CDIE
Impact Evaluation
United States Agency for International Development

SAVING ENERGY IN GUATEMALA

A USAID project in Guatemala and four other Central American countries benefited 2,000 industrial firms by training managers and technicians in ways to use energy more efficiently. However, economic policies and conditions prevailing at the time of project implementation limited the scope for widespread adoption of energy conservation practices.

The Agency's $6 million 1982–89 Regional Industrial Energy Efficiency project

- Trained a small cadre of energy conservation experts. These professionals formed the potential core of an energy audit and conservation consulting industry.
- Supported publication of technical manuals and training guides that became universally regarded as high quality, relevant, and well presented.
- Helped participating companies save an estimated total of $7 million a year.
- Increased demand for energy conservation among companies with an awareness of its financial rewards.
- By increasing energy efficiency at participating companies, set the stage for easing pressure on energy supplies and improving the quality of the environment.

But the project fell short of achieving some of its objectives. It failed to

- Stimulate demand for energy conservation services sufficient to sustain an independent private energy audit and conservation consulting industry
- Encourage medium-term industrial lending by commercial banks for investments in energy conservation measures and equipment

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SUMMARY

For decades, Guatemala and its neighbors relied on cheap-energy policies to fuel economic growth. That worked well enough so long as international petroleum prices were relatively low. Energy lost through inefficient use could be compensated for, not through conservation but by producing yet more energy.

Then came the oil shocks of the late 1970s and early 1980s. The Guatemalan government found it increasingly difficult to sustain its cheap-energy policy, and many energy-wasting industries began to experience rising costs and declining profits.

With help from USAID, in 1982 Guatemala, Costa Rica, El Salvador, Honduras, and Nicaragua launched the Regional Industrial Energy Efficiency project (PEEIR). Targeting manufacturers—large energy users—the $6 million effort conducted training in energy management and energy audits. The project provided advisers and trainers, held seminars and demonstrations, and produced technical manuals and training guides for energy conservation measures.

The project emphasized simple, inexpensive conservation measures such as repairing leaks and installing insulation. It focused on efficiency in energy use, not power production. Moreover, only modest attention was given to energy price policy issues that influence conservation priorities. It has had some notable successes. By project termination in 1989, an estimated 2,000 companies had benefited from PEEIR. Estimates put energy savings for participating companies at more than $7 million a year throughout the region, clearly a positive economic payback.

It has had potentially beneficial environmental effects as well. Less oil burned means cleaner air, and more efficient use of hydropower (now a dominant energy source) translates into reduced pressure to build new dams. That helps relieve stress on forest habitat.

PEEIR also created a critical mass of energy conservation professionals and a fledgling energy audit industry. The longer term impact of the project may be the 30 to 40 local staff who were on the project team. A few have moved on to become independent energy auditors and conservation consultants while others continue as energy managers for the industrial firms that participated in the project.

But demand for their services in Guatemala remains limited. The oil shocks were short-lived and, as fuel prices returned to more stable levels, incentives for energy conservation also declined. While financing has been available from domestic and international sources for power generation, industrialists pointed to the lack of commercial medium-term credit for energy conservation with manageable collateral and interest rate terms.

The PEEIR experience generated a workable approach to promoting energy conservation in one segment of the economy, manufacturing. Spreading conservation more widely, however, will require a more supportive economic policy environment than what prevailed at the time of project implementation.

THE PROBLEM

The president and plant engineer of Guatemala's only paper recycling company know that more efficient energy use will bring greater profits and a cleaner environment. Along with other industrial managers in Central America who took part in USAID-sponsored training in energy management and energy audits, they have introduced a range of measures to cut their company's fuel consumption, costs, and waste emissions. Moreover, their energy conservation investments have produced a prompt payback and improved profits. They are now developing plans for using paper waste to fuel a generator that will not only meet their electric power requirements but provide an excess to sell to the national grid.

Equally important, the company's participation in the USAID program has led to additional environmental improvements and energy savings through water recycling. By constructing biological sluices of aquatic plants to reduce water turbidity and toxicity, the company now has lower water-pumping bills and protects the quality of downstream areas.

For this firm, USAID-supported energy conservation measures have also led to production practices with broader environmental benefits. For example, the firm reduced more expensive water pumping by introducing waste water recycling that also meant less toxic effluent into nearby streams and riverbank habitats.

Still, today company managers are frustrated. Plans to produce electric power from paper waste are blocked by high costs of medium-term bank financing. And cheap (though unreliable) electric power, they argue, further discourages the paper company and other industries from underwriting energy conservation measures.

The experience of the paper company managers reflects a common problem confronting those who take part in USAID programs to conserve energy and improve environmental conditions. Despite opportunities for a cleaner environment and greater economic growth, energy conservation efforts have been tempered by economic disincentives in Guatemala.

Guatemala, like most of its neighbors, used industrial incentives—including cheap energy prices—to usher in a period of economic growth that lasted through the 1970s. All that ended with global fuel shortages in the late 1970s and early 1980s. The government found it increasingly difficult to sustain its cheap-energy policies, and many energy-wasting industries began to experience rising costs and declining profits. Guatemala had reached a point where a dollar invested in more efficient energy use promised to yield more than a dollar invested in more energy production.

THE PROJECT

With help from USAID, Guatemala, together with Costa Rica, El Salvador, Honduras, and Nicaragua, in 1982 launched the Regional Industrial Energy Efficiency project (PEEIR) to promote energy conservation. The program targeted industrial energy users and employed a strategy of performing "energy audits" and conducting training and awareness programs to introduce more efficient energy management. The Central American Industrial Technology Institute (ICAITI) conducted PEEIR activities from 1983 through 1989.

The project aimed to establish a self-perpetuating initiative to promote energy conservation. The design was based on the assumption that returns from investments in energy conservation would be great enough to be shared by participating industries as profits from lower production costs, by consumers as lower product prices, and by private engineering consulting firms as fees for energy audit and training services. To make a market for energy conservation services among industrial energy users, the project prepared and equipped engineers from ICAITI and the private sector to conduct

energy audits and training. Project designers expected that these energy conservation engineers could charge fees sufficient to cover the cost of their services.

CDIE STUDY

In October 1995 a three-person CDIE evaluation team traveled to Guatemala to evaluate the economic and environmental impact of more efficient energy use that resulted from PEEIR. The team consisted of Phillip E. Church, CDIE economist and team leader; David Leibson, USAID Global Bureau, Environmental Center, coordinator for Latin America and the Caribbean; and Eduardo Maal, environmental engineering consultant. For two weeks the team gathered information from a range of industries and individuals that had participated in PEEIR activities. The evaluators also interviewed other individuals and institutions that have since emerged with interests in the environmental impact of energy conservation and use. One team member traveled to Costa Rica to assess the spread of project activities in that country.

This evaluation looked at the effectiveness of the project's approach of promoting energy conservation by developing a local industry of independent energy auditors and conservation consultants. Since the project was interested in energy use rather than energy production, the evaluation excluded issues related to the efficiency of power generation or merits of alternative energy use. While important in Guatemala's overall energy picture, power generation and alternative energy extended beyond the scope of the evaluation's focus on promoting better energy use through energy audits, consulting, and training of industrial energy users.

The evaluation examined four strategies implemented under PEEIR:

- Building institutional capacity to promote and service energy conservation activities
- Introducing technology for better energy management
- Increasing awareness and understanding about economic and environmental benefits from energy conservation
- Reforming policies that discourage environmentally sound energy use

This report highlights Guatemalan and regional trends in energy consumption and summarizes energy conservation activities conducted through a regional USAID project. It summarizes what evaluators found about changes in conditions resulting from implementing the four strategies. It describes the project's impact on industrial energy conservation, on environmental and economic conditions, and on the sustainability and spread of energy conservation practices. Finally, the report presents lessons drawn from the evaluation.

BACKGROUND

Industrial growth has been a key component of Guatemala's economic development. Energy, from hydropower generation or imported as petroleum products, has been a critical input to the country's industrial expansion. Since 1980 the demand for electric power in Guatemala and its Central American neighbors has grown steadily. With average increases of 6 percent a year, in each country electric power demand has grown faster than the overall economy. The result: expansion of the electric energy share of economic value added in the region and greater dependency on electric power in industrial production.

Petroleum-based energy shortages in the 1970s and early 1980s severely constrained Guatemala's industrial and overall economic performance. During the 1980s, gross domestic product stagnated, leading to what has been called the "lost decade of the 1980s" for Guatemala and its neighbors. Political disturbances and global economic recession were also factors, but rising international energy costs drove the problem.

Production Over Productivity

The development impact of the energy sector was further diminished by inefficiencies resulting from cheap-energy policies pursued to promote industrial growth and competitiveness regionally and internationally. Subsidized energy prices proved unsustainable for Guatemalan authorities forced to trim deficit spending. Higher fuel prices and electric power rates have left many industries with shrinking profit margins and reduced attractiveness for further investment and expansion.

Inefficient energy use also has contributed to environmental degradation. Mismanaged electric power leads to production and distribution losses. It contributes to increased demand for thermal electric and hydroelectric facilities, with accompanying distress to air quality and wildlife habitat. Pressures on the national power system caused frequent brownouts for industry and led to installation of emergency backup systems that added further air pollutants. Guatemala has improved petroleum prices, which currently do not diverge as widely from actual production costs as in other countries. However, economic distortions in capital markets limit investments in cleaner power generation and use.

High fuel prices in the late 1970s and early 1980s stimulated measures to improve energy efficiency. Because Guatemala's energy problems were similar to those of its neighbors, USAID chose to support energy conservation through a regional institution, the Central American Industrial Technology Institute.

Guatemala and its neighbors have worked to meet their energy needs in three ways. For more than 15 years, they have participated in a regional agreement with Mexico and Venezuela for regular supply of petroleum products on easy credit terms. At the same time, with international financing, they have expanded the capacity of their public sector electric power generation facilities. Finally, the governments have set prices and regulated supplies to allocate electric power among users—industry, residential, public, transport, and the like.

Over 20 years, Guatemala has shifted dramatically from thermal to hydropower for electricity generation (table 1). In 1970, public sector power production from thermal sources was 431 million kilowatt-hours or 57 percent of the total. Thermal production peaked at 1,339 million kilowatt-hours, 83 percent of the total, in 1980 and then fell to 240 million or 9 percent in 1992. The country's installed hydropower capacity of 696 megawatts in 1992 is less than 10 percent of estimated total potential capacity. Investment in hydroelectric power production, therefore, continues to be a major strategy for meeting power needs. Increased private sector

Table 1. Public Sector Power Trends in Guatemala

Year	Electric Power Production (million kilowatt-hours)		Hydropower Capacity (estimated megawatts)		
	hydro	thermal	total	actual	potential
1970	328	431	759	216	4,950
1980	278	1,339	1,617	410	9,652
1992	2,340	240	2,580	696	9,652

participaton in power production is now also a critical component of energy policy.

Despite recent economic difficulties in Mexico and Venezuela, Guatemala and its Central American neighbors continue to count on low-cost petroleum products from these suppliers. With (relative) assurance of foreign petroleum supplies and recent expansion of domestic hydropower generation, Guatemala's power authorities continue to pursue a strategy of "producing" themselves out of energy supply difficulties. They pay less attention to gains achievable from more efficient energy management and use. This strategy may have met the needs of the economy during early stages of industrialization, but periodic energy shortages and strains on the ability of the public power system to deliver electricity to rural areas suggest a broader energy strategy is warranted—one that includes more conservation and demand-side management along with production and distribution.

A Regional Approach

Interest in energy conservation in Guatemala first emerged in the early 1980s as a strategy to help the country's balance of payments by reducing industrial consumption of imported petroleum. More recently, limits on domestic power generation have begun to hamper economic growth. Waste in energy consumption is also gaining recognition as an environmental problem.

In 1982, the Regional Industrial Energy Efficiency project provided $6 million for consultants, energy audits, seminars, demonstrations, exhibits, training, promotion, a database, and library services through ICAITI. USAID contracted an American consulting firm and a university engineering program to provide advisers and trainers in energy conservation. It also funded studies of energy policy through a small grant with the Secretariat for Central American Economic Integration.

For several reasons, the project emphasized industry and not other sectors. First, designers felt the public sector, with financing from other donors, was giving appropriate priority to developing alternative domestic energy sources, notably hydropower. Second, while transport was consuming nearly half the region's petroleum imports, introducing alternative fuels would have required more time and research. Third, residential and commercial sectors consumed a relatively small share of petroleum imports, thus offering limited opportunity for savings.

The project assumed profit motives in the industrial sector would induce plant owners to initiate measures for reducing energy costs in the production process. To improve efficiency, plants could take many relatively simple steps for which a wide range of technologies of varying sophistication and cost could be applied.

Project strategy was to target industries consuming the most energy, presenting the best opportunities for replication, and in reach of USAID's partners in project implementation. Data on 9,000 companies in the region were evaluated, and 3,000 plants in the beverage, chemical, textile, and food-processing industries were targeted. These represented 60 percent of value added in the manufacturing sector. The largest companies were generally excluded on the assumption they could obtain their own expertise. Those with fewer than five employees were also excluded; assisting them would not have been cost-effective.

The project emphasized simple, inexpensive measures. These included cleaning, metering, repairing leaks, performing maintenance, tracking energy costs, and naming plant energy managers. Depending on need and cost, further measures to conserve thermal energy included insulation, alternative fuels, automatic gauges and valves, more efficient boilers and furnaces, and preheating with recovered waste heat and condensate. Measures promoted to conserve electrical energy included cogeneration (utilizing waste energy), sizing of motors, alternative lighting systems, and start-up timing of equipment to minimize peak demands.

PROJECT ACCOMPLISHMENTS

Major accomplishments centered on industrial plant visits and audits to promote energy conservation on-site and identify energy conservation opportunities. Two types of audits were conducted:

Level 1 audits were energy profiles based on a visual and qualitative diagnosis of energy use. They led to identification of immediate opportunities to improve energy efficiency. Recommendations typically included routine practices to eliminate obvious wastage and raise consciousness of the need for conservation. Level 1 audits took a day or two. About 150 were completed.

Level 2 audits provided detailed quantitative diagnosis of energy flows through a plant, using measuring equipment to locate and document energy use and loss. They included a technical evaluation of the performance of major energy systems: furnaces, burners, boilers, tanks, heat transfer surfaces, pumps, motors, and other electrical machinery. Recommendations were accompanied by economic analyses of costs, benefits, and payback period for needed improvements. Level 2 audits averaged 35 person-days. About 130 were completed.

ICAITI did not charge firms, or calculate its costs for level 1 audits, which it conducted mainly as an awareness-raising activity. In 1987, level 2 audits cost about $2,700 in Guatemala and up to $5,200 in other countries, depending on the need for travel. Firms were initially charged a minimum of $500. Beginning in 1987, the price was set at 60 percent of estimated average costs. Today, ICAITI appears to be covering most costs of its audits from fees charged.

Technical manuals and training guides were universally regarded as high quality, relevant, and well presented. Six manuals were published (in Spanish) and 65 to 85 seminars presented to 2,500 technicians and plant managers on subjects ranging from boiler efficiency to "energy savings in your plant" (for executives). Only a few demonstrations and plant exhibits were staged, but it has been estimated that 1,500 to 2,000 industrial companies benefited directly or indirectly from the project.

Table 2. ICAITI Energy Audits and Seminars, 1983–92

Country	Energy Audits		Energy Seminars	
	number	percent	number	percent
Guatemala	64	25.1	18	24.4
El Salvador	59	23.1	12	16.2
Honduras	38	14.9	10	13.5
Nicaragua	5	2.0	10	13.5
Costa Rica	89	34.9	12	16.2
Regional	—	—	12	16.2
Total	**225**	**100**	**74**	**100.0**

Training auditors was especially important. Ten project-funded engineers (at least one from each country in the region, the rest from Guatemala) worked closely with American advisers on all phases of the audits. They grew into a corps of highly regarded professionals, most still active in the field. Five project-funded professionals working on training, promotion, and database/library services were also well trained under the project. Table 2 summarizes the number of energy seminars conducted during the project.

Regular bulletins and flyers reporting seminars, industrial audits, and other energy

conservation activities in the region reached an estimated 2,000 individuals and companies. These helped promote a consciousness of energy conservation that can still be found. Project-funded delegates were attached to the Chamber of Industry in three countries to promote the program regionally.

A database built on information collected during energy audits was intended to provide a base for research and analysis, but it did not survive. The ICAITI energy library the project helped build is still in use but is not kept up to date.

Five project-funded professionals at the Secretariat for Central American Economic Integration, including a senior economist, worked on macroeconomic studies of energy policy and national planning. They prepared more than 30 documents on public policy and about 20 on financing, largely for distribution among Central American energy technicians and officials at regional meetings.

The project was originally designed for implementation in 1982–87. Project evaluations conducted in 1985 and 1987 surveyed beneficiary companies and recommended several changes to improve performance. Of particular significance was the recommendation to conduct more focused energy audits aimed at quicker payback for participating companies as a means of generating more interest in audits and more willingness by industries to pay a larger share of audit costs. Essentially on target in 1987 for the number of audits and seminars to be conducted but with unexpended funding, project activities using USAID money were extended until 1989.

FINDINGS

Conducted six years after project termination, the CDIE impact evaluation looked for evidence that energy awareness, training, and auditing activities started by the project were continuing to take place and that participating firms were continuing to practice more efficient energy management. The evaluation also sought to assess the environmental and economic impacts of project activities.

Institutional Capacity

Regionally, ICAITI now functions as a research-and-development center for energy conservation and other environmental management and quality-control activities. Through PEEIR, the institute developed technical capacity and, during the project, played a key role in promoting efficient energy use by participating industries in Guatemala and other countries in Central America. ICAITI is now at a crossroads in reshaping its role of meeting today's needs and financial realities. The institute depended too much in the past on international donors to finance its core operating costs and must now take an aggressive approach to marketing its services if it is to remain viable. It has begun to partner with technical experts in the region as a means of extending its services. For example, ICAITI's laboratory and quality-certification facilities can effectively support energy and environmental management consultants who have the needed skills but lack equipment.

ICAITI also plans to pursue a more entrepreneurial approach to marketing its services to generate revenues needed to be a player in energy conservation. Although it has developed a business plan for achieving its goals, it does not yet have a firm grasp on how it will generate revenues needed to carry out the plan. Nevertheless, PEEIR implementation demonstrates that energy management consulting and training services can generate revenues sufficient to cover their costs.

Nationally, small energy and environmental service firms have emerged to support increased awareness and improved practices. The longest term impact of the project may be the 30 to 40 local staff who were on the project team and have moved on to become independent energy conservation consultants and energy managers for industrial firms. Several conduct energy audits as part of their engineering and contracting businesses, or they promote energy-efficient equipment, which they import

and sell. Industrial and other client demand remains limited, however, so consulting engineers conduct energy audits as one among several services provided. A major barrier for these firms is establishing a fee structure for their services. That's because, generally, energy conservation benefits they identify and propose as part of their audits show up only indirectly and over an extended period.

In addition to consulting work, some PEEIR staff and trainees are now chief engineers or plant managers in up-to-date enterprises. They keep themselves current with energy management measures, so they can improve their firms' bottom lines. Some of these firms have introduced environmental quality circles (with representatives from each company department) and other environmental management programs as outgrowths of energy conservation work initiated when they took part in PEEIR.

Awareness and Education

Awareness of the need and opportunities for energy conservation is greater, but not in all circles. Energy conservation and environmental concerns are in the consciousness of the 64 Guatemalan businesses (225 regionally) that took part in project energy audits. Project-trained engineers with enhanced skills in efficient energy management are now scattered among a number of industries or in nongovernmental organizations and engineering consulting firms. Still, these relatively few "enlightened" energy engineers uniformly lamented that the scope for energy savings is not well understood among the majority of public officials and private entrepreneurs.

Team members frequently heard comments from industrial energy users that PEEIR energy conservation seminars, publications, and energy audit training were useful. Through September 1992, PEEIR had presented 74 energy seminars to 2,067 participants regionally. However, ICAITI has done little follow-up to assess the actual impact of training on participant practices. Since the project ended in 1989, energy conservation training courses have been conducted less frequently, but with good attendance.

Team members heard some critical comments about the overly theoretical nature of some courses. Attendees wanted a more practical approach, compatible with Guatemala's industrial environment. Seminar participants interviewed frequently suggested that while ICAITI's promotion of "housekeeping" types of energy conservation technologies was OK, they would have liked to receive more production process–related information. Suggestions included assistance to modify an alcohol-refining process and teaching more efficient use of raw materials to increase productivity and reduce energy use while maintaining quality.

Demand for energy conservation information and publications is strong among those with an awareness of its financial rewards. Managers of industries visited by the CDIE team corroborated the need for energy conservation brochures, manuals, and publications in Spanish. At the ICAITI library the team was able to identify 6 PEEIR publications, 46 informational brochures, 16 bulletins, and 9 promotional brochures. There were also many publications related to alternative energy sources, biogas, ethanol, and solar energy. Project staff produced many publications—of high quality, very well received—that are still being used by industries and individuals and have been the basis for most of the energy conservation publications in Central America.

It is apparent that ICAITI has stopped or greatly reduced the amount of publications and outreach activities during the last four years. The ICAITI library held no brochures, flyers, or case studies dated later than 1989, and the library lacked a list of available publications. On the positive side, during 1995 newspapers published several articles about ICAITI's activities in energy conservation in Guatemala and in Nicaragua. Articles about ICAITI's laboratory wastewater analysis also ran.

Since project termination, the momentum of activities in energy conservation awareness has decreased markedly. The bulk of this awareness development took place during the active life of the project (1982–89). It is evident the energy conservation awareness created after 1989 stems from the project's momentum as well as ICAITI's continued (but reduced level of) training and outreach activities. The institute still uses course materials developed during PEEIR implementation and continues to market copies of training manuals. It has also formed partnerships with producer associations such as the national Chamber of Industries to conduct seminars, short courses, and workshops.

However, most of these efforts appear to be passive. ICAITI lacks a strategy for aggressively marketing its training services, and the team could find no advertising or bulletins in which it promoted its energy conservation publications. Nor does ICAITI market one of the key energy audit manuals produced during the project. The institute has no clear policy to promote this activity among private consulting firms that would compete with it for future energy auditing business.

Technology Development and Introduction

Guatemala has plenty of energy-saving technology information on the shelf and accessible to engineering contractors and factory managers, but use of this information is limited. ICAITI has information on a number of energy management technologies. PEEIR, through translations of U.S. energy conservation materials, produced an extensive number of technical energy conservation documents in Spanish. These documents are detailed and technically accurate, and they're still used by industries and energy conservation engineers as reference material. Private engineering consultants also know where to go to get the latest technology in areas such as minicogeneration and alternative energy systems.

However, current demand for industrial energy conservation technologies now goes beyond the basic conservation practices promoted by ICAITI through PEEIR. Calls for information on a wide range of more sophisticated conservation measures—cogeneration, waste recycling, improved process controls, and others—currently exceed the capacity of ICAITI to supply.

Costa Rica shows even more significant evidence of a positive impact of PEEIR-produced technical documentation on public sector energy-related entities. To support implementation of a new Costa Rican law to regulate the use of energy, the Ministry of Natural Resources, Energy, and Mines developed guidelines for standardizing energy audit reports. PEEIR supplied 70 percent of the technical data and information contained in this document.

In Guatemala, PEEIR laid the foundations for developing more advanced, production-related energy conservation technologies. These foundations were laid through the project's earlier programs in energy conservation awareness, training, information dissemination, and industrial energy audits. This has led to increased demand for more advanced production-related energy conservation technologies in addition to standard energy conservation technologies. Increased demand was evident during meetings with some of Guatemala's progressive industrialists. Standard conservation technologies (such as cogeneration, waste heat recovery, and improvements in combustion efficiency) are already well known in most Guatemalan industries, in part because of PEEIR.

Growth in demand for more advanced energy conservation technologies is a normal development in countries where there have been energy conservation programs and where energy subsidies are being reduced and energy costs become an important financial consideration for managers.

Policy Reform

The oil shocks that sparked energy conservation interest in the 1970s and 1980s were relatively short lived, and Guatemala has continued to concentrate on providing a cheap supply of dependable power to users. Public and private investments in expanding hydroelectric power capacity continue to dominate the government's energy agenda. Assured of regular low-cost petroleum imports from Mexico and Venezuela, Guatemala currently faces no serious energy problems. But with revenues from utility user fees inadequate to cover costs of maintaining power facilities, low quality, irregular electrical service seems most likely for the foreseeable future.

The most common comment heard in energy-using firms was that industrial energy conservation is a low government priority. Furthermore, Chamber of Industry representatives point out the reluctance of energy users to support the higher energy prices needed for power system maintenance, for ensuring more reliable supplies, and for encouraging energy conservation when the public sector is, itself, a wasteful energy user. "Just look at all the power lost in government buildings kept illuminated 24 hours a day," goes the gist of their arguments. "Let the government get its house in order first, let it lead the rest of the economy before it raises rates to encourage conservation measures elsewhere."

Perceived past mismanagement in public power generation and distribution discourage industry support for utility rate reforms. "Why should we give the government the scope to escape from its own responsibilities?" informants asked.

Industrialists pointed to credit as another area where national policy discourages energy conservation. Commercial interest rates currently average 22–24 percent, too high, they argue, to finance retrofitting and more efficient equipment.

Financing for energy-saving investments, as well as for private investments in energy power production projects such as cogeneration, is costly, often too much so for potential borrowers. For example, one paper recycling plant has completed feasibility studies for a 1.2-megawatt cogeneration facility that would meet its internal needs of 0.4 megawatts and produce a surplus for sale to the national electric power grid. The cost of available short-term credit, however, exceeds what the firm can afford to pay until the project comes on line. Long-term financing for energy conservation either is unavailable or requires collateral of plant and equipment, a risk and commitment that borrowers are reluctant to take.

PEEIR attempted to encourage national banks to set up special lines of credit for funding energy investments. No banks responded. With regard to what the government can do about economic policies to motivate energy conservation, the answer of most respondents was simple: help get the country's economic house in order so the cost of borrowing and level of risk are brought within manageable limits. Industries did not see a need for any special funds allocated for investments in energy conservation. Firms that did make investments in energy conservation did so from internally generated funds or short-term credit from equipment suppliers, not with bank financing.

Since PEEIR ended, the Guatemalan government has made steady steps toward eliminating market distortions that slow the introduction of energy conservation and environmental management. Targets include increased private participation in the generation and supply of hydroelectric power, and investments in alternative energy sources. Still these efforts are largely directed toward power production, not energy conservation among users.

Energy Conservation Practices

Most Guatemalan industrial firms participating in the project have adopted low- or no-cost

energy conservation practices. Most firms visited and audited by PEEIR first improved their insulation and then proceeded to improve their steam systems. This included improvements in boiler combustion through periodic manual checking. Only one of the firms interviewed tried to use more sophisticated on-line combustion exhaust gas analyzers to regulate air-to-fuel ratios. However, this company had equipment problems that could not be resolved, so it bypassed the system and regulated combustion manually. This is an example of an advanced technology's being insensitive to the region's realities, thus making it ineffective. These misapplications frequently sour industrialists on advanced energy conservation measures.

A smaller number of Guatemala's PEEIR participating industries have adopted energy conservation practices requiring medium to large investments. On the electrical side, the evaluation found that power-factor improvement through installation of capacitor banks (devices for temporarily storing electricity) has also been successfully applied as an energy conservation practice in several industries. This has become more prevalent since Guatemala's electric utility began levying penalties for a power factor below 0.85. (The power factor, the ratio of true to apparent power, measures how efficiently factory electrical systems use energy.)

In two instances the evaluation found that energy audits had encouraged firms to size motors to better match their workloads. One firm had an organized program to verify loads and proceed to install correctly sized high-efficiency motors on a plantwide basis. The other firm took the more conservative approach of verifying motors' loading and then replacing them with correctly sized high-efficiency motors as they broke down. Improved lighting efficiency and use of sunlight to supplement or replace incandescent lighting has also been adopted.

Some firms have adopted energy management as an operational concept. Adoption of energy management practices was not uniform among the firms included in the evaluation. Two industrial firms have adopted internal energy management groups, headed by an energy manager (usually the plant manager or chief production engineer). The groups meet regularly to identify energy savings measures and report on results of conservation practices already adopted. Two other firms also adhere to the energy management concept but do so through the efforts of one person per plant, with strong top management support. By contrast, a family-owned candy manufacturer was content to conduct business as usual in a well-protected market that ensured comfortable profits. He did so despite obvious opportunities to cut costs with minor investments in improved energy use.

Energy management systems are generally used in large commercial structures, such as hotels, hospitals, and office buildings, or in continuous chemical process industries, such as breweries, distilleries, oil refineries, and petrochemical plants. Automated or computerized process-control systems in those settings generally bring large energy savings. They monitor system performance and signal plant managers when power systems need adjustment. However, during its period of field work in Guatemala, the evaluation team found no cases where such systems were used. In their absence, engineers could only guess at the extent of energy savings, emissions reductions, and revenue gains from improvements introduced after PEEIR audits and training.

PROJECT IMPACT*

Environmental Impact

Introduction of energy audits and training has led to broader environmental applications and provided a basis for building "clean technologies" into a range of economic activities. The trend is growing of coupling energy conservation with pollution reduction, both philosophi-

*For separate USAID Guatemala comments on project impact, see p.15

cally and through technical applications. Newly founded Guatemalan environmental regulatory agencies are beginning to encourage operation of industrial plants in an environmentally responsible manner. But they still have limited enforcement power. This, coupled with economic incentives to improve production efficiency, has led progressive industrialists to adopt technologies that simultaneously achieve economic and environmental goals.

In one instance encountered by the evaluation team, environmental regulations pressured an industrialist to reduce exhaust emissions from furnaces. The plant engineer applied energy conservation skills acquired through the project to improve thermal efficiency by installing energy-efficient, environmentally sound, U.S.–manufactured furnaces. This particular industry also modified one of its basic production processes to reduce zinc waste and its by-products. The effort increased plant productivity and environmental quality at a lower unit cost.

Industrial application of energy conservation technologies has set the stage for other positive environmental impacts. One example is air pollution reductions obtained from substituting liquified or natural gas for crude (bunker) oil as boiler fuel. This is becoming commonplace in Central American industries and utilities. In addition to fuel substitution, industries can have a secondary, positive environmental impact through reduced electricity use resulting from such measures as better lighting, improved switch gears, power factor improvement, and use of high-efficiency motors.

Economic Impact

USAID support for energy conservation through PEEIR clearly has generated benefits for participating companies that exceed combined project costs and conservation expenditures of firms. ICAITI estimates more than $3 million per year in energy savings for participating firms in Guatemala alone and more than $7 million annually in the five countries of the Central American Common Market. This is well within the range of significant positive payback to the total of $6 million in project costs and estimated expenses incurred in adopting new measures by participating firms.

Sustainability and Spread

Most companies that participated in energy audits and training continue to follow conservation practices and in some instances have introduced related environmental measures in their operations. The evaluation found a high degree of commitment to energy conservation among plant managers and engineers in firms that participated in PEEIR activities. Several plant engineers interviewed still retained, and reported regularly consulting, the PEEIR energy audits performed on their firms. Most praised ICAITI for its training efforts and for the quality of technical skills allocated to energy audit activities.

The evaluation looked for evidence that adoption of energy-efficient practices has spread beyond participating industrial firms to other firms in the same sector or to other economic sectors—such as transport, commerce, government. The team had neither time nor resources to survey firms and sectors beyond those reached by the original project. Instead, the evaluation centered on assessing the supply of energy audit and conservation consulting services as a measure of sustainability and spread. In interviews, those energy engineers who participated in the project said they were unable to make a living from the sporadic requests for these services. The energy conservation consulting they could do was coupled with regular engineering design work. Energy audits and conservation consulting, they felt, offered a precarious livelihood.

Occasional energy conservation messages appear in public media sponsored by the national power company, and the government environmental regulatory agency occasionally sponsors media announcements encouraging users to conserve energy. However, such campaigns

Environmental Benefits Promoted by PEEIR

A soap products factory reduced air pollution by installing a "baghouse" (a specialized gas-filtering structure) for soap/detergent dryers that recycles exhaust gases through a heat recovery and exchanger system and also saves fuel.

A paper products plant has solved a water turbidity and toxicity problem by installing an energy-efficient system for using biological aerators to recycle water used in production. Sugarmills that participated in the project now burn sugarcane bagasse to produce electric power not only for their own use but to sell to the national power grid as part of a recent "cogeneration" program. This surplus power is made available during the dry season when hydropower drops, averting the need for costly additional petroleum-supplied thermal production. Moreover, surplus bagasse is now incinerated at clean high temperatures rather than dumped as industrial waste in rivers and ravines.

are infrequent, according to experts who monitor Guatemala's environmental scene. (The team noted that Costa Rica recently legislated a requirement for energy audits of all industrial companies—with the costs of energy audits to be paid by participating firms. This step has stimulated the local market for audits and technical services.)

By targeting relatively large industrial firms for energy audits and training, PEEIR enhanced the cost-effectiveness of project investments. The PEEIR experience also generated a workable approach to promoting energy conservation in one segment of industry—manufacturing. However, energy engineers who participated in the project indicated that they have experienced little demand for energy audit services from other economic sectors.

ICAITI continues to offer energy conservation services at cost to industrial companies in Guatemala and other countries in the region, but at a much lower level of activity and with much reduced capacity. To do energy audits, ICAITI now subcontracts private engineers, some of whom are former PEEIR project staff or trainees. One ICAITI representative indicated that two industrial energy audits per month is the institute's capacity. Moreover, ICAITI has no plan to reach the broad spectrum of smaller industrial energy users. A fledgling market now exists for energy audit and energy management training services in Guatemala, but at the cost of these services, demand is small and irregular.

LESSONS LEARNED

Education and awareness activities are a critical component of programs to promote industrial energy conservation. One important vehicle for encouraging energy audits and improved energy management is education. Short courses and seminars sponsored by trade associations, government agencies, and regional organizations are powerful tools for informing managers about the cost savings energy conservation allows. In Guatemala, seminars and workshops informed engineers about energy auditing services available to them and provided technical information they could use to improve energy management. Education and awareness go a long way in selling responsible energy management and in making a market for energy auditing and consulting services.

Sound price policy and responsible public sector power management are critical to building commitment to energy conservation by indus-

trial users. Cheap, if not always reliable, fuel and power supplies offer little incentive to adopt and follow responsible energy management practices. The bottom line clearly drives energy use decisions by Guatemalan industrial companies. Energy conservation discipline flows as much from price incentives as from knowledge and awareness.

Energy audits are a good entry point for encouraging adoption of broader environmental measures. Experience with energy auditing can be a bridge to environmental auditing. Industrial companies participating in energy audits and adopting resultant recommendations frequently move on to address broader environmental problems (solid-waste management, wastewater treatment) that also benefit their cost performance and lead to a cleaner environment. (Requirements for certification of environmentally sound production processes, as issued by the International Standards Organization, will soon be a major force for environmental auditing, particularly in export industries.)

Project personnel and participants can form the basis of a constructive energy conservation network for advancing energy conservation after project funding ends. Energy conservation project staff and seminar and audit participants can be directed toward sustaining project goals after funding ends. ICAITI pursued this strategy by contracting former staff and participants to conduct audits and seminars. Such efforts can reinforce as well as spread the impact of energy conservation initiatives.

What Is a CDIE Impact Evaluation?

CDIE impact evaluations are a unique type of USAID evaluation, providing an *independent examination* of development results. They critically question all the assumptions and benefits of a project and develop useful lessons to improve program performance.

The Administrator has placed special emphasis on ensuring the independence, integrity, and objectivity of CDIE evaluations. Thus, CDIE selects for its evaluation teams experienced experts who are not associated with either the USAID Mission or the program being evaluated.

Often USAID documents go through a clearance process designed to build consensus on major issues. However, because impact evaluations must be objective they are not subjected to this clearance process. The USAID Mission reviewed this evaluation and its comments and suggestions helped sharpen the analysis. In several cases the evaluation team and the Mission hold different opinions. The evaluation team took the Mission's views into account where it could, but in several cases, where the differences could not be resolved, the team had to rely on its own judgment.

To enable the USAID/Guatemala Mission to voice its dissenting views, without compromising the evaluation team's own independent assessment, the Mission's statement is included below. CDIE welcomes such debate and differences of opinion as an important aspect of the learning process that will ultimately improve our understanding of the development process.

USAID Guatemala comments on evaluation findings

As noted in the report and project documents, by 1989 approximately $7 million per year was being saved as a result of a $6 million project (PEEIR). That benefit has continued to grow and expand thanks to a cadre of 30–40 project-trained professionals who have continued to work successfully as private consultants in this field in the seven years since the project ended, and thanks to ICAITI, which has maintained service in this sector throughout this period without USAID support. This demonstrates that demand has spread and continued beyond the industries that took part in the original project.

The report fails to mention the tiny size of the project's policy activity (approximately $400,000 spread over six Central American

countries and nine years, or approximately $7,000 per country-year). Nor does it credit the role PEEIR played by contributing to critically important policy changes that speak for themselves. Using Guatemala as an example:

- petroleum was subsidized, nearly all electric power was thermal, and 100 percent was generated by a public sector monopoly at project start-up
- by project finish, nearly 70 percent was renewable, petroleum subsidies were being lowered, and the first contracts for private generation by sugar mills were being negotiated
- today (1996), the private sector supplies an astounding 47 percent of Guatemala's power, and 55 percent remains renewable

The project promoted better pricing policies in general for Central America and the report notes that Guatemala is better than most other countries in terms of real petroleum prices (in fact it is outstanding in its class among oil-producing, developing countries). The price of gasoline, at $1.85 per gallon, has strong conservation ripple effects. For example, Guatemala's vehicle fleet is quite new and fuel efficient compared with many other countries.

While it is difficult to measure the share of attribution PEEIR deserves for these policy improvements (laying some groundwork) compared with many other USAID projects and other donor interventions that have continued to adddress these policy issues since, the results are clear.

Concerning institutional sustainability, the report does not highlight the unusual success of this USAID project in leaving a highly qualified team of independent consultants working privately throughout the region. It also does not address the fact that ICAITI was the first USAID-supported Central American regional institution to "graduate" and become independent, in part owing to the success of PEEIR.

The report correctly noted that this project focused by design on conserving oil, specifically through industry. The project fulfilled this objective and left mechanisms in place that have sustained and amplified benefits in the seven years since project completion. Furthermore, even though it was *not* the crux of the project, several major enterprises, including the country's largest food chain, utilized and implemented PEEIR conservation technology for electrical savings.

Another lesson learned: A donor (USAID) can start something sustainable by building on small successes and changes in awareness. PEEIR started with simple, low-cost measures to save energy that were quickly adopted by more than 2,000 firms in Central America. This foundation of awareness and interest among plant managers and engineers has helped maintain energy conservation initiatives in the region for seven years without direct USAID assistance.

To order paper copies of this report, order number PN–ABS–550, please contact USAID's Development Information Services Clearinghouse, 1611 N. Kent Street, Arlington, VA 22209; by phone (703) 351–4006; fax (703) 351–4039; or Internet docorder@disc.mhs.compuserve.com. This report is the sixth in a series of six impact evaluations on energy conservation. The other countries evaluated are Pakistan (PN–AAX–269), Jamaica (PN–ABS–536), Czech Republic (PN–ABS–546), Philippines (PN–ABY–206), and Hungary (PN–ABY–511). A synthesis of all six country case studies is scheduled to be completed by Fall 1996.

To access electronically from the Internet, the address is gopher.info.usaid.gov. Look under Documents and Publications, then under USAID Publications and Reports, in the sector "Protecting the Environment."

For those with access to the Agency's Banyan local area network, select PPC File Access System, then Program Evaluation, then New Evaluation Reports.