Market transformation for energy-efficient products: lessons from programs in developing countries

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Abstract

The Global Environment Facility (GEF) has allocated more than $90 million over the past 10 years to eight energy-efficient-product market transformation projects in developing and transition countries. We review the early experience and lessons from these projects and offer a framework for thinking about market transformation program design based on GEF project designs, cataloging both demand-side and supply-side strategies. GEF support has indeed managed to transform markets for energy-efficient products, with cost-effectiveness in the $1 to $10/ton carbon range. Sustained market, institutional, and policy changes have occurred, including price reductions, new standards, and higher market volume. Recommendations are given for future market transformation program designs.

1. Introduction

Market transformation programs are strategic interventions that cause lasting changes in the structure or function of markets for specific energy efficient products (Geller and Nadel 1994, Nadel and Geller 1996). These market changes should in turn lead to sustained increases in the adoption of energy-efficient products, services, and/or practices. Market transformation programs rest on several key principles: (a) interventions are direct responses to identified market barriers; (b) benefits are inherently sustained because the entire market changes permanently so that further interventions are unnecessary; (c) new products, services, or practices appear within already existing market frameworks; (d) private capital and know-how and competitive market forces drive energy efficiency gains; and (e) partnerships between government, the private sector, NGOs, consumers, and other stakeholders commonly influence market structure and function.

Historically, the concept of market transformation grew out of utility demand-side management (DSM) experience in North America and Sweden in the 1980s and early 1990s. Utility-run DSM programs had used audits, information, rebates, and other tools to achieve a target penetration of energy-efficient products. These programs typically sought to meet short-term energy efficiency

objectives, such as certain kWh savings per year. They did not explicitly address underlying market barriers that hinder the long-term adoption of energy-efficient products and practices (Nadel and Latham, 1998).

At the beginning of the 1990s, analysts observed that DSM programs were producing *sustained* changes in the marketplace; that is, the changes brought about by a program persisted beyond the program's closing (Keating et al. 1998). For example, the Bonneville Power Administration discovered that its four-year incentive program to replace inefficient streetlights had captured so much of the Northwest market that distributors no longer stocked inefficient fixtures. Thus was born the idea of a permanent "transformation."

From its early roots in the early 1990s, market transformation blossomed into a comprehensive energy efficiency approach widely sanctioned as effective and low-cost, and became a common energy efficiency policy in Canada, the United States, Britain, the Netherlands, Sweden, and several other European countries (Henriques 1993, Martin et al 1998, Cockburn 2000, Neij 2001, Geller 2003).[1] In developing and transition countries, market transformation programs have made some inroads, but not on the scale found in developed countries. Countries with notable programs include Brazil, China, Hungary, Mexico, Peru, the Philippines, Poland, South Africa, and Thailand (Lin 1998, Martinot and Borg 1998, Sinton et al 1998, Granda 2000, Geller 2000, Friendmann 2000, Lebot 2000, Singh and Mulholland 2000, Verdote 2000, Ürge-Vorsatz and Hauff 2001, Geller 2003).

We review here the early experience and lessons from several market transformation programs in developing and transition countries supported by the Global Environment Facility (GEF). From these projects and a broader review of the literature, we then offer a framework for market transformation program design. This paper is based on a study by the authors as part of a broad effort by the GEF Monitoring and Evaluation Unit during 2000-2002 to review the impacts of all GEF climate change programs (Birner and Martinot 2002, GEF 2002). Our analyses draw upon some of the methodologies and indicators from the growing literature on assessing the impacts of market transformation (Prahl and Schlegel 1993, Feldman 1995, Reed and Hall 1997, Martinot 1998, GEF 2000, Neij 2001).

2. Experience and Lessons from the GEF Portfolio

From 1991 to 2000, the GEF approved eight projects designed to stimulate markets for energy-efficient products—lights, refrigerators, industrial boilers, and building chillers—in 12 developing and transition countries (Table 1). Total project costs for this portfolio are about $520 million, with GEF contributions of $90 million and co-financing from other donors, multilateral agencies, governments, and private companies of $430 million. These projects use a combination of approaches to remove supply-side and demand-side barriers to sustained markets for energy-efficient products. The projects were implemented by the World Bank, the International Finance Corporation (IFC), and UN Development Program (UNDP). Descriptions of experience and lessons from seven of these eight projects follow (the China lighting project

[1] Perhaps the first formal recognition of market transformation as a theory took place at the 1992 Summer Study of the American Council for an Energy-Efficient Economy (Keating et al. 1998).

had not yet started implementation). For more details on each project, see Birner and Martinot (2002) and the other references cited in each case.

2.1. Mexico High Efficiency Lighting Project

From 1995 to 1997, the Mexican national electric utility (CFE) purchased CFLs in bulk from manufacturers and then sold them directly to utility customers. Competitive bulk procurement allowed the utility to purchase lamps at a significant discount over retail market prices, and to pass those savings along to consumers. CFE was also able to improve the technical specifications of lamps purchased, relative to existing lamps on the market, which allowed higher-quality CFLs onto the Mexican mass market. As a result of economies from bulk procurement and a utility subsidy of about $7 to $10 per lamp, the consumer price for a high-quality lamp was down to about $5 to $8, compared with a market price of up to $25 or more prior to the project (GEF 1994, Sathaye et al. 1994, Friedmann et al. 1995, Martinot and Borg 1998, Krause et al 2001).

CFE advertised its CFL sales through the mass media. Initially, sales were limited to the capital cities in the two states where the program was implemented. Since Mexicans usually pay electricity bills in the utility's offices, lamps were sold through utility offices. Customers could pay for the lamps in full, or could pay in installments through a leasing arrangement with the utility. Customers who opted to buy on credit would pay for the lamps over two years, in 12 bimonthly installments. The rebate was calculated so that for customers paying a tariff corresponding to less than 75 kWh per month, the bimonthly payments could typically result in a two-year payback through savings in their electricity bill.

The project was designed to target low-income consumers because of the large subsidy the utility paid for electricity sold to these consumers. This meant that economic returns to the utility were larger for CFLs installed by low-income households. But in 1995, when Ilumex started, Mexico faced a severe economic depression. Mexicans were hesitant to take out loans, even the modest pay-on-the-bill CFL loans offered by CFE. Because of the economic crisis, sales volumes to low-income households were lower than expected – middle-income households that were willing to purchase or lease CFLs became saturated faster than predicted, and fewer low-income homes were able to participate, as they needed all available income for food. In an effort to maintain high sales, the program expanded beyond the initial two target cities and also sold lamps at special booths placed in factories, where workers could buy the lamps and then pay for them through salary deductions.

The Mexican utility sold 2.5 million CFLs from 1995 to 1997, higher than the 1.7 million targeted. These sales are all the more remarkable given that a devaluation of the peso took place four months before the start of CFL sales. Although market transformation was not an explicit project goal, a great variety of CFL lamp models appeared in retail stores after completion of the project, and average prices of CFLs have fallen by about 30%. This could be interpreted as a clear indication of market transformation. Stakeholder interviews generally support the idea that the project significantly accelerated the pace of market transformation. CFL distributors and retailers initially feared that CFL distribution by the utility would lead to a loss in their own

market share. However, they have found that overall, the program has increased their sales (presumably because the program has led to greater awareness of the benefits of CFLs).

Based on the experience gained during the project, CFE together with FIDE, a public/private non-profit organization, undertook a follow-on lighting project starting in 1998. This program did not include subsidies and further reduced administrative costs. Within two years, this new project sold an additional 4.8 million CFLs throughout the country, both in retail outlets and again through utility offices. A media campaign would promote CFLs in a particular city for a period of 6 to 9 months, during which time CFLs could be bought or leased at CFE offices. After the campaign, CFLs were no longer sold in CFE offices, but only in retail outlets. CFL manufacturers planned their own advertising campaigns around the timetable and locations of FIDE's campaign.

Lessons suggested by experience are that: (a) utility demand-side management (DSM) programs can deliver a targeted number of CFLs in a developing country context; (b) bulk purchases by a centralized agency can lower retail costs to consumers and increase product quality; (c) utility offices can serve as sales outlets for large numbers of CFLs; (d) the institutional capacity created during the original project facilitated a follow-on project with significant replication within Mexico.

2.2 Thailand Promotion of Electricity Energy Efficiency Project

In 1993, the Thai national electric power utility (EGAT) launched a comprehensive five-year demand-side management (DSM) program. The utility first created a new DSM office and then supported that office in developing and implementing a number of different market interventions for energy efficiency. Once a process of initial training was completed for the DSM office staff, the office displayed strong leadership, initiative, and capability. Such leadership and initiative were among the factors that made the program successful. Another was that the utility decided not to use subsidies in any of the programs, a decision that reflected a "cultural tendency" in Thailand to avoid subsidies in public programs. Rather, EGAT relied on manufacturer collaboration and public promotions. Attention to cultural factors was also crucial to ensure high consumer acceptance and participation (Singh and Mullholand 2000, Martinot and Borg 1998).

Four specific efforts were quite successful: voluntary agreements on efficient fluorescent tubes, bulk purchases of CFLs to lower retail prices, and consumer labels for refrigerators and air conditioners. Other commercial and industrial initiatives, such as for more efficient motors, were not as successful, largely due to lack of access to viable financing sources in the industrial and commercial sectors for the investments required. Some of EGAT's programs were also constrained by the fact that EGAT, as a wholesaler, did not sell power directly to end-users and, therefore, did not have previous relationships with consumers.

Market switching from thick (T-12) to thin (T-8) fluorescent tubes. Thin T-8 tubes use less energy and are cheaper to manufacture than thick T-12 tubes. But manufacturers were reluctant to sell them because of a common consumer perception that a thick tube gives more light than a thin one. As part of the DSM program, EGAT negotiated a voluntary agreement with all five

Thai manufacturers of T-12 tubes, as well as the one importer of T-12 tubes. The manufacturers and importer agreed to switch from T-12 tubes to the more efficient T-8 tubes. In return, EGAT supported the manufacturers with an $8 million consumer information campaign, which explained that thin tubes provide more light for the same energy cost. This agreement effectively and completely eliminated the less-efficient T-12 tubes from the Thai market, estimated at 20 million tubes per year. In 1994, when the program began, efficient T-8 tubes had a 40% market share. By the end of 1995, the efficient T-8 tubes had achieved a 100% market share.

CFL bulk purchases. EGAT purchased CFLs in bulk and re-sold them through a distribution network of 7-11 convenience stores. EGAT tested and labeled lamps to ensure consistent quality and also paid for advertising costs. Bulk distribution and partnership with franchised retail outlets allowed substantial reduction in transaction costs. Over 900,000 CFLs were sold as of early 2000, at 40% below the prevailing market price.

Refrigerator labeling. EGAT first negotiated with manufacturers a voluntary labeling scheme for refrigerators that awarded refrigerators a label designating efficiency from level-1 to level-5 (level-5 most efficient). EGAT also sponsored an advertising campaign to promote the label, and partnered with a Thai technical standards institute to test domestically available refrigerators. A few years later, the label scheme was made mandatory, and EGAT reached agreement with the manufacturers to increase by 20% the efficiency requirements for each label level. Impacts of the labeling scheme were slower than with fluorescent tubes, but no less dramatic. In 1994, only one single-door model and 2% of double-door models qualified as level-5. By 2000, all single door and 60% of two-door models met the level-5 requirements. The DSM office estimated that the program contributed to a 21% reduction in overall refrigerator energy consumption.

Air conditioner labeling. EGAT also tried to develop a labeling scheme for air conditioners. However, in contrast to the small number of fluorescent tube and refrigerator manufacturers, the Thai air conditioner industry was more diverse and fragmented, with more than 55 different manufacturers. In addition, the added cost for more-efficient air conditioner models were higher than for refrigerators. EGAT's approach was to partner with local credit card companies and offer interest-free loans for the added costs of level-5 units. EGAT also offered rebates to retail stores which sold level-5 models during promotional summer periods. However, EGAT has been unable to reach agreement with the air conditioner industry on mandatory labels or on ratcheting up efficiency levels for each label level over time.

Lessons suggested by experience are that: (a) In a market with a small number of suppliers, and when good relationships exist between a market transformation program and the suppliers, voluntary agreements can be effective in bringing about large changes in the market; (b) well-designed product marketing can help market transformation programs achieve significant savings impacts at relatively low costs; (c) market research helps point to the most effective approaches; (d) lack of financing can be a serious barrier for commercial and industrial programs; (e) mandatory labeling has clear advantages over voluntary labels, since mandatory labels ensure that even lower-efficiency models are labeled and thus allow consistent comparisons; (f) DSM programs require strong management and leadership; (f) DSM programs should initially focus on skills development and smaller pilot programs before activities are scaled up; (g) if

distribution utilities have better access to end-users, DSM programs may be better located within distribution utilities than within national generation utilities.

2.3 Poland Efficient Lighting Project

From 1995 to 1997, a private-sector project management unit created by the project took actions to educate consumers and reduce retail prices of CFLs in the polish market. Through a combination of GEF subsidies and manufacturer-provided wholesale price reductions, CFL prices were reduced by an average of $6 during the project. In addition, demand was increased through a through a mass media campaign (GEF 1996b, Martinot and Borg 1999, Navigant Consulting 1999, Granda et al. 2000).

The project offered specially-priced CFLs during two winter "lighting seasons," roughly October through March, when sales of residential lighting products in northern hemisphere countries tend to be at their peak. In an effort to encourage the development of Polish CFL manufacturers, the subsidy was only available to manufacturers with facilities in Poland. However, this "Polish content" requirement did not appear to benefit any parties. Rather, this requirement excluded the second largest manufacturer of CFLs serving Poland, thereby limiting consumer choice.

Eligible manufacturers competitively bid voluntary wholesale price reductions in their proposals to participate in the project. These wholesale price reductions gave GEF subsidies additional leverage, providing a final retail price decrease of $2.80 for every dollar of GEF subsidy, once avoided VAT and retailer mark-ups are included. Overall, GEF subsidies of $2.6 million leveraged total retail price reductions worth $7.2 million on over 1.2 million CFLs. This translates into an average retail price reduction of about $6 per CFL from an average GEF subsidy of $2.10 per CFL. The GEF subsidy induced an average consumer investment of around $10 per CFL.

During the winter of 1995-1996, four manufacturers of CFLs qualified for participation. One manufacturer encountered problems with the availability of components, and so used only a small amount of subsidies, and another had difficulties meeting Polish government electrical safety regulations and was unable to participate. During the winter of 1996-1997, three manufacturers participated, including the two who were most successful during the first season.

The public education component of the project promoted the CFL subsidy program to the public by providing general consumer information on the benefits of energy-efficient lighting from a trusted, non-industry source. The project's "green leaf" logo, developed by a Polish advertising firm, was promoted as a consumer brand connoting energy-efficiency and high quality. The logo was used on posters, in project publications, and in promotions in the Polish press that included a short television spot and printed media advertisements.

In all, consumers bought 1.2 million CFLs through the project. CFL prices decreased by 34% in real terms from 1995-1998 and this price decrease was sustained after the project completed. The percentage of Polish households using CFLs increased from 10% to 30%. New manufacturers entered the Polish market, increasing competition, and the total number of CFLs in use increased to about 1.6 million units in 1996, up from 0.6 million in 1994. An independent

evaluation of PELP's total program impacts, conducted after the program completed, suggested that PELP accelerated the growth of the Polish CFL market by about three years (Navigant Consulting 1999). This is consistent with views expressed by CFL manufacturers who participated in the program.

Lessons suggested by experience are that: (a) The purely private-sector approach was able to have a significant market transformation impact on the Polish CFL market at a reasonable cost; (b) Wholesale price discounts by manufacturers, representing competitive manufacturer "subsidies" to the project, resulted in high leverage of public (GEF) funds; (c) A private project management team supported by public funds can coordinate different interested parties behind a single, easily recognized campaign with a straightforward message; (d) Restriction of participation to Polish manufacturers did not prove to be an effective way to strengthen local manufacturers.

2.4 China Efficient Industrial Boilers Project

Started in 1994, this project was designed to assist a select group of Chinese industrial boiler manufacturers to improve the energy efficiency of their projects through international technical know-how transfer. At that time, Chinese boiler technology lagged substantially behind international levels in terms of efficiency and performance, and the project was to be the first large-scale infusion of international boiler technology to China since the 1940s, according to original project documents. Due to technology license procurement delays, by 2000 the project had finally entered the active technical know-how transfer stage, and the nine participating Chinese boiler manufacturers had begun to upgrade the technical designs of their boiler models (GEF 1996a, GEF STAP 2001).[2]

Technology licenses for the nine participating boiler manufacturers and auxiliary equipment manufacturers were signed during the period 1997-2000. One of the reasons for the long delay between project start-up and signing of the licenses was that the project had to engage in several rounds of international competitive bidding for technology licenses, as the interest and willingness of foreign suppliers to transfer technical know-how under the conditions of the project proved elusive or fickle. Initially, pre-qualification of potential foreign suppliers of technology licenses focused on large foreign companies. After initial discussions and outreach, letters of intent to bid were received from 18 such companies. But during a first round of bidding, some of the requests for proposals received no response from any bidder, and others received a response from only one bidder. As a result, only one license was awarded during this first round.

The project management speculates that suppliers who initially expressed interest in bidding were dissuaded when they saw the amount of project funds available to pay for licenses. About $17 million was available for nine technology licenses, and foreign suppliers did not think a one- or two-million dollar contract would be worth their trouble. In addition, some suppliers could not comply with the requirement that boilers be able to burn raw Chinese coal, a technical

[2] The material in this section is also based in part on country visits to China by Martinot in 1999 and 2000 to interview project participants.

performance criteria for which boilers manufactured outside of China are not normally designed. Compliance with the commercial terms offered by the Chinese was another sources of negotiation breakdowns.

So the project engaged in a second round of license bidding, this time identifying smaller foreign suppliers and ensuring a number of specific suppliers for each of the nine licenses to be procured. Even then, the same difficulties as in the first round persisted. In some cases, licenses were awarded but then the supplier subsequently withdrew from signed contracts. Formal procurement rules and procedures required by the World Bank, as the GEF project implementing agency, further increased the contracting burden, as disbursements required many levels of approval by the project management office, the World Bank, and the Chinese government. Unfamiliarity with international competitive procurement practice was also a factor. Eventually, after a lengthy and time-consuming process, all nine technology licenses were contracted.

Of the nine licenses, six are for incremental technology improvements to the efficiency of existing boiler designs, and three adapt technology for completely new boiler designs. Some also include transfers of more general design methodologies and analytical tools that will allow the Chinese manufacturers to improve their design capabilities. A total of $15 million was spent on the nine licenses, which along with auxiliary equipment licensing and purchasing brought the project's total procurement to $21 million. The boiler technologies are essentially those originally planned in 1994; the project did not significantly reevaluate technology needs in the interim, considering changing market needs, although technology contracts did incorporate some changes in the design and capacity of the boilers.

The technology contract amounts were limited partly by the ability of Chinese manufacturers to share the licensing costs with the project, which was a requirement of their participation. Budget limitations also meant that contracts were for one-time technology purchases and did not include provisions for further improvement and upgrading of the transferred technologies. Finally, budget limitations meant that GEF funds were used mostly to purchase technology licenses, with fewer funds available for capacity building to support the technical know-how transfers.

Provisions for replication of the technology licenses have been included in the license contracts. The technology licenses formally belong to the State Economic and Trade Commission (SETC). This agency has the option of selecting an additional 2-3 Chinese enterprises to receive each license. The foreign technology supplier must agree to the selection, and then receives royalties, paid either over a 15-year period in a declining trend, or as a single lump-sum licensing fee. Thus many additional manufacturers can potentially benefit from the licenses once their usefulness is proved by the original manufacturers participating in the project.

The project has also indirectly accelerated industry-wide efforts in China to improve boiler efficiencies, to at least some degree. Stagnant for decades, the Chinese boiler industry has begun to consider higher efficiencies. Before the project, some non-participating manufacturers had begun to develop high efficiency boilers, but over the course of project implementation, the desire of all manufacturers has increased and efforts to improve efficiency are proceeding faster. At least one boiler manufacturer which has not participated in the project decided to initiate boiler technology improvements on their own. This manufacturer credits exposure to the project

for its decision. Recently, the government has been suspending production of certain lowest-efficiency boiler models. The government was also developing minimum energy efficiency standards and considering more stringent emissions standards.

However, a 2001 review of the project by the GEF Scientific and Technical Advisory Panel concluded that the delays in license procurement have had a negative impact on the project (GEF STAP 2001). Partly the problem is institutional; during the eight years since the project was originally conceived, all of the Chinese parties involved experienced significant staff or organizational changes. For example, the Ministry of the Machinery Industry, which had sponsored the project, was reorganized as an administrative department of the government, no longer a separate ministry. By the time the project starts wide-spread marketing and sales of the new boiler designs, even more changes are possible.

In addition, boiler markets are changing more rapidly than when the project was conceived, and several exogenous market factors may limit the project's ultimate long-term impact. It is becoming easier for boiler makers to sell higher-priced high-efficiency boilers because the price of coal has been rising, and with it the demand for efficient boilers. Environmental pressures and stricter enforcement of environmental regulations are also increasing demand. Emerging boiler technology needs have overtaken the original project plan and budget (in particular for circulating fluidized bed boilers). Recent energy policies that penalize coal-fired boilers are starting to appear, especially in larger cities like Beijing. Still, demand for the types of industrial coal-fired boilers targeted by the project will remain strong.

There also remain large demand-side barriers to more efficient boilers, and the project has not addressed the demand side of the market. High-efficient boilers are more expensive than established products, and as with all high-efficiency products, potential buyers of high-efficiency boilers need to be persuaded that the improved technical performance will outweigh the higher purchase cost. The manufacturers involved in the project still face strong competition from established lower-cost models.

Lessons suggested by experience are that: (a) the simple existence of the project, prior to any actual technical know-how transfer and efficient-boiler production by participating manufacturers, has had an indirect effect on the industrial boiler market; (b) technical incompatibilities, insufficient budgeted resources, cumbersome administrative procedures, and lack of experience with technology license contracting seriously slowed the know-how transfer process; (c) over the project's long (5+ years) technology license contracting period, exogenous market factors may have dampened the project's potential impacts; (d) the level of funds necessary for technology procurement was underestimated; and (e) the project design should have targeted demand-side measures in addition to supply-side technology improvements.

2.5 China Energy-Efficient Refrigerators Project

This project began in 2000 with the goal of transforming both the supply and demand sides of the market for efficient refrigerators in China. On the supply side, the project was to provide technical assistance and training for Chinese compressor and refrigerator manufacturers,

including both technical training to understand more efficient designs and, equally important, business training to understand how to sell and market the efficient designs. The project was to also provide financing and incentives for these manufacturers to modify their product designs and convert their production facilities.[3] On the demand side, the project was to conduct education programs to enable consumers to understand the benefits of efficient refrigerators, create incentive programs for retailers to stock the efficient models, enact a national labeling program so consumers had the right information to choose between different models in the store, and create national standards against which different models could be compared. Finally, a consumer buyback/recycling program was to allow consumers to trade in their old refrigerators when purchasing a more efficient model so as to discourage consumers from continuing to operate the old refrigerator in parallel with the new one (GEF 1999a).[4]

Even before the project formally began in 2000, substantial results were achieved through the project development process.[5] Notably, the project helped establish new national energy-efficiency standards for refrigerators. Other early impacts resulted from increased contacts with foreign manufacturers and increased awareness among government officials and manufacturers that efficient refrigerator models were "an idea whose time has come." For example, the share of efficient refrigerators (consumption of less than 75% of the current standard) of one participating manufacturer went from 2% in 1997 to 10% in 1999. "Because of the GEF project we have seen increased pressure on the market for efficient refrigerators and we are responding" said the manufacturer. To be sure, pressures on the industry existed beyond the project, including China's expected entry into the WTO and increased foreign competition in domestic markets. But the Chinese government set the tone by telling manufacturers "with [UNDP/GEF] help, efficient refrigerators are the way it's going to be," according to one manufacturer. Prior to 1997, technological change in the industry was relatively stagnant, but increased rapidly in the late 1990s. At an international exhibition in 2000, three large refrigerator manufacturers and several smaller firms displayed prototypes of efficient refrigerator models that benefited from acquisition of foreign technology during early project preparation.

In 2000, the project sponsored several study tours abroad and focused on training activities. Compressor manufacturers wanted to gain exposure to international experience before deciding what types of project activities would be most useful. The study tours included foreign universities and research centers, but were unable to gain access to foreign manufacturers even though the original project plan anticipated such visits. Requests to four foreign companies were turned down, presumably because of international competitiveness concerns. Chinese manufacturers found the visits to foreign academic institutions of only limited practical usefulness. They said they needed the concrete know-how that can be gained only from other manufacturers. Besides technical know-how, "we need to see how the technologies are marketed and sold" said one Chinese manufacturer. Similarly, foreign manufacturers refused to come to

[3] Domestic compressor manufacturers were equally important to the project because of the low efficiencies of domestic compressors, a key refrigerator component, and because of the huge price advantage that domestic compressors enjoyed over foreign, higher-efficiency imports.

[4] The material in this section is also based in part on a country visit to China by Martinot in 2000 to interview project participants.

[5] The project development process was a multi-year process, to which various funders, such as USAID and EPA, contributed. The GEF proposal was one of the outcomes of years of research and project development efforts in the China refrigerator arena with the help of such bilateral assistance.

China to train domestic manufacturers, so the project had to hire foreign academics and retirees rather than people active in industry. Foreign compressor manufacturers were willing to participate in training workshops to present their products and experience only if the audience was Chinese refrigerator manufacturers (as potential customers), not Chinese compressor manufacturers (as potential competitors).

The project also established an information dissemination center with the existing Chinese Household Electrical Appliance Association and a national testing function with the existing Chinese Household Electric Appliance Research Institute.

In 2000, the project announced a competition for Chinese manufacturers to innovate with energy-efficient designs, with a one million Yuan prize (worth about $150,000). This attracted considerable media attention and increased the exposure of consumers to energy-efficient refrigerator publicity. However, in administering the competition, the project was faced with the dilemma of whether to allow foreign subsidiaries and joint ventures with substantial foreign ownership to participate—that is, how to define a "Chinese manufacturer." Because partial foreign ownership was growing among the leading enterprises in the refrigerator industry, it was becoming increasingly infeasible as an eligibility criteria.

Ultimately, it appears that the project will prove of greater utility on the demand side and of declining utility on the supply side. In 2001 there were 24 refrigerator manufacturers in the Chinese market, with an annual production capacity of about 20 million units. There has been a serious consolidation in the past few years, down from 60 manufacturers prior to the project. The 16 manufacturers participating in the project hold 95% of the domestic market. Five of these 16 are joint ventures. Before the late 1990s there was no foreign participation in the industry at all. Clearly, the industry has changed drastically since the project was initially conceived in 1996, and manufacturers are larger and have more foreign resources. As a result, the larger manufacturers may be "overtaking" the project. Still, smaller manufacturers will benefit from training and design tools, provided they survive. Continuing shake-outs were anticipated, given production overcapacity and increasing competition. Prices of ordinary-efficiency refrigerators declined by 30% from 1997-2000 as manufacturers reduced their profits and cut costs in response to increased competition. This meant that the "gap" in price between ordinary and energy-efficient refrigerators increased to about 20%, higher than expected in the project design. Exports, representing about one-quarter of total production, continued to grow while domestic demand remained flat.[6]

Lessons suggested by experience are that: (a) project-sponsored manufacturer incentives are complicated by partial foreign ownership of Chinese manufacturers; (b) technical know-how transfer through visits by Chinese manufacturers to foreign manufacturers has proven unfeasible; (c) project preparation and approval activities have, by themselves, had a large influence on the market for energy-efficient refrigerators; (d) manufacturers are responding to future expectations about the market, due to both the project and to other competitive pressures; and

[6] Interestingly, demand in rural areas for refrigerators is increasing, while demand in urban areas is declining. This trend should result in a greater influence on purchases of efficient refrigerators, as rural electricity rates are higher than in urban areas. On the other hand, more consumer education programs will be required in dispersed rural areas, where they are likely to be more expensive and time-consuming than in concentrated urban areas.

(e) the market for energy-efficient refrigerators faces an uphill battle for price competition not envisioned in the project design; and (f) manufacturers also can benefit from assistance in non-technical areas like marketing.

2.6 Multi-Country Efficient Lighting Initiative (ELI)

The Efficient Lighting Initiative, which began implementation in 2000, is designed to be a comprehensive approach to lighting market transformation in seven countries (Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa). The program includes electric utility programs, public education and marketing, training, standards, financing mechanisms, targeted subsidies, and pooled purchasing to aggregate markets (GEF 1999b).[7]

Early impacts of ELI have included increased interest and understanding about efficient lighting in the participating countries among a variety of stakeholders, along with early work on technical specifications, quality standards, and product certification. Early in project implementation, ELI developed technical specifications for a wide range of energy-efficient lighting products. Products meeting specifications were allowed to bear a special logo as "ELI-qualified products" and to qualify for ELI support. In 2000, ELI posted technical specifications on web and notified interested participants of their availability. Less than a year later, over 16 manufacturers from more than 6 countries had submitted requests for ELI qualification, resulting in 98 products being qualified.

However, the cost versus quality trade-off was revisited early in implementation. Initially, ELI managers were concerned that lower quality lamps could "spoil" the market by flooding markets with low-quality products and giving CFLs a bad reputation. So ELI was designed to promote high-quality lamps. Although lamps with short lifetimes are still cost effective for consumers, ELI technical specifications initially required a minimum product lifetime of 6,000 hours. However, such lamps generally cost at least twice as much as those with 3,000-hour lifetimes. As the project progressed, ELI managers became more concerned that the project would promote a level of quality that consumers in some of the participating countries could not readily afford, and were considering changes in standards to allow lower quality, lower cost products.

Another early impact of ELI was the changed perception by multinational firms of the barriers to market entry in the seven ELI countries. The project has provided a single entry point into seven country markets, supported by a credible logo that can help a new market entrant gain consumer trust. This is important, because in small, non-competitive markets, the barriers to entry, and the ratio between cost of entry and the returns, can significantly deter manufacturers. For example, as a result of early ELI activities, a U.S. manufacturer entered the Argentine market, and was planning to establish local manufacturing facilities there.

Utility approaches are part of ELI's design "toolkit," but the approach has not proven universal. Utilities have participated in ELI when they have been sufficiently motivated to conduct a demand-side management program. This has been the case for Argentina, South Africa, Peru

[7] The material in this section is based in part on interviews by Birner in 2001 with project managers and stakeholders.

and the Philippines, where the utilities have agreed to implement one or more ELI activities. However, in the Czech Republic and Hungary, where the very survival of local utilities is threatened by pending market liberalization, utilities have not participated.

Lessons suggested by experience are that: (a) a multi-country program approach has led to the involvement of a greater number of manufacturers, and potentially to a larger program impact; (b) the tension between product quality and cost, and its implications for effective program approaches, has become apparent in early project activities; and (c) utilities can be willing and interested partners in market transformation programs, at least in certain national circumstances.

2.7 Thailand Building Chiller Replacement Program

Implementation of this project, designed to transform the market for chillers, was expected to start in 2001. Under the project, twenty-four chillers were to be replaced with more efficient models, as a demonstration. Chillers are very large air-conditioning units found in factories, hotels, and commercial buildings. The typical chiller lifetime is long—25 years or more. Today's models are 30%-40% more efficient than those manufactured before 1993, and replacements can pay for themselves in 4-5 years. However, replacing an existing chiller with a new, more efficient model is not common practice in Thailand. Reasons include lack of awareness of the benefits of efficient chillers, high up-front investment costs, perceived technology risks, and lack of relevant technical skills. The project is designed to remove these barriers (GEF 2001a).[8]

Interviews and surveys suggest that potential chiller buyers in Thailand like the project concept because a low-interest loan allows them to spread the first-cost of a new chiller over several years. They also like the project because a project-provided performance guarantee shelters them from the risk of poor chiller performance and the project teaches them about new chiller technology and their own energy consumption. Chiller suppliers like the project because it has opened up a new market for them (the retrofit market); because it helps the customer overcome the first-cost barrier; and because the project's case studies, which rely on an independent evaluation of chiller performance, will provide them with good public relations.

The project is being executed by the Industrial Finance Corporation of Thailand (IFCT), a Thai development bank partly owned by the government, and the Thai Department of Industrial Works (DIW). These agencies designed the project in close cooperation with chiller owners, manufacturers, government departments, and other parties.[9] In 2000, as part of the appraisal process, IFCT organized a series of workshops to inform chiller owners of the advantages of energy-efficient chillers, and to invite applications for participation in the project. Of 56 applicants, IFCT was able to meet its goal of identifying 24 who met the project's technical criteria and also satisfied IFCT's financial due diligence. Project development negotiations were slow, however, because of the rigidity of the World Bank's procurement and disbursement

[8] The material in this section is based in part on a country visit by Birner in 2001 to interview project participants.
[9] These included the Ministry of Finance, the National Energy policy Office, and EGAT. Also, as part of its technical assistance responsibilities under the Montreal Protocol, UNEP worked with the DIW to assemble technical material related to chiller replacement.

policies, which are not suited to the swift approval of a series of smaller investments projects, and in particular, projects implemented through financial intermediary institutions.

Early project development activities have already produced results and emerging lessons. In particular, the project has raised expectations and commitments to further replicate pilot results. As a result the IFCT workshops, chiller owners are better informed about energy efficiency potential. As a result of the program's informational activities, at least two chiller owners who are subsidies of multinational corporations have undertaken chiller retrofits on their own; in this case, the parent companies had enough cash to cover the up-front costs without a loan. If demonstration project experience turns out as expected, the government has said it will replace an additional 400 chillers, perhaps replicated and financed through the Thai Energy Conservation Fund. It is likely that other tropical developing countries could benefit from a chiller replacement program. The extensive technical materials which IFCT and DIW have developed as part of the appraisal process could easily be adapted for use in other countries.

Lessons suggested by experience are that: (a) The project approach to replacing existing chillers has generated enthusiasm among chiller suppliers and chiller purchasers; in particular, soft loans can be an effective means of stimulating the market; (b) documents and approaches developed through this project have the potential to be replicated; (c) early project preparation activities have already had an impact on the chiller market; (d) when a financial institution plays an important role in a project, the project design team should include a finance specialist; and (e) GEF implementing agencies such as the World Bank need to allow flexibility in procurement rules when working with small SMEs and financial intermediaries in a country like Thailand.

3. Framework for Market Transformation Program Design

Based on an analysis of project designs from the GEF projects described above, along with general practice with market transformation from around the world, we provide a framework for market transformation program design, incorporating both supply-side and demand-side interventions (see Tables 2 and 3). Experience shows that an effective market transformation program acts as a catalyst to enhance existing market forces. It provides both "supply push" and "demand pull" for a particular technology. Simultaneously addressing both supply and demand is necessary when markets are "stuck"; producers are unwilling to produce efficient products because no established market exists and consumers do not demand these products because they are not produced or marketed.

3.1 Supply-Side Approaches

(a) Provide technical assistance and technical know-how transfer to manufacturers to upgrade their product designs or improve quality. The literature on technical know-how transfer is vast and we have not attempted to review it here. Know-how transfer in the private sector typically occurs through joint ventures, subsidiaries, licensing agreements, and technical assistance contracts. Publicly-supported know-how transfer can occur in similar fashion (IPCC 2000). Technical assistance and know-how transfer for designing and producing more-efficient

products is incorporated into the GEF China industrial boilers and refrigerators projects; in both projects, the actual costs of conversion are financed from commercial or government sources. The China lighting project surveys raw material and component quality problems among manufacturers, assists them with mitigating such problems, and conducts manufacturing technology retrofit demonstrations.

(b) Support development of minimum efficiency standards and building codes. Efficiency standards have been advocated by many as the cornerstone of energy efficiency programs because they can produce large energy savings very cost-effectively. Minimum efficiency standards help remove the least efficient products from the market and 'push' to manufacturers to retool to provide more efficient products (Wiel et al. 2001). Building codes address the energy use of entire buildings or of building systems such as heating, ventilation, and air conditioning (Meyers 1998). Most OECD countries have enacted energy efficiency standards for a variety of products (IEA 2000a). Developing and transition countries with mandatory or voluntary standards adopted or in process include Brazil, Bulgaria, China, Colombia, Costa Rica, the Czech Republic, Ecuador, India, Indonesia, Iran, Korea, Malaysia, Mexico, the Philippines, Poland, Russia, Taiwan, and Vietnam (IEA 2000a, Wickler 2000, Dasek 1999, Gabriello and Prias 2000, Marin and Sanchez 2000, Balseca 2000). The use of building codes is widespread in developed countries, but less common in developing countries, where enforcement of mandatory codes or adoption of voluntary codes varies widely by country. The GEF China refrigerators, China industrial boilers, China lighting, and Thailand DSM projects all support development of minimum energy efficiency standards. The China lighting project also develops design standards for six categories of buildings to assist architects with efficient lighting designs.

(c) Facilitate voluntary agreements with manufacturers and distributors. Another non-regulatory approach for transforming markets is to obtain voluntary commitments from companies to improve their energy efficiency practices and products. Voluntary agreements were facilitated in the Thai DSM program, where a neutral third party acted as an 'honest broker' to facilitate change in the marketplace.

(d) Pilot new distribution mechanisms through retailers, dealers, or electric utilities. In the Mexico lighting project, the electric utility distributed CFLs through utility offices. In cooperation with the program, certain private companies offered their employees the opportunity to make installment payments on a CFL purchase through a monthly paycheck deduction. The Thailand DSM project introduced lamp distribution through a chain of "7-11" convenience stores, a new distribution mechanism in that market. In Latvia, the Efficient Lighting Initiative is running a pilot CFL program in which municipalities distribute lamps to their citizens.

(e) Provide financial incentives to producers and dealers. Financial incentives reduce the product price and thereby reduce the first-cost barrier (Meyers 1998). The most common incentives are price rebates or grants, though tax credits and no-cost direct installation have also been used. Vendor incentives can help increase product availability and reduce prices through higher market volume. One good example of incentives was BC Hydro's efficient motors program. As a result of initial incentives, high-efficiency motors became a standard vendor stock item, leading to a natural decrease in price, and BC Hydro was able to gradually eliminate the incentive without adverse effects (Henriques 1993). Manufacturer incentives were present in

the GEF Poland lighting project (to lower retail prices), the China lighting project (low-interest loans and grants to finance capacity expansion for domestic manufacturers), and the China refrigerators project (competition and awards for product design and conversion of factory production lines). Dealer incentives were present in the China refrigerators project and the Thailand refrigerator and air conditioner programs (to encourage dealers to actively stock and sell more efficient models).

(f) Provide quality testing. Perceived and actual problems with quality can be a strong deterrent to the purchase of an energy-efficient technology. Contemporary CFL markets in particular have products of widely varying quality. Quality testing is one way to overcome misperceptions and provide consumers with credible quality information. Quality testing is part of most GEF projects. The Thailand DSM project established test procedures and provided testing capabilities and certification for fluorescent lamps and refrigerators. The Thailand chillers project provides a performance guarantee for each chiller backed by independent on-site testing. The Poland lighting project conducted random testing of CFLs to make sure that off-the-shelf products lived up to the quality commitments that manufacturers had made. The Efficient Lighting Initiative has developed quality specifications for a range of lighting products. The China lighting project provides a product certification program and assists national test laboratories to improve procedures and ensure testing consistency among laboratories.

(g) Provide financing for manufacturing upgrades. Both the China refrigerators and China industrial boilers projects include commercial or government loans to manufacturers to convert production facilities for producing more efficient models. These loans are provided in conjunction with technical assistance and technical know-how transfer to design the products themselves and to upgrade production facilities.

3.2 Demand-Side Approaches

(a) Educate consumers about the characteristics, costs, and benefits of the energy-efficient technology. Information is an important aspect of market transformation—such as financial benefits, technologies for different applications, local contractors able to install technologies, decision support tools, sources of grants or loans, product quality and performance labeling, education for schoolchildren, and energy audits. The Green Buildings for Africa and Philippines Green Buildings illustrate programs with strong information components. All GEF projects include a consumer education component. Energy efficiency product labels were developed for refrigerators (Thailand DSM and China refrigerators projects) and air-conditioners (Thailand DSM project). The Poland lighting project and the Efficient Lighting Initiative promoted a "green leaf" product logo to identify high-quality and environmentally-friendly products. In China, consumer education is fostered through retailer displays, product labels, a "green lights" web page, and a series of books on efficient lighting design for households and small businesses.

(b) Conduct media campaigns to increase consumer awareness of energy-efficient technology, and to increase its mass appeal. Increased awareness and "popularity" of energy-efficient products is also important. All GEF projects contain mass-media campaigns. The Thailand DSM program allocated $8 million for an awareness campaign as part of its voluntary

agreement with manufacturers, including ads in television, radio and print media, and local demonstrations in city halls and schools. In the Philippines, the Efficient Lighting Initiative ran a large media campaign for CFLs featuring one of the nation's most popular comedians. The Poland lighting project developed consumer awareness of the "green leaf" logo with a media campaign. The Mexico lighting project conducted consumer outreach through utility offices.

(c) Educate professionals about the characteristics, costs, and benefits of the energy-efficient technology. Professionals such as architect/engineers and facilities managers often have little information on the benefits of energy-efficient equipment. Professional education has been an important component of several GEF projects. Examples include training for industrial enterprises to understand, procure, and operate higher-efficiency boilers (China), education for building chiller owners about the advantages of replacing existing equipment with high-efficiency models (Thailand), and educational events for building designers and lighting professionals (China, Poland, and ELI). The China lighting project also assists installation contractors and building maintenance firms to develop services related to efficient lighting.

(d) Reduce retail prices of technology through rebates or subsidies. GEF projects to develop CFL markets have used different mechanisms to reduce retail prices. The Poland and Mexico efficient lighting projects provided per-lamp subsidies. The Poland lighting project took a unique approach to subsidies by obtaining subsidy contributions from lighting manufacturers, in the form of agreements to provide products at reduced wholesale prices.

(e) Conduct bulk purchases and procurements. Procurement is a non-regulatory approach to lowering market prices in which a large buyer, or a coordinated group of smaller buyers, purchase in quantities large enough to attract favorable pricing from suppliers, often through competitive bidding (Engleryd and Ofverholm 1999, IEA 2000b). Sweden pioneered bulk procurement as a tool to improve energy efficiency in the 1980s and has conducted many procurements since then (IEA 1997). The Thailand DSM project, Mexico efficient lighting project, China efficient lighting project, and the Efficient Lighting Initiative all substantially lower retail prices by relying on the economies of bulk purchases from manufacturers.

(f) Provide consumer financing. Consumer financing can improve affordability for the poorest of households, and overcome high consumer discount rates or other consumer-related barriers (Ürge-Vorsatz and Hauff 2001). European and North American utilities have had much experience with pay-on-bill consumer financing programs, but experience among developing countries is less widespread. Pay-on-bill schemes have been notable in Peru and Mexico (Mexico lighting project). Other examples of consumer financing are loans for building owners to purchase efficient chillers (Thailand chillers project) and loans by credit card companies for the added costs of highest-efficiency air conditioners (Thailand DSM project).

(g) Offer buy-back/recycling programs. The China refrigerators project gives purchasers of efficient refrigerators the opportunity to sell their old refrigerator back to the shop where the new one was purchased, for destruction and recycling. This provision was considered important because otherwise consumers might not bother to dispose of the old refrigerator. Rather, the project supposed consumers would run both the new and the old refrigerators simultaneously (perhaps keeping one in the basement), thus negating energy savings from the new purchase.

(Of course, consumers have a choice, but the buyback/recycling program facilitates their making the environmentally responsible choice.)

(h) Facilitate voluntary agreements by industrial consumers to improve efficiency. Voluntary agreements can also occur on the demand side. Notable examples are US EPA's Green Lights program, and its successor, the Energy Star Buildings program. These programs have been replicated in several developing countries. The Philippines now has a Green Buildings/Resorts program (Verdote et al. 2000). South Africa has also initiated a similar program, called Green Buildings for Africa. As a flagship demonstration site, the facilities of the South African utility (ESKOM) were the first buildings to upgrade their energy efficiency under the program.

4. Conclusions

Analysis of market indicators shows that GEF support has indeed managed to transform markets for energy-efficient products. The GEF has already achieved significant CO2 emissions reductions and is demonstrating highly cost-effective potentials for doing so—to less than $1 per ton of carbon. Many of the lighting programs have resulted in cost-effectiveness in the $5-10 per ton range. Replacing existing building chillers before the end of their useful life also appears to be particularly cost-effective because chillers last about 25-30 years. Replacing existing Thai chillers with more efficient models pays back within 4-5 years and can reduce CO2 emission at less than $1 per ton of carbon, and even less in terms of public (GEF) funds per ton, given the project leverage of other financing sources.

Project impacts from the GEF portfolio discussed in this paper are becoming significant. Three projects in Thailand, Mexico, and Poland have resulted in installation of more than 4.6 million compact fluorescent lamps (CFLs) and annual electricity savings of at least 3,500 GWh. Sustained retail price reductions in the CFL markets in those three countries of 30-35% were also achieved. The Thailand project resulted in the compete transformation of the fluorescent-light market, representing 20 million lights sold annually; market share of the more-efficient lights went from 40 to 100 percent during the project. In Poland, the share of households with CFLs increased from 12 to 20 percent. In Thailand, the market share of efficient refrigerators went from 12 to 96 percent and the share of efficient air conditioners went from 19 to 38 percent. Large changes in consumer awareness and understanding have accompanied these projects.

New institutions and regulatory changes are also important project outcomes. In China, new energy-efficiency standards for refrigerators were enacted. In Thailand, a demand-side management office was created within the national utility; that office successfully negotiated voluntary agreements with the private sector, conducted bulk procurement and distribution of CFLs, promoted public awareness, and instituted appliance labeling, among many other achievements. In Mexico, new demand-side management programs have been established since the original GEF project and new CFL standards enacted. Although the potential for demand-side management programs by electric utilities may diminish as utilities continue to privatize and lose public-interest mandates or oversight, experience suggests that even private utilities can be willing and interested partners in market transformation programs in some national contexts.

Market impacts appear even before formal project implementation in at least three GEF projects. Increased expectations of future markets for efficient products, increased awareness of energy savings potential, and increased understanding of market transformation approaches can be enough by themselves to affect market. It appears that early project preparation activities and the commitment by GEF to undertake such projects have encouraged market players to believe that that increased investment and publicity will occur, which motivates them to increase their market presence, develop prototypes, and act to position their products to take advantage of the project. For example, early in the China efficient refrigerator project, one Chinese refrigerator manufacturer said that "because of the GEF project we have seen increased pressure on the market for efficient refrigerators and we are already responding." New product standards were also a factor, arising in part from earlier bilateral donor assistance.

Evidence is emerging that the market changes brought about by GEF-supported efficient-products projects are sustainable. For example, retail price reductions for CFLs have been sustained after projects completed. High-efficiency refrigerators and florescent lights are now the norm in Thailand, and the highest level of efficiency for these products became the dominant unit on the market. In fact, surveys show that a variety of energy-efficient appliances promoted through the Thailand project have sustained markets, although some programs, like the labeling program for air conditioners, appear to have been less effective at achieving sustainable changes. Sustainability is difficult to assess in some projects because of the lack of established baselines and surveys of non-participants.

Experience from GEF market transformation projects is catalyzing similar activities locally and in other countries. The three completed projects in the portfolio are all being replicated in some form. The clearest example of replication is in Mexico, where the original GEF-supported utility DSM program led to further energy efficiency programs for lighting, with almost five million additional CFLs sold, as well as to programs for building insulation and air conditioning. The seven-country Efficient Lighting Initiative was developed in response to requests from countries which had heard of the Poland lighting project. And Sri Lanka and Vietnam are incorporating lessons from the Thailand DSM project into their own programs.

Based on this review, we recommend eight principles for designers of future projects: (a) make sure to target both supply and demand sides of a market; (b) take a holistic view of the market by carefully examining all stages of the supply and demand chain; (c) leverage competitive market forces whenever possible; (d) build flexibility into program design so that program activities can respond effectively and rapidly to changing market dynamics; (e) carefully consider what vehicles for technical assistance and technical know-how transfer will be workable; (f) place emphasis on standards, labeling, and building codes; (g) allocate a portion of the program's budget for activities that support replication and the dissemination of results; and (h) begin monitoring and evaluation early to measure pre-program baselines.

Consideration of the proper and unique roles of different stakeholders is also a critical aspect of market transformation. Stakeholders can include manufacturers, wholesalers, retailers, and industry associations, consumers, governments, electric utilities, local and international NGOs, international assistance agencies, bilateral donors, regional development banks, foundations,

energy efficiency business councils and advisory councils, and other international organizations. Examples of participation of all these different stakeholders can be seen in the mix of GEF projects discussed.

There appears to be no single prescriptive approach that guarantees the success of a market transformation program. The variety of approaches used reflect the barriers and opportunities in each target market, as well as the capacity and creativity of each program design and implementation team. Some notable program schemes include the voluntary agreements negotiated between the Thai electric utility and Thai importers and manufacturers of fluorescent tubes, in which EGAT funded a massive education campaign on the benefits of more efficient 'thin' tubes, in exchange for a complete production changeover to thin tubes; the Poland lighting project's per-lamp price subsidy, competitively-allocated at the manufacturer level, which led to a subsidy-multiplier effect at the retail level; and the Thailand chillers project's combination of low-cost loans and performance guarantees, which have been met with enthusiasm by both manufacturers and potential purchasers.

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Table 1: GEF Efficient-Products Portfolio (as of 2001)

Project (date approved by GEF Council)	Implementing agency/budget	Description
Mexico High Efficiency Lighting Pilot (1991)	World Bank $10 m. GEF $23 m. total	Pilot a utility DSM program to sell CFLs to residential consumers
Thailand Promotion of Electricity Energy Efficiency (1991)	World Bank $9.5 m. GEF $190 m. total	Conduct a five-year utility DSM program by the national electric utility responsible for power generation (EGAT)
Poland Efficient Lighting Project (1994)	IFC $5 m. GEF $5 m. total	Stimulate the national market for energy-efficient lighting in Poland, particularly for CFLs.
China Efficient Industrial Boilers (1996)	World Bank $33 m. GEF $101 m. total	Develop affordable energy-efficient industrial boiler designs and mass produce and market these designs throughout China.
China Commercialization of Energy-Efficient CFC-Free Refrigerators (1998)	UNDP $9.9 m. GEF $41 m. total	Assist Chinese manufacturers to design, produce, and market efficient refrigerators; raise demand with education, marketing, incentives and labeling.
Multi-Country Efficient Lighting Initiative (1998)	IFC $15 m. GEF $50 m. total	Promote market expansion for energy-efficient lighting in Argentina, Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa.
Thailand Building Chiller Replacement Program (1998)	World Bank $2.5 m. GEF $5 m. total	Remove barriers to widespread replacement of low-energy efficiency chillers with new, high-efficiency, non-CFC chillers.
China Barrier Removal for Efficient Lighting Products and Systems (2000)	UNDP $8.1 m. GEF $26 m. total	Assist Chinese manufacturers to upgrade designs and lower costs of lighting products, educate consumers, conduct market promotion activities.

Table 2: Supply-Side Market Transformation Approaches

	Mexico lighting	Thailand DSM	Poland lighting	China industrial boilers	China refrig-erators	Multi-country lighting	Thailand building chillers	China lighting
(a) Technical assistance and technical know-how transfer				yes	yes		yes	yes
(b) Development of equipment standards and building codes		yes		yes	yes		yes	yes
(c) Voluntary agreements by private sector		yes	yes					
(d) Incentives for producers and dealers		yes			yes			
(e) New distribution mechanisms	yes	yes	yes			yes		
(f) Quality testing		yes	yes			yes	yes	yes
(g) Financing for manufacturing upgrades				yes	yes			

Table 3: Demand-Side Market Transformation Approaches

	Mexico lighting	Thailand DSM	Poland lighting	China industrial boilers	China refrig-erators	Multi-country lighting	Thailand building chillers	China lighting
(a) Consumer education	yes	yes	yes	yes	yes	yes	yes	yes
(b) Media campaigns to increase awareness among consumers	yes	yes	yes		yes	yes		yes
(c) Professional education		yes	yes	yes		yes	yes	yes
(d) Retail price decreases (subsidies, rebates, etc)	yes	yes	yes					
(e) Bulk purchases or procurement by public agencies	yes	yes	yes			yes		yes
(f) Consumer financing (through bank, through utility bill, etc)	yes	yes	yes			yes	yes	yes
(g) Buy-back/recycling programs					yes			
(h) Voluntary agreements by industrial consumers								