conduct feasibility studies, to develop and finance projects, and to promote private independent power producers 4.1 Government program for biomass energy development enacted

Project Example 2: India Alternative Energy (FY92)

The objectives of the India Alternate Energy project are to promote commercialization of wind power and solar PV technologies by strengthening the capacity of the India Renewable Energy Development Agency (IREDA) to promote and finance private-sector investments. The project is designed to pioneer financing and market delivery mechanisms based on private-sector intermediaries and suitable incentive schemes and policies for small independent power producers. Markets for these technologies are catalyzed through large-scale demonstration, increased consumer confidence, and enhanced willingness to pay. One component of the project directly finances wind farm installations by private-sector developers through a policy framework that provides strong financial incentives. A second component provides for a marketing campaign, credit facilities, and subsidies to rural consumers for purchasing solar PV systems. The project has supported policies that encourage small-scale independent power producers to invest in wind farms and mini-hydro installations.

Direct investments and sales. Data are available from IREDA, which has authority for approving installations. The project targeted 85MW of commercially operated private wind farms to be financed through the GEF and the International Development Association (IDA; a member of the World Bank Group), with co-financing from the Danish government and from other resources mobilized by IREDA. As of March 1998, over 270 MW had been financed by IREDA and commissioned, including 41 MW commissioned with GEF and IDA financing and 10 MW commissioned with Danish funds. The project targeted 2.5 to 3.0 MWp of solar PV. As of March 1998, about 0.3 MWp had been commissioned and an additional 1.0 MWp was in the active pipeline. As of 1997, 125 MW of hydro was in the pipeline.

Indirect investments and sales. Data are also available from IREDA. The baseline before the project for grid-connected wind farms was 38 MW of state-operated demonstration projects, largely a result of Danish government assistance. As of March 1998, a total of 968 MW of wind farms were installed and operating in India, of which 917 MW were commercial and privately operated. Promotion of private sector wind farms has thus been highly successful, although installed capacity does not provide the full picture. These indirect commercial installations were strongly influenced by incentives provided to wind-farm developers in the form of highly favorable investment tax policies. These policies provided strong incentives for capacity installation but not for high capacity factors after installation, so average capacity factor is also an important indicator. Before the project, 8,000 villages had solar PV lighting systems and there were about 1200 solar PV water pumps, about 5,000 domestic solar PV lighting units, and about 0.6 MWp of capacity among 50 village power systems. As of March 1998, 32 MWp solar PV capacity had been installed in India (in more than 350,000 systems by 1996).

Market structure/function changes. The chief sources of information are IREDA and discussions with industry players and financial institutions. The GEF project helped to catalyze significant changes in market structure/function. For example, the project helped to raise awareness among investors and banking institutions on the viability of wind power technology and helped to lobby for lower import tariffs for both wind and solar PV systems. Many more financial institutions decided to offer financing for wind farms and a wind-power loan portfolio among commercial banking institutions emerged (this was a key project goal). New suppliers entered the wind power and solar PV markets. Before the project there were three major companies involved in the wind industry, including one state firm and two joint ventures with Danish partners. By 1998, as many as 26 companies were engaged in the wind turbine manufacturing industry, many with foreign partners. High-technology wind turbine designs up to 600-kW with variable speed operation were produced by 14 companies. Manufacturers had also achieved a high degree of domestic content. Although wind turbine blades were still largely imported, domestic production of blades had begun and exports of blades and synchronous generators to Europe were underway. Wind turbine exports to other countries also began. The installed costs of wind turbines in India declined from around $1200/kW in 1991 to $815-1050/kW in 1998. The number of Indian consultants capable of developing wind power investment projects increased dramatically, in part because of GEF-supported training and networking activities for consultants, technicians and private firms (a roster of consultants was available from IREDA for reference by investors).

Data on the solar PV industry is also available from the Ministry of Non-Conventional Energy and from an association of solar PV manufacturers. The application of solar PV became more diversified to include rural telecommunications (42%), PV water pumping (9%), streetlighting (9%), rural home lighting (8%), solar lanterns (5%), power plants (5%), and many other applications. Promotional efforts and numerous business meetings organized by IREDA increased awareness of various PV applications among potential users. Between 1992 and 1995, these meetings mushroomed from a handful of attendees to large ballroom-size affairs. In 1991, domestic production capacity for solar modules was 3 MWp and annual production was 1 MWp, with 16 companies involved in the PV industry. By 1996-97, annual production was 4 MWp of solar cells and 8 MWp of PV modules. By 1998, fourteen companies were engaged in the manufacture of PV modules and 60 companies in the manufacture of a variety of PV systems. Despite the industry growth, there have been problems in extending credit to potential rural PV consumers. Opinions gathered from financial institutions and industry players have suggested that financial institutions perceive rural consumers as unwilling to repay loans and therefore have not extended credit. Suppliers have prioritized their marketing efforts first to government programs, secondly to consumers who can pay cash, thirdly to corporate purchases, and only last to consumers needing credit.

(continued on next page)

Project Example 2: India Alternative Energy (FY92) (cont'd)

Thus the project's main impact through 1998 from promotional and networking activities was on PV cash sales. Direct observations during visits to project sites and PV manufacturing facilities provided data on the quality of installed PV systems (which was fair to excellent in terms of equipment and poor to mediocre in terms of systems integration, according to a 1996 report). Also, the lack of infrastructure for after-sales support and service has emerged as an additional difficulty in rural markets.

Market sustainability indicators. For wind power, market sustainability in the absence of investment tax incentives remains to been judged. With an installed capacity base now rivaling many developed countries and existing wind turbine production capacity, there would seem to be little doubt of a continuing industry. The 1996 GEF Project Implementation Review (PIR) concluded that "the India Alternative Energy project has been successful in adapting and expanding technologies for electricity generation from wind farms, but widespread replication of these advances, as well as expanded use of solar PV systems, has been limited by policy and financial constraints." The PIR further concludes that "It is unlikely that the PV markets will be sustainable after this project," because of "softer" financing options, higher marketing costs, lower consumer awareness, and limited ability to pay. In particular, future consumer acceptance of solar PV is uncertain. According to a 1996 supervision report, a combination of tax credits and 2.5% to 5% lending rates was creating a market for solar PV primarily in the corporate commercial sector, but this market may be much less viable in the absence of such strong incentives.

India Alternate Energy Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs	**Market Sustainability Indicators** Cost-competitiveness of wind farms without accelerated depreciation Continuation and commercial viability of joint ventures and PV dealers
Development and Global Objectives Promote commercialization of wind power and solar PV technologies in India. In particular, pioneer financing and market delivery mechanisms based on private-sector intermediaries	**Market Development Indicators** _ Installed capacity of wind farms and mini-hydro _ Installed capacity of solar PV systems _ Capacity factor of wind farms (%); other technical performance ratings _ Costs of installed wind farms and PV systems _ Number of wind turbine manufacturers & joint ventures in Indian market _ Existence of new support firms, like wind-turbine calibrators to improve turbine performance _ Ratings of capabilities of private-sector developers to design, finance, contract, install, and operate wind farms, mini-hydro, and solar PV _ Energy generated by wind farm and mini-hydro installations (kWh)
Outputs 1. Private-sector wind farm and mini-hydro development and demonstration 2. Solar PV credit line and marketing program 3. India Renewable Energy Development Agency (IREDA) marketing, technology, entrepreneurial, and project development functions strengthened 4. Studies for improving policy environment for small-scale IPPs	**Market Intervention Indicators** 1.1 Installed capacity of wind farms and mini-hydro financed through project (target: 85 MW) 1.2 Ratings of understanding and acceptance by project developers and utilities of the technical, economic, and commercial viability of wind farm and mini-hydro development 2.1 I Installed capacity of solar PV systems financed through the project (target: 2.7 MWp) 2.2 Ratings of rural consumer familiarity with, understanding and acceptance of solar PV systems; consumer plans or deliberations to purchase solar PV systems 2.3 Ratings of credit availability to rural consumers to buy PV systems 3.1 Ratings of the capabilities of IREDA to market and develop renewable energy technologies 4.1 Policies enacted or considered that encourage small-scale independent power producers to invest in wind farms and mini-hydro installations

Project Example 3: Sri Lanka Energy Services Delivery (FY97)

The objectives of the Sri Lanka Energy Services Delivery project are to: (1) promote the provision by the private sector, NGOs and cooperatives of grid and off-grid energy services using renewable energy technologies; (2) strengthen the environment for DSM implementation; and (3) improve public- and private-sector delivery of energy services through renewable energy and DSM. The main component of the project provides credit channeled through designated local financial institutions for medium-and long-term financing to private-sector firms, NGOs, and cooperatives for solar home systems, village-scale mini-hydro, grid-connected mini-hydro, and other renewable energy investments. Grant co-financing from the GEF is available for solar home systems and village mini-hydro subprojects. The project also finances a pilot grid-connected wind farm of approximately 3 MW. Technical assistance is offered to improve the capabilities of utilities, private-sector developers, and NGOs to promote and deliver energy services using renewable energy technologies, including: Small Power Purchase Agreements; generation planning models that incorporate intermittent, nondispatchable renewable energy generating sources; and feasibility studies and business plans. Technical assistance also supports the development of an Energy Efficient Commercial Building Code of Practice.

Direct investments are renewable energy systems installed by private-sector developers, NGOs, and cooperatives that are directly financed and/or subsidized by the project.

Indirect investments are installations not directly financed or subsidized by the project. Indirect investments can be measured through reports by the utility about power-purchase agreements and purchases of electricity from small power producers, utility wind farm reports, surveys of small power producers, and surveys of households. Indirect installations can be attributed to the original project if surveys of renewable-energy small power developers confirm that the developer's investment decision was influenced by the project, or if the developer received technical assistance or training, directly or indirectly, through the project. More loosely, all indirect market impacts that occur through the Standard Small Power Purchase Agreement mechanism could be attributed to the project.

Direct market structure/function changes would measure whether the utility developed a Standard Small Power Purchase Agreement; whether capabilities of the utility, private-sector developers, and NGOs that participate in the project improve (including capabilities to prepare feasibility studies and business plans); whether renewable energy is accepted by consumers, project developers, and financial institutions; whether information and experience from the pilot wind farm is disseminated; whether the Energy Energy-Efficient Commercial Building Code of Practice is issued; and whether capabilities of public and private agencies to incorporate the code into building designs are developed.

Indirect market structure/function changes can be measured through utility reports and surveys of consumers, project developers, and financial institutions about plans to purchase, develop, or finance renewable energy technologies (including preparation of feasibility studies and business plans). The number of private-sector developers in the market with plans to continue is also a key indicator.

Sri Lanka Energy Services Delivery Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs	**Market Sustainability Indicators** Ratio of commercial vs. public financing for private-sector developers Financial sustainability of PV vendors
Project Development & Global Objectives Promote the sustainable provision by the private sector, NGOs and cooperatives of grid and off-grid energy services in Sri Lanka using renewable energy technologies; strengthen the environment for DSM implementation	**Market Development Indicators** Installed capacity of grid and off-grid renewable energy Number of off-grid customers served by renewable energy Number of private-sector developers and PV businesses in the market Volume or number of new buildings constructed according to Energy Efficient Commercial Building Code of Practice
Outputs 1. Renewable energy projects by the private sector, cooperatives, and NGOs (wind farms, solar home PV and village hydro) 2. Pilot wind farm of about 3 MW 3. Improved private-sector, public sector and NGO capabilities to promote and deliver energy services using renewable energy technologies 4. Strengthened DSM implementation capabilities by utility and private-sector 5. Code of practice for energy efficiency in commercial buildings	**Market Intervention Indicators** 1.1 Installed capacity of grid and off-grid renewable energy through project (target: 16 MW by 2002) 1.2 Standard Small Power Purchase Agreement, non-negotiable power purchase tariff in place. 1.3 Number of Small-Power Purchase Agreements signed by utility (target: 12, including one for a private wind-power project) 2.1 Installation of pilot wind farm; performance ratings 3.1 Ratings of capabilities of Ceylon Electricity Board to contract for private power 3.2 Ratings of capabilities of private-sector developers to prepare feasibility studies and business plans and to obtain financing 3.3 Generation planning models prepared by utility that incorporate intermittent, nondispatchable renewable energy generating sources 3.3 Ratings of acceptance by consumers, project developers, and financial institutions of the viability of grid and off-grid renewable energy 4.1 Ratings of institutional capacity in public and private sectors to incorporate the Energy Efficient Commercial Building Code of Practice into building design and operations 5.1 Energy Efficient Commercial Building Code of Practice issued

Project Example 4: Argentina Renewable Energy in Rural Markets (projected FY99)

The objectives of the Argentina Renewable Energy in Rural Markets project are to develop a market for renewable energy systems in those rural markets where electric power grid extensions are prohibitively expensive. In these markets, households use kerosene for lighting; solar PV, wind, hydro, and mini-diesel systems can replace this kerosene consumption, with corresponding reductions in GHG emissions. The mechanism chosen by the government is to award 15-year contracts on a competitive basis to concessionaires who will have a monopoly for providing energy services in a particular province. The concessionaire, at a household's request, will install a solar home PV system installation for a down- payment and a monthly fee for the lifetime of the system. The GEF will subsidize the initial cost of the PV system for certain consumer categories (where incremental costs are positive). This scheme requires technical assistance in three categories: (1) suitable regulatory, contractual, and procurement capabilities among government agencies; (2) adequate knowledge by potential concessionaires and government agencies about PV technologies, costs, financial models, rates of return, risks, operation and maintenance, and market potential; and (3) marketing and dissemination of information to households.

Direct sales are renewable energy systems installed by the concessionaires and financed and subsidized by the project. These sales will be measured through concessionaire reports.

Indirect sales are installations not directly financed or subsidized by the project. Indirect sales are most likely to occur after project completion. Indirect sales can be measured through reports by concessionaires, perhaps verified by independent, third-party market surveys. Indirect sales could be attributed to the original project if performed by concessionaires who have installed renewable energy systems under the project, because a strong case could be made that these concessionaires are continuing to offer renewable energy systems and consumers are continuing to buy them because of the original project. Indirect sales would also occur through concessions in areas beyond the 10 provinces targeted by the project.

Direct market structure/function indicators can be measured through project progress reports by the Secretariat of Energy and Ports, enacted tariff schedules, enacted regulations, enacted codes and standards, reports by provincial governments about regulatory activities, contract documents (and revisions) between the government and concessionaires, household surveys, and surveys of contracted or potential concessionaires about their capabilities.

Indirect market structure/function indicators could reflect the installation, operation, and maintenance costs of solar PV systems; the market share of renewable energy equipment produced according to standards; and the proportion of the rural market served by concessions.

Argentina Renewable Energy in Rural Markets Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs	**Market Sustainability Indicators** Lease renewal rates for solar home systems Long-term financial sustainability of concessions
Project Development & Global Objectives Provide rural off-grid energy services in Argentina sustainably through the private sector using renewable energy systems	**Market Development Indicators** Number of installations of solar home systems by concessions throughout the country Overall market share of renewable energy systems in off-grid applications (relative to conventional off-grid energy supply) Installation costs of solar PV systems (per peak watt); operation and maintenance costs (per unit) Market share of renewable energy equipment produced according to standards Proportion of the rural market served by concessions
Outputs 1. Concession contracts for providing electricity services 2. Promotion, installation and operation of reduced-cost renewable energy systems by private-sector concessions 3. Strengthened regulatory function and capability of provincial governments 4. Greater consumer awareness and acceptance of renewable energy systems 5. Standards and certification for renewable energy systems	**Market Intervention Indicators** 1.1 Standard concession contracts in place to provide electricity services using renewable energy systems in the rural market (target: 10 contracts by 2002) 2.1 Installations of solar PV systems in households and public agencies by participating concessions (target: 14 MW and 120,000 systems by 2002) 2.2 Installations of mini-hydro plants for small communities by participating concessions (target: 450 plants, 3-10 kW each, serving 13,500 households) 2.3 Installations of pilot wind home systems (target: 2); performance ratings 2.4 Share of renewable energy systems relative to conventional systems installed by participating concessions 2.5 Ratings of capabilities of participating concessions to design, purchase, finance, market, install, operate, and maintain renewable energy systems 3.1 Regulations enacted by provincial governments that promote renewable energy systems (target: 10 provinces by 2002) 3.2 Ratings of capabilities of provincial governments to regulate markets and concession contracts for renewable energy systems 4.1 (also 2.6) Ratings of household familiarity with, understanding and acceptance of renewable energy systems; household plans or deliberations to purchase renewable energy systems 5.1 Number of suppliers and installers certified; standards issued

Project Example 5: China Renewable Energy Promotion (projected FY99)

The objective of the China Renewable Energy Promotion project is to build commercial markets for wind farms and PV systems. The project will support: (a) installation of wind farms; (b) supply of PV/wind hybrid systems to households and institutions in remote areas of four Northwestern provinces; (c) technology innovation to reduce cost and improve performance of wind-farm and solar PV technologies in China; and (d) strengthening of institutional capacity and market infrastructure for large-scale commercialization of wind farms and solar PV.

Direct sales and investments are 190 MW of wind farms in operation and PV systems providing electricity to 200,000 rural households. These indicators will be tracked by the executing agency.

Indirect sales and investments will be measured by the installed capacity of wind farms in China, the installed capacity of solar PV in China, and the number of PV systems sold in China. Government data exist for these indicators. The project is conducting a PV market survey to help establish the market baseline prior to project start-up.

Direct market structure/function changes related to PV systems include new payment mechanisms to make PV systems more affordable to consumers, increased consumer awareness and improved credibility of PV technology, improved quality of equipment and after-sales service, improved commercial capabilities of PV dealers (especially with respect to accounting, financial management, and ability to get loans), establishment of a PV technology testing center, national PV system standards, and a government PV industry strategy. Market structure/function changes related to wind farms include improved technical, financial and operational capability of wind-farm companies; availability of legal and commercial documentation for wind farm development by the private sector; and increased capacity to mobilize private investment in wind farm development. Other changes relate to quality improvements in locally produced technologies and lower equipment costs in those areas where Chinese firms have a competitive advantage. The direct sales and investments associated with the project will also strengthen the capabilities of specific private-sector PV installers and wind farm developers.

Indirect market structure/function changes will be reflected in the number of independent power producers in China (available from government data), the number of PV vendors in the market, the availability of payment mechanism to improve affordability of PV systems, and the reduction of capital costs of wind and PV systems in China.

China Renewable Energy Promotion Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs	**Market Sustainability Indicators** Cost competitiveness of wind farms without utility subsidies Financial sustainability of PV vendors
Development and Global Objectives Develop commercial markets for wind farms and PV systems in China	**Market Development Indicators** Installed capacity of wind farms in China (target: 1,060 MW by 2007) Installed capacity of solar PV in China (target: 20 MW by 2007) Number of PV systems sold in China (target: 414,000 by 2007) Number of independent power producers in China Reduced capital costs of wind and PV systems in China (target: wind from $1,300/kW in 1998 to $950/kW in 2007)
Outputs 1. 190 MW of wind farms in operation 2. PV systems providing electricity to 200,000 rural households 3. Local production of PV and wind equipment strengthened 4. Information disseminated and improved capabilities 5. PV Test Center 6. National PV system standards 7. PV industry strategy	**Market Intervention Indicators** 1.1 Wind farm capacity installed and in operation 1.2 Ratings of understanding and acceptance by local developers and government agencies of the technical and economic viability of wind farms. 2.1 Number and capacity of PV systems installed 3.1 Ratings of the capabilities of local producers to produce PV and wind equipment; market share of domestic equipment production 4.1 Ratings of capabilities of wind farm project developers 4.2 Volume of information disseminated to potential investors and developers about technologies and wind farm performance 5.1 PV Test Center accredited and certifying products 6.1 National PV system standards adopted 7.1 PV industry strategy developed

Project Example 6: Brazil Biomass Power Commercial Demonstration Project (projected FY99)

The objectives of the Brazil Biomass Power Commercial Demonstration Project are to demonstrate the commercial viability of using wood as a feedstock for power generation through the Biomass Integrated Gasification/Gas Turbine (BIG/GT) concept. Because this project is under GEF Operational Program 7 ("reducing the long-term costs of low greenhouse-gas emitting technologies") and concerns a technology which is not yet commercial (in contrast to the technologies in Project Examples 1 to 5, which are already commercially viable), the direct project outputs consist only of the working demonstration plant. The project does not include any "barrier removal" activities directed at specific national or regional markets. The demonstration is intended to spur further research, development, and commercialization of the technology worldwide. The indirect impacts of the project can be measured by adoption of this technology worldwide as costs are reduced and perceptions of its commercial feasibility change.

Brazil Biomass Power Commercial Demonstration Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Reducing the Long-term Costs of Low Greenhouse-gas Emitting Technologies	**Market Sustainability Indicators** Life-cycle costs of BIG/GT plants relative to conventional generating plants Long-term sustainability of fuelwood supplies for BIG/GT
Development and Global Objectives Demonstrate the commercial viability of the BIG/GT concept	**Market Development Indicators** Capacity of BIG/GT plants constructed worldwide; financial commitments for new plants Number of suppliers of BIG/GT plants worldwide; degree of local involvement and backwards integration Private-sector investment in BIG/GT research and development (R&D) Diversity and innovativeness of technology available commercially
Outputs 1. 30 MW demonstration plant 2. Plans for commercial dissemination	**Market Intervention Indicators** 1.1 Demonstration plant operational; plant performance indicators 1.2 Demonstration plant life-cycle costs 2.1 Number of engineers and managers worldwide exposed to demonstration plant, dissemination literature, and project personnel

Project Example 7: Thailand Promotion of Electricity Efficiency (FY93)

The objectives of the Thailand Promotion of Electricity Efficiency project are to (a) build institutional capability in the Thai electric power sector and the energy-related private sector to deliver cost-effective energy services; and (b) to pursue policies and actions that will lead to the development, manufacture, and adoption of energy-efficient equipment processes. This project is a comprehensive five-year utility DSM program, which created a DSM office within the national electric utility (EGAT). The DSM office is developing and implementing a number of market intervention strategies in the residential, commercial, and industrial sectors. The project provides for financing mechanisms, energy-efficiency codes and standards, appliance labeling, testing laboratories, monitoring and evaluation protocols and systems, development and training of energy service companies, integrated supply-side and demand-side planning, and load management programs. EGAT wished to avoid direct subsidy programs, and has tried to rely instead on voluntary agreements, market mechanisms, and intensive publicity and public education campaigns. The project has several components, including a high-efficiency fluorescent tube lamps program (voluntary agreements by producers and importers to switch from T-12 tubes to more efficient T-8 tubes), a CFL promotion and distribution program, a low-loss magnetic ballast promotion program, and development of commercial building audits and design standards. In addition, EGAT is promoting investments by private-sector energy service companies.

Direct sales. So far the largest numbers of direct installations have been of CFLs. CFL sales data are reported by EGAT and distributors (7-11 convenience stores nationwide) purchasing CFLs through EGAT bulk purchases. As of March 1998, over 498,000 CFLs were sold.

Indirect sales. The CFL market baseline is fairly large, and the indirect installations associated with the CFL component of the project may not be measurable. The CFL market was estimated at 2 million/year in 1996, with an estimated growth of 30%/year. Data on T-8 lamps comes from self-reporting by manufacturers and importers of T-8 lamps (only T-8 lamps are now sold) and consumer surveys regarding switching from T-12 to T-8 lamps (consumers aware of benefits of high-efficiency lamps and have no choice but to buy them). Based on market sales projections of T-8 lamps (45 million tubes/year over five years), the project estimates that electricity demand will decrease by 7,200 GWh over the life of 225 million tubes. For the entire program taken together from 1993 to March 1998, EGAT estimates a peak load reduction of 320 MW and annual electricity savings of 1,200 GWh. Data on investments by energy service companies, including number of projects and expected/actual energy savings, should be obtainable from these companies in the future.

Market structure/function changes. EGAT's Demand-Side Management Office has been created. Many signs point to increasing capabilities of this office, including the successful negotiation of voluntary T-12 to T-8 lamp changeover, bulk procurement of CFLs and arrangements to distribute them through convenience stores nationwide, a successful campaign to promote public awareness of energy efficiency and conservation, appliance energy labels, and dissemination of classroom educational materials.

Thailand Promotion of Electricity Efficiency Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Removal of Barriers to Energy Efficiency and Energy Conservation	**Market Sustainability Indicators** Financial sustainability of energy service companies Financial sustainability of EGAT DSM office and continued ability to intermediate in energy-efficiency markets
Development and Global Objectives Build institutional capability in the Thai electric power sector and the energy-related private sector to deliver cost-effective energy services Pursue policies and actions that will lead to development, manufacture, and adoption of energy-efficient equipment and processes	**Market Development Indicators** Investment volume in energy-efficiency measures made by energy service companies Sales volume of CFLs and other efficient lighting products sold Investment volume in renovations to commercial and industrial facilities for higher energy efficiency Relative market share of new, high-efficiency products (refrigerators, lights, motors, etc.) relative to established products; percentage of established manufacturers that produce and sell high-efficiency equipment of each type Number of third-party energy service companies operating; ratings of their capabilities to design, finance, market, contract, install, maintain, and monitor energy-efficiency projects Electricity saved (MWh) and system peak load reduction (MW)
Outputs 1. Support for Thai fluorescent tube manufacturers and importer to switch to production and import of high efficiency tubes 2. CFL sales to consumers 3. Demonstration commercial building retrofits 4. New commercial building energy-efficiency codes 5. Demand-Side Management Office in electric utility (EGAT) 6. Labeling and standards for appliances and other equipment 7. Public education campaigns for energy conservation and efficiency	**Market Intervention Indicators** 1.1 Agreements by T-12 tube manufacturers/importers to switch to T-8 1.2 Market share of T-8 tubes relative to T-12 tubes (target: 100%) 2.1 Annual sales volume of CFLs sold under project 2.2 Annual sales volumes of low-loss magnetic and electronic ballasts 2.3 Number of retail distributors selling CFLs 3.1 Volume or number of commercial buildings retrofit under project 3.2 Ratings of understanding and acceptance by building contractors and architects of energy-efficiency technologies and practices for commercial buildings, and of the new commercial building energy-efficiency codes 4.1 New commercial building energy-efficiency codes issued 5.1 Ratings of capabilities and activities of Demand-Side Management Office in designing, conducting, and evaluating DSM programs 6.1 Market share of products with labels and/or produced according to standards; comparison of labels and standards with international practices

Project Example 8: Poland Efficient Lighting (FY95)

The objectives of the Poland Efficient Lighting Project (PELP) are to stimulate the market for energy-efficient lighting in Poland and advance the growth of that market by five years, to develop the capacity of entities within Poland to deliver DSM resources, and to demonstrate the value of DSM programs to the Polish electric power sector, the Polish government, and NGOs. There are five components: (1) promotion of CFL sales by means of subsidies (provided on a competitive basis) to manufacturers to reduce CFL wholesale prices; (2) a study of strategies for promoting CFL luminaire sales, voluntary adoption of CFL luminaires by housing cooperatives, and incorporation of CFL luminaires into school lighting standards; (3) a pilot DSM program by three municipal governments and their local electric utilities to reduce peak electric demand by installing CFLs; and (4) a public education program.

Direct sales. Manufacturers kept track of CFL sales themselves as part of their contractual obligations (manufacturers competed to provide the largest guaranteed sales at the lowest project subsidy cost, and were required to verify sales performance before receiving subsidy payments). About 1.2 million CFLs were subsidized and sold under the project. Using manufacturers' data about CFL sales and the average wattage of the lamps replaced by CFLs (obtained from consumer surveys conducted by a market research firm), the project evaluators calculated avoided electricity generation of 725 GWh over the life of the CFLs sold under the project.

Indirect sales. Data will come from annual CFL sales figures during the years following project completion, most likely determined by market surveys conducted by an independent market research firm. These figures will be compared with preproject baseline estimates of CFL sales figures (estimated at 600,000/year in 1994 and projected to grow to saturation of 4.7 million CFLs per year by 2012 in the absence of the project, according to the project pre-appraisal report). Total sales during the project, including sales of unsubsidized lamps, were not measured.

Market structure/function changes. There are a wealth of market structure/function data for this project. A third-party market research firm conducted numerous market research studies before, during, and after the project. This research included a consumer response card survey, consumer studies, retail shop surveys, a sign and TV awareness survey, and wholesaler interviews. According to the survey data, after the project 35% to 40% of the population was aware of CFLs (in contrast to an estimated 10% before the project, although there was no preproject survey data), 20% of households had CFLs (versus 12% preproject, according to survey data), 54% of respondents knew someone with CFLs (versus 38% preproject from surveys), and about 97% of consumers were satisfied with CFLs purchased under project. After the project, 75% of retail shops were stocking CFLs, compared to 71% before the project. There were a variety of other data sources as well. In a testimonial mailed to the project management, the Ministry of Education wrote "it is apparent that as a result of the project large numbers of students and teachers have gained useful insight into the use of energy and its impact on the environment." A PELP evaluator wrote in 1997 that "CFLs have been successfully advertised in TV and print media over the last two years." Real CFL prices, after removal of subsidies, were lower by 30% after the project compared to preproject prices. Numerous CFL manufacturers have entered the Polish market for the first time, increasing competition. Discussions with CFL manufacturers show expectations of an expanded market because of increased consumer awareness.

One other effect tracked by the project was the decrease in peak power demand in an electric power distribution system due to a DSM pilot component. This component included a six-month monitoring period of local distribution networks (six locations at both the 0.4kV and 15kV levels). The first month of monitoring gathered sufficient data to develop a baseline power use profile. During the second and third months, a CFL promotional campaign was conducted; during the fourth through six months, the impact of CFL installations on the distribution system was monitored. Although the evaluation was not yet complete at the time of this report, preliminary indications in one distribution system showed reduced peak residential electricity demand of 15%. Additionally, some monitored households exhibited up to a 40% reduction in peak power demand after CFL installation.

Poland Efficient Lighting Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Removal of Barriers to Energy Efficiency and Energy Conservation	**Market Sustainability Indicators** Retention rate of CFLs (share of worn-out CFLs replaced with new CFLs) Continuation rates of dealers stocking CFLs
Development and Global Objectives Improve the energy efficiency of electric power end-use in Poland. In particular, (a) stimulate the market for energy-efficient lighting; and (b) develop the capacity of entities within Poland to deliver DSM resources and demonstrate the value of DSM	**Market Development Indicators** Quantity of unsubsidized CFLs sold in the Polish market CFL retail prices Number of manufacturers actively selling CFLs in Poland. Quantities of dedicated CFL luminaires sold per year Electricity saved by CFLs (kWh) and reductions in electric power distribution system peak loads (%)
Outputs 1. CFL sales to residential consumers 2. Public education program 3. Utility DSM pilot program	**Market Intervention Indicators** 1.1 Quantity of subsidized CFLs sold through the project (target: 1.2 million) 1.2 Percentage of lighting distributors / dealers stocking CFLs 2.1 Ratings of consumer satisfaction and acceptance of CFLs; consumer plans or deliberations to purchase CFLs 3.1 Percentage of consumers in targeted geographic areas who respond to DSM promotional campaign 3.2 Ratings of capabilities, interest, and plans of municipal governments to implement DSM programs with CFLs

Project Example 9: China Efficient Industrial Boilers (FY97)

The objectives of the China efficient boilers project are to develop affordable, energy-efficient, and cleaner industrial boiler designs, to mass produce and market these high-efficiency boiler designs, and to disseminate more energy-efficient and cleaner boiler technologies throughout China. Proposals from Chinese boiler manufacturers were solicited; nine were selected for participation in the project. The project provides technology transfer and technical assistance to these nine participating boiler manufacturers to develop high-efficiency boiler models. The project provides GEF grants for acquiring advanced equipment from abroad to upgrade production with new boiler models. Technical assistance is provided for developing production, marketing, and financing plans for the new boiler models and for strengthening customer service programs. The project also provides technical assistance and training for industrial enterprises to understand, procure, and operate the higher-efficiency boilers, and for design and research institutes and government agencies to disseminate the technologies to other boiler manufacturers.

Direct sales. Direct boiler sales can be determined from reports by the nine participating boiler manufacturers about their production and sales; these reports are required under the terms of the project.

Indirect sales. Indirect boiler sales can be determined by surveys of other (nonparticipating) boiler manufactures' product development activities and sales of high-efficiency boilers. However, because of manufacturer secrecy and the difficulty of contacting many different manufacturers, these data may be difficult to obtain except through established government statistical sources. Attribution of indirect impacts could be attempted by asking manufacturers whether their plans or activities to develop higher-efficiency boilers were influenced by contacts with the nine participating boiler manufacturers, by participation in the initial project selection process, by technical assistance (outreach and dissemination activities) under the project, or by changes in their own market projections attributable to the project.

Direct market structure/function changes will reflect enhanced capabilities of the nine participating boiler manufacturers, upgraded product lines, and new marketing efforts. Other changes will occur on the consumer side as a result of technical assistance to industrial enterprises.

Indirect market structure/function changes will occur as nonparticipating boiler manufacturers begin to produce high-efficiency boilers and as understanding and awareness about high-efficiency boilers increases for industrial enterprises not receiving technical assistance from the project. Information dissemination will play a key role in indirect changes. In post-project monitoring, special attention should be paid to the form of dissemination of technical information and know-how. It is not yet clear how technically specific or useful the technical information "packages" to be assembled and disseminated to other boiler manufacturers as part of the project will be, depending upon licensing agreements with foreign technology suppliers and the requirements placed on the nine participating boiler manufacturers to share their specific technologies. The "technical information packages" may inspire some manufactures to seek technology licenses, but may not be sufficient for them to adopt the technology directly.

Data sources for post-project market development indicators. Market surveys will be necessary in the post-project phase, focusing on boiler manufacturers, financial institutions, and industrial enterprises. The Ministry of Machinery has historically kept track of all boiler manufacturers and their activities, but because of economic reforms, this Ministry's future responsibilities are unclear. There may be no government data source in the post-project phase, which may hinder measuring market development, especially market structure/function changes.

China Efficient Industrial Boilers Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Removal of Barriers to Energy Efficiency and Energy Conservation	**Market Sustainability Indicators** Continued financial and economic viability of high-efficiency boiler production by manufacturers relative to conventional models
Development and Global Objectives Build the market for higher-efficiency industrial boilers in China. In particular, (a) develop affordable energy-efficient small- and medium-scale coal-fired industrial boiler designs; and (b) produce and market energy-efficient boiler designs throughout China.	**Market Development Indicators** Aggregate capacity of high-efficiency boilers produced and sold by all boiler manufacturers Sales share of high-efficiency boilers produced and sold by all boiler manufacturers, relative to total boiler sales (by capacity; target 35% by 2002) Number of boiler manufacturers making improvements to the thermal efficiencies of their model boiler units
Outputs 1. Upgraded designs for existing Chinese boiler models 2. Nine participating boiler manufacturers have production equipment and capabilities to produce upgraded boiler models 3. Industrial enterprises and financial institutions knowledgeable about high-efficiency boilers 4. Operators trained on upgraded boilers 5. Boiler technology disseminated to manufacturers and design institutes. 6. National boiler standards	**Market Intervention Indicators** 1.1 Aggregate capacity of high-efficiency boilers produced and sold by the nine participating boiler manufacturers (target: 27,000 tph capacity by 2002, two years after project completion) 2.1 Sales share of high-efficiency boilers produced and sold by the nine participating boiler manufacturers, relative to their total boiler sales (by capacity totals) 2.2 Levels of higher thermal efficiencies achieved in model boiler units by the nine participating boiler manufacturers 2.3 Ratings of capabilities of the nine participating boiler manufacturers to design, produce, market, and service high-efficiency boilers 3.1. Ratings of understanding and acceptance by industrial enterprises and financial institutions of the technical, economic, and commercial viability of high-efficiency boilers 4.1 Number of boiler operators trained and ratings of their capabilities to operate high-efficiency boilers 5.1 Ratings of availability of high-efficiency boiler technology to boiler manufacturers and design and research institutes and their knowledge of the technology 6.1 Revised national boiler standards issued

Project Example 10: China Energy Conservation (FY98)

The objectives of the China Energy Conservation project are to achieve sustainable investments and increases in energy efficiency through the proliferation of energy performance contracting to a variety of companies in China and through improved access to information on successful experiences with energy efficiency. The project supports the establishment and pilot demonstration of the first Energy Management Companies (EMCs—similar in concept to energy-service companies) in China, followed by a program to support proliferation of the EMC concept. These commercial companies will engage in self-sustaining energy-efficiency investments through energy performance contracting. The project also seeks to increase energy efficiency by strengthening China's national efforts to improve access to specific information about successful domestic experiences with energy energy-efficiency measures and projects. This information is directed in particular to financial decision-makers in enterprises. The project creates an EMC Development Unit (EMCDU) to disseminate information about performance contracting, and an Energy Conservation Information Dissemination Center (ECIDC) to distribute information about experiences with energy efficiency.

Direct investments are subprojects by the three demonstration EMCs. The project requires that total actual energy savings and associated CO2 emissions reductions achieved from these subprojects be reported by each EMC in annual project reports. The project has deemed energy savings indicators important for holding the EMCs contractually accountable for concrete results from the GEF assistance, and for fostering attitudes of accountability among project participants. Actual energy savings for each EMC energy performance contract are relatively easy to monitor during implementation of the energy performance contracts; measurement or confirmation of stipulated energy savings are key aspects of these contracts. To assess energy savings from projects after contract periods are over, EMCs will complete sample surveys of sufficient size to ensure the reliability of results, using internationally accepted scientific sampling and statistical methods.

Indirect investments are projects and associated energy savings made by EMCs throughout China. Energy savings estimates from activities of other Energy Management Companies not participating in the project will be more difficult to obtain; reliance on published government statistics may be necessary. Indirect investments include investments and purchases made by industry that are verified to be a result of the specific information from the ECIDC. Estimates of annual energy savings and associated CO2 reduction indicators for information dissemination activities under the project will be required of the ECIDC under its contract with the State Economic and Trade Commission (SETC). Once again, energy savings indicators are used to encourage accountability for the center, and to encourage the center to devote resources to evaluating its advertising effectiveness rather than just monitoring the volume of information disseminated. The center can use the energy savings figures to justify its cost-effectiveness and thus prolong government funding.

Direct market structure/function changes are the formation and successful operation of the three demonstration EMCs, the EMC Development Unit, and the Energy Conservation Information Dissemination Center. As noted above, reports by the three demonstration EMCs are required under the project. Another project condition is that the government fund the information dissemination center for five years after project completion.

Indirect market structure/function changes will be reflected in an increase in the number of Energy Management Companies in China, as well as ratings of the understanding and acceptance of the viability of energy performance contraction on the part of potential EMCs, financial institutions, and industrial enterprises. (Viability in this case means financial, legal and commercial.)

Data sources for post-project market development indicators. The State Economic and Trade Commission (SETC) will continue to closely monitor the proliferation and performance of EMCs in China through surveys; continued contact with the appropriate personnel even after project completion will facilitate post-project evaluations. The ECIDC will continue to collect data on the impacts of its information dissemination activities. These data should be available to GEF evaluators in the post-project phase if the government keeps its agreement to continue to fund the center.

China Energy Conservation Project

Narrative Summary	Key Performance Indicators
GEF Operational Program: Removal of Barriers to Energy Efficiency and Energy Conservation	**Market Sustainability Indicators** Financial sustainability of energy service companies Commercial bank financing availability for energy service companies
Development and Global Objectives Achieve sustainable investments and increases in energy efficiency in China. In particular, (a) proliferate energy performance contracting to a variety of companies in China, and (b) improve access to information on successful, energy-efficiency experiences	**Market Development Indicators** Investment volume in energy-efficiency measures made by Energy Management Companies in China Energy savings from investments made by Energy Management Companies in China Number of Energy Management Companies in China Ratings of the understanding and acceptance by potential EMCs, financial institutions, and industrial enterprises of the financial, legal and commercial viability of energy performance contracting
Outputs 1. Three Energy Management Companies (EMCs) are developing and demonstrating energy performance contracting 2. EMC Development Unit formed and disseminating information about performance contracting 3. Energy Conservation Information Dissemination Center (ECIDC) formed and disseminating information	**Market Intervention Indicators** 1.1 Ratings of capabilities of the three demonstration EMCs to market, design, finance, contract, implement, and monitor energy-efficiency measures through energy performance contracting 1.2 Investment volume in energy-efficiency measures made by the three demonstration Energy Management Companies 1.3 Energy savings resulting from investments made by the three demonstration EMCs 2.1 Volume of information disseminated to potential/active EMCs by EMC Development Unit 3.1 Volume of information disseminated to industry by the information center (number of case studies and technical guides prepared and distributed; number of enterprise managers contacted directly or indirectly; number of enterprise contacts that result in implementation of the energy-conservation measures being promoted) 3.2 Ratings of understanding by industrial enterprises that have had contact with the information center of successful, financially attractive energy-efficiency measures; plans to adopt such measures 3.3 Investment volume in energy-efficiency measures adopted by industry that result from specific information provided by the center, or as a result of the technology marketing activities of the center; associated energy savings

Annex A: Determining Avoided CO_2 Emissions

Climate change projects can measure avoided CO_2 emissions from direct project physical outputs and can estimate avoided CO_2 emissions from market development indicators if a suitable market development baseline exists. The units in which to express measurements of these avoided CO_2 emissions should always be carefully specified, because there are several different ways to quantify avoided CO_2: annual avoided emissions for a specific year, total avoided emissions over the equipment lifetime, cumulative avoided emissions from some base year, or total avoided emissions over a specific target time period. Measuring avoided CO_2 emissions requires technical methodologies related to end-use energy metering, take-back effects, capacity factors of renewable energy technologies, conventional-fuel shares used in electricity production, emissions factors of different fuels, transmission and distribution losses in electricity or district-heat supply systems, and marginal vs. average electric power capacity displacement. Guidelines for measurement and evaluation of these indicators are provided in two World Bank documents: *Greenhouse Gas Abatement Investment Project Monitoring and Evaluation Guidelines* (1994) and *Greenhouse Gas Assessment Handbook* (1998). Several other protocols developed for climate-change mitigation projects also address measurement and evaluation approaches. See Vine and Sathaye (1997) for a survey of protocols and U.S. Department of Energy (1997) for a proposed international protocol.

For grid-connected renewable energy installations, electricity generation data should be readily available from utilities and/or project operators. However, translating these figures into avoided GHG emissions requires information about the marginal displaced generation source of the electric power grid and about transmission losses and power plant efficiencies. The simplest approach is to assume a particular fuel type and use standard or average emissions factors, power plant efficiencies, and transmission losses. More sophisticated approaches use generation dispatch models to determine marginal fuel-type displacement (which could also account for the time-of-day of renewable energy production and its coincidence with peaking generation plants) and use measured emissions factors and generation and transmission efficiencies.

For solar home PV systems, baseline surveys of kerosene consumption for different categories of households are necessary to accurately establish the baseline CO_2 emissions. Because no metering data are available from typical solar home PV installations, three approaches to measuring energy consumption and avoided CO_2 emissions can be used singly or in combination: (1) metering of kWh from solar PV of a statistical sample of households, based on assumptions about avoided kerosene purchases; (2) surveys of households regarding daily hours of operation of PV systems based on assumptions about kWh generation and avoided kerosene purchases; and (3) surveys of households regarding avoided kerosene purchases.

For energy-efficiency measures in power plants or industrial processes with on-site fuel combustion, energy-savings estimates may be available directly in the form of avoided fuel consumption, in which case CO_2 emissions can be calculated using standard emissions factors. If energy-savings estimates are in the form of avoided electricity or heat consumption, then fuel and power-plant types as well as distribution losses for electricity or heat generation must be known or estimated for the energy-supply system that serves each end-use site claiming energy savings. For end-use electricity-efficiency measures, determining avoided CO_2 emissions uses a process similar to that used for the grid-connected renewable energy case above, given an estimate of the end-user's avoided kWh consumption.

For high-efficiency equipment production, for example in the case of high-efficiency coal boilers supplanting low-efficiency ones, determining avoided CO_2 is fairly straightforward. Avoided coal consumption can be determined from published technical efficiencies of the energy-efficient boilers sold compared to consumption of ordinary boilers of similar capacity available on the market. Estimates must then be made of daily operating usage. Accuracy of estimates can be improved through surveys of boiler operators to determine this daily usage. A project could specify that avoided CO_2 will be determined from published technical efficiencies at a point two years after project completion, and participating manufacturers could be required to submit these data.

Indirect avoided CO_2 emissions for both renewable energy and energy efficiency are much more difficult to estimate. Estimates require comparison of market development indicators against a market-forecast baseline which shows where the market was projected to be and attributes the observed changes to the project itself (as discussed in Section 3). Observed changes in the market (in terms of sales or investments) must then be translated into equivalent energy production or energy savings estimates, to which the methodologies described above can be applied.

Annex B: Sample Terms of Reference for Project Assessors

(The following are sample terms of reference for a hypothetical renewable energy project involving grid-connected wind turbines and solar home PV systems.)

Consultant shall investigate and describe, in narrative form, changes that have occurred in the market for grid-connected wind-farm development and for installations of solar home PV systems. Market changes may be described in terms of investments and sales, the number and nature of market participants (including ratings of their capabilities and knowledge), the characteristics of the technologies, and the rules governing transactions. Consultant shall analyze the degree to which these market changes represent reductions in barriers (barriers must always be analyzed in relation to a specific geographical or institutional scale). To the degree possible, consultant shall also analyze plausible links between observed changes in the market, particularly reductions in barriers, and specific project interventions by the GEF. Finally, consultant shall evaluate the extent to which the observed market changes appear sustainable, providing specific justifications where possible.

Data for the analysis should come from the following sources and activities:

1. Consultant shall collect any documentation already available on market characteristics before and after the project. Such documentation may be available from project files, project participants, published sources, government agencies, and/or market-research firms.

2. Consultant shall identify and describe any market interventions outside the project (i.e., other projects, international assistance, government policy changes) that have reduced or could reduce market barriers for grid-connected wind or solar home PV systems, including any monitoring and evaluation results for these interventions. Consultant shall identify and describe any macroeconomic factors outside the project that may have changed the market environment for these technologies.

3. Consultant shall select and interview a sample of wind-farm project developers, local wind turbine manufacturers, and PV system integrators and installers, emphasizing the following questions: (a) What are their views on the past, present, and future market, in terms of market segments, consumer willingness to purchase PV, utility willingness to contract for independent power production, banks' willingness to extend credit, price trends, after-sales service networks, and competition? (b) What business plans are they formulating? (c) What barriers do they still face? (d) Are PV installers providing credit to their customers? Consultant shall also interview the regulatory agency responsible for independent power production (IPP) contracts to understand the capabilities of the agency for regulating IPP contracts and the trends in IPP contracting.

4. With the assistance of local social research firms, consultant shall commission and conduct a survey of a random sample of rural households to measure their awareness and understanding of solar home PV technologies, their plans to purchase such technologies, and their satisfaction with installed systems if they have already purchased.

Annex C: Review of Literature on Market Transformation Assessment

Literature on assessment of market transformation for energy efficiency in the United States is relevant to the GEF because there is a strong parallel between U.S. electric utility efforts to stimulate energy efficiency during the past two decades and GEF climate-change operational programs. At first, utilities were concerned with the direct energy savings of their demand-side management (DSM) programs, and a whole industry and literature evolved to assess the direct energy savings resulting from these programs (Nadel 1992; Violette et al. 1998). This stage in utility DSM could be likened to the GEF's pilot phase, in which many projects directly subsidized (via incremental cost methodologies) energy efficiency and renewable energy technologies, and success has been measured by direct physical changes and associated avoided GHG emissions. In the U.S. electric utility industry, as awareness has grown regarding the potential to alter markets for energy-efficiency efficient technologies, the new concept of market transformation has emerged.

The objective of market transformation is similar to the objective of GEF programs to reduce barriers to energy efficiency and renewable energy. The National Association of Regulatory Utility Commissioners defines *market transformation* as: "changing the types of products or services that are offered in the market, the basis on which purchase and behavioral decisions are made, the type or number of actors in the market, or in some other way altering this set of interactions in a self-sustaining way" (Hastie 1995, p.S-1).

The literature on market transformation has its roots in utility demand-side-management (DSM) approaches. Instead of targeting "participants" with rebates and other DSM programs, a market transformation approach considers that utilities should act to transform the broader market in a sustainable manner. Market transformation entails reducing market-barriers and expanding the role of energy-efficient products and services. One theme of the market transformation literature is the "spillover" effects of traditional DSM programs, "unintended impacts" on "nonparticipants" in the broader market (such as consumers who install an energy-efficient technology without the subsidy or incentive offered by the DSM program). Another theme of market transformation literature concerns strategies and regulatory approaches to encourage utilities to pursue market transformation. A small segment of the literature focuses on measuring the impacts of market transformation programs; this segment is the most relevant to GEF attempts to assess the long-term impacts of operational programs #5 and #6.

One of the reasons that the literature on measuring the impacts of market transformation has remained small is that measuring market impacts is even more problematic than measuring the effects of traditional DSM programs. "Measuring market transformation will be a daunting challenge, requiring major changes in the focus and methodology of DSM evaluation," according to Prahl and Schlegel (1993). Wirtshafter and Sorrentino (1994) conclude that "closer examination of the data requirements [for measuring market transformation] indicates that major increases in the costs of evaluation [compared to costs for DSM programs] are likely to be required to evaluate market transformation programs" (p.10.262).

Dimensions and Nature of a Market

Feldman (1994) defines a market as "a system for the voluntary exchange of certain economic goods and services between individuals or groups, according to rules" (p.8.42). The three key defining dimensions of a market are:

- Number and nature of participants
- Variety and characteristics of the products and services available
- Rules governing exchanges that occur.

These dimensions must be included in any baseline characterization of a market. Interventions that are designed to alter the market can be assessed in terms of whether the number and nature of participants changes, whether the mix of economic goods and services exchanged is altered, and/or whether the rules of exchange are reconstructed (see Box 1 for examples). Many authors emphasize, however, that markets are far from static and market change is a very complex process. Markets are dynamic, interactive, and change over time in response to combinations of many factors.

Market Change Indicators

Feldman (1995) provides a number of general market-change indicators, such as:

- Market saturation
- Market share
- Technology penetration rate
- Number of dealers/distributors
- Number of manufacturers
- Distribution of market among different size manufacturers
- Price levels
- Retooling investments
- Market segments served
- Standards
- Infrastructure
- New entrants, and
- New product models.

Most of the above indicators are sales related. Some involve measuring the transaction costs inherent in the current market. Feldman points

Box 1: Examples of Changes in a Market (Feldman 1994)

Number and nature of participants

New buyers or sellers may enter the market; e.g., customers who previously could not afford efficient technologies or distributors who did not stock efficient units.

Entrepreneurs may enter the market to provide previously difficult-to-obtain services, such as ensuring the functional effectiveness of building systems (commissioning).

Variety and characteristics of the products and services available

New technologies may be developed or inefficient production may be phased out as demand changes or competing options are introduced.

Supplies of new products may increase and become more readily available.

Rules governing exchanges that occur

Customers may ask suppliers about new technologies or features, such as the energy efficiency of products offered for sale.

Sellers may promote energy efficiency as an expected attribute of their products or services.

Prices of energy-efficient products may decline.

out that sales data are often very difficult to acquire and that measurement of prevailing transaction costs may be a cheaper, more expedient "proxy" indicator of market changes than measuring sales data. Further, sales data are trailing indicators because sales are the final outcome of a whole range of market interactions and dynamics. In general, Feldman advocates the use of leading indicators. Changes in transaction costs and distribution networks could be considered leading indicators (see section below on market barrier indicators) because, "increased sales are simply indirect evidence that transaction costs have been reduced" and

> The effectiveness of market transformation programs should *not* be judged only by savings achieved or by surrogate measures such as sales of efficient products and services. Instead, evaluation of market transformation programs should also focus on the identification and measurement of transaction costs. Among the transaction costs that can be identified are hassle, lack of information, and avoidance of risk [e.g., concern over potential product failure or premature wear-out]. Marketers and analysts can readily specify proximate indicators of each of these costs. Sample indicators might include, e.g., the number and distribution of retail outlets (as a measure of hassle imposed on the purchaser) or the marginal expenditures required to make customers aware of a new technology and its benefits (as a measure of information costs imposed on sellers). The monitoring and analysis of changes in these gauges yield partial estimates of the value added by market transformation programs. (Feldman, 1995, p.ii)

Lee and Conger (1996) agree that leading indicators are more useful because there are likely to be fewer confounding factors, so evaluators can have increased confidence in causal attribution. In addition, leading indicators "are more likely to provide better insights into how well the program is working or if and how program elements should be changed" (p.3.70). Some specific examples of leading indicators for the U.S. Super-Efficient Refrigerator Program are:

- Efficient refrigerator models on the floor of dealers
- Dealer in-store displays and sales techniques
- Dealer information on customer awareness
- Dealer training received from producers and distributions (as a measure of producer commitment)
- Retail prices of more-efficient and less-efficient refrigerator models
- Public statements from the industry
- Institutionalized organizational and product-line changes by producers, and
- Producers' statements about the effects of a program on their decisions and products.

Weisbrod, Hub, and Kelleher (1994) give an indication of the difficulty but not impossibility of getting sales data, at least in a developed country. Producers of lighting, air conditioners, and motors in the U.S. were asked to report the share of sales that was for highly-energy-efficient equipment in two separate years, before and after interventions that were being evaluated. Of the 36 producers responding, 15 were willing to disclose the information for the most recent year, and 12 were willing to disclose it for both years.

Feldman (1995 and 1996) suggests applying the following selection criteria to decide which market change indicators to use. Feldman recommends considering whether the indicators are:

- Meaningful (results can be communicated to executives or commissioners)
- Theoretically defensible (results relate to an underlying theory of market transformation)
- Easy to apply (measurement rules can be readily learned and used)
- Inexpensive (they require only limited, readily available data)
- Reliable (different evaluators can repeat the measurement procedures)
- Sensitive (they change rapidly with changes in marketing strategies)
- Actionable (results suggest whether to maintain, discard, or change program) and
- Verifiable (alternative measurement techniques provide convergent results).

Violette and Rosenberg (1995) suggest using equipment saturation surveys to measure market changes and to develop time-series of the penetration of efficient equipment. Periodic interviews and focus groups with trade ally panels can be another source of market change information. Questions can be asked about general market conditions and stocking and sales patterns. Periodic interviews with stable panels of market participants can increase data reliability and validity.

Market change indicators should change over time relative to a baseline. To establish baseline market data, some of the following indicators can be used in conjunction with the market change indicators above:

- Past market performance
- Market projections for the future, and
- Underlying macroeconomic/institutional conditions.

An approach taken by Weisbrod, Hub, and Kelleher (1994) was to consider overall national trends as the baseline and to examine market changes in particular regions of the country (or electric utility service territories) relative to the national trends. The problem with this approach, they note, is that differences in energy prices or regulations in different regions can skew the data.

Market Barrier Indicators

Measurement of market barriers can provide a proxy, leading indicator of changes in a market. In particular, changes in transactions costs can reflect changes in market barriers. Some examples of barriers to energy-efficient technologies include:

- Knowledge and perceptions of market participants and would-be participants
- Skills of market participants and would-be participants
- Degree of participation of certain types of participants (banks, poor consumers, etc.)
- Presence or absence of specific technologies or technological practices
- existence of institutional arrangements and legal frameworks
- Presence of industry "standard practices" codified or informal
- Local capacity for market diffusion
- Availability of local financing
- Availability of public-or private-sector financing
- Development of new institutions and their characteristics and effectiveness
- Dissemination of information
- Changes in policy or regulatory framework
- Plans of utilities
- Development or number independent power sales contracts
- Commercial bank loans and programs for renewable energy investments
- Investor confidence
- Consumer satisfaction.

When market barriers are measured, many aspects of markets may be wrongly ignored because of a focus on consumers and producers. For example, dealer and distributor comfort with a new technology can be the critical determinant of changes in a market in cases where consumers have developed trust in dealers and distributors and look to them for guidance and information. Feldman (1994) describes an example:

> In Wisconsin, air conditioner dealers in some of our focus groups have described their efforts to be perceived as trusted recommenders and suppliers. They have also told us how they sell against high efficiency units, fearing that customers will be disappointed with the payback and blame *them* for encouraging overinvestment in the technology. (p.8.41)

Measurement must account for all market participants, including producers, distributors, consumers, financiers/intermediaries, regulators/governments, media, and NGOs.

Proving Causality

The question of what constitutes evidence of causality—how specific project interventions cause CO2 reductions beyond the baseline—has been characterized as especially problematic in the literature. One landmark study by Kushler, Schlegel, and Prahl (1996) measured differences between two states (Wisconsin and Michigan) in the penetration of high-efficiency gas furnaces and attempted to prove causality by using one state as a "control." They concluded that "a series of government and utility actions to encourage installations of high-efficiency natural gas furnaces in Wisconsin has almost completely transformed the market (90 percent of new furnaces purchased...were high efficiency), whereas a neighboring state (Michigan) that did not pursue those initiatives has experienced a much lower level of market penetration (...37 percent...)" (p.3.59). But such tailor-made situations are not common, especially in developing countries, and thus such "controls" are usually unavailable.

Wirtshafter and Sorrentino (1994) acknowledge that "nothing as conclusive as 'fingerprints on the murder weapon' exist for [market transformation] programs" and that "any proof available will be, at best, circumstantial" (p.10.262). Thus any attempt to prove causality will rely on circumstantial evidence and a credible "story" (Herman et al 1997). Wirtshafter and Sorrentino go on to say that "the circumstantial nature of the evidence means that regardless of the size of the investment in evaluation activities, utility cost recovery [cost effectiveness of market interventions] remains uncertain" (p.10.263).

One important aspect of proving causality is attempting to understand why consumers make certain purchase decisions. A consumer's decision to accept a new product involves stages of transformation from awareness to positive identification to attempted purchase. Causality means showing changes in behavior anywhere along this continuum. The process is dynamic: the consumer's opinion changes over time as do the availability, characteristics, and price of products. Measuring changes in consumer behavior requires tracking consumer attitudes and awareness before and after a market intervention.

One clear example of causality related to consumer purchase decisions is provided by Lee and Conger (1996, p.3.73):

> Dealers who mentioned that they had conducted more promotional activities tended to sell a larger share of [efficient] units. Dealers who did not stock [efficient] units consistently said that they sold an almost negligible amount. Although not surprising, this finding confirmed the importance of having a [efficient] model on the floor for consumers to see and ask about.

The literature offers two divergent approaches to causality: (a) attempt to establish and prove causal links to project interventions; or (b) ignore causal links and set overall market change targets that should be achieved (perhaps in partnership with other activities by the government or other parties) regardless of the extent to which the interventions of a specific project contributed.

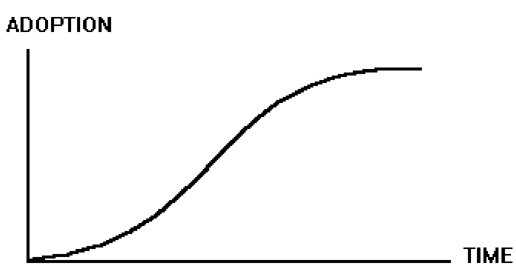
A careful appraisal of the most suitable of these two approaches is critical for GEF projects; the second approach could well be more cost-effective than the first. In either case, "regulators who want to take advantage of the substantial and lasting impacts promised by market transformation programs will probably want to require that pre-implementation agreements be reached...with regard to what will constitute evidence of impacts for specific programs" (Hastie 1995, p.S-8).

The Time Dimension and Technology Diffusion

The dimension of *time* is brought to the understanding of markets from the literature on technology diffusion (Rogers 1995). Formally, Rogers defines technology diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p.10). There are three ways time is introduced. First, the S-shaped technology diffusion curve represents the rate of adoption of a new technology over time (Figure 1). Secondly, Rogers characterizes different stages of the curve as modeling the adoption of an innovation by five different adopter categories—*innovators, early adopters, early majority, late majority,* and *laggards*. Third, over time, individual adopters progress through five different stages with respect to adoption of a new technology. These five stages are *awareness* (potential adopters are learning about an innovation for the first time), *persuasion* (potential adopters are actively seeking out information about the innovation in order to make a decision), *decision* (potential adopters have decided to adopt the innovation), *implementation* (adopters have carried out the decision), and *verification* (adopters have verified whether the decision was a good one).

Thus an understanding of how and when different groups of adopters progress through each adoption stage can be an important source of market change information. Too often projects may promote awareness but stop there and do little to assist potential adopters in seeking *technology-evaluation information* in the persuasion stage and in finally making a decision. Thus although project evaluations can start by measuring awareness of a technology, they should go further to ask whether potential adopters have actively sought more information about a technology, whether they have initiated a discussion about the technology with others, whether they have decided to purchase a technology, and if so when they plan to purchase. Those who have adopted can be asked to what extent they have evaluated their decision and whether they believe it was a good decision. Potential adopters are defined broadly here—including consumers, industrial enterprises, government agencies, and electric power utilities.

Figure 1: Technology Diffusion Curve



The concept of *communication networks* is also important to an understanding of markets. How do market actors learn about technologies and decide to adopt them? According to Rogers (1995):

> ...mass media channels are more effective in creating knowledge of innovations, whereas interpersonal channels are more effective in forming and changing attitudes toward a new idea, and thus in influencing the decision to adopt or reject a new idea. Most individuals evaluate an innovation, not on the basis of scientific research by experts, but through the subjective evaluation of near-peers who have adopted the innovation. (p.36)

In Rogers' conception there are two ways that innovations are diffused. Early adopters learn about an innovation directly through change agents or media channels and decide to adopt based on these contacts. However, most adoption of new innovations occurs through the exchange of subjective evaluations of the innovation among peers. Reed and Hall (1997), conclude that "a significant factor affecting the rate of adoption of innovations is the degree to which an innovation penetrates social networks....a major key to both implementing a market transformation program and determining its effects is understanding the structure of the market network" (pp.179,181).

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