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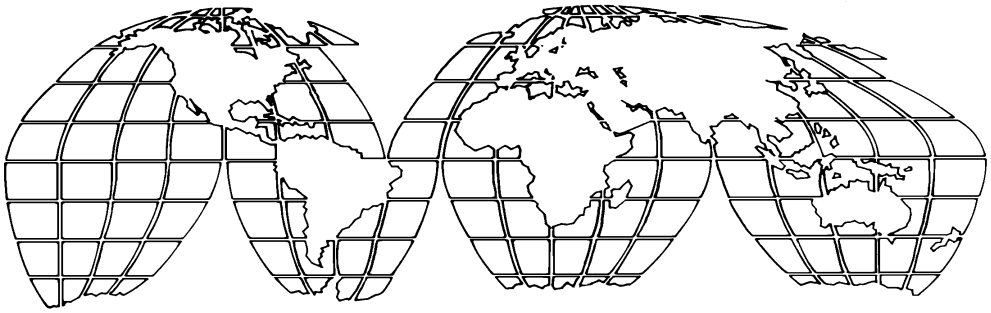
Shining the Light on Energy Conservation: A Synthesis of Six Country Studies



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Summary

A visitor to the capital of almost any developing country, be it Bangkok, Cairo, Manila, or Mexico City, will have a common experience—almost continual traffic gridlock and the sight of factory smokestacks belching pollution. Those who last saw these places 10 or 15 years ago are struck by the massive increase in air pollution from automobiles, trucks, and factories.

As development takes hold and growth accelerates, energy use increases dramatically. But in many cases developing countries do not use energy efficiently. They often require two to four times more energy than industrial countries to produce the same output. This excessive fuel consumption speeds up the accumulation of carbon dioxide, a greenhouse gas, in the atmosphere, contributing to possible global warming. In addition, fuel combustion is often dirty and incomplete, generating local pollution. A final burden is the heavy foreign exchange cost as developing countries sharply increase their fuel imports.

Solutions do exist, but sustaining change remains elusive. Energy-efficient equipment and improved energy management can greatly reduce energy consumption. Over the last 10 to 15 years USAID launched a number of energy conservation projects aimed at industrial energy use. These projects helped create an interest in energy efficiency, trained local engineers in energy management, and sponsored energy audits and demonstration investments. The projects were technically successful and had good economic rates of return. In most cases, fuel savings paid for the cost of investments in a year or two. By reducing energy consumption, the measures also reduced pollution.

The projects themselves were successful—but what happened after the projects ended?

In 1995 USAID's Center for Development Information and Evaluation (CDIE) conducted extensive field evaluations of the early and subsequent success of the Agency's energy conservation projects. The evaluations were based on projects carried out in the Czech Republic, Guatemala, Hungary, Jamaica, Pakistan, and the Philippines. The resultant CDIE report, *Shining the Light on Energy Conservation: A Synthesis of Findings From Six Evaluations,* underlies this Evaluation Highlights.

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The evaluation found that the projects achieved "a big bang for the buck" during the period of USAID support. However, once USAID funding ended, replicating and disseminating technology beyond the original demonstration sites was difficult. Few other plants made similar investments, and USAID-trained energy engineers had difficulty finding energy conservation jobs.

There is a clear need to help developing countries improve their energy efficiency. In this vein, USAID needs to carefully analyze prices, markets, institutional capacity, government controls, and the investment climate to determine whether new technology stands a chance of being replicated. USAID needs to better assess when conditions are favorable, and should not push energy investments in a counterproductive environment. Instead it should work on policy and institutional reforms that will help lay the groundwork for an effective energy program.

The Agency has learned it is hard to promote lasting energy efficiency when

- *Government policies*, particularly energy price policies, discourage energy conservation
- The *investment and business climate* is depressed, and financing is not available
- The *technology* introduced is too sophisticated to yield rapid benefits
- *Energy education and awareness* are not actively promoted to business managers and the public
- *Institutions* are not available to bring together energy users, equipment suppliers, and energy engineers

Background

In the 1979 oil crisis, international crude-oil prices more than doubled, jumping from $15 a barrel to more than $30 a barrel. (Six years earlier oil was less than $4 a barrel.) Many experts expected prices to reach $50 a barrel within a few years.

The increases jolted the world, most of all developing countries. The industrial sector in most developing countries is small, but such countries usually turn out several products with good growth and export prospects. These include shoes, garments, and electronics as well as processed bulk commodities, agricultural products, and industrial parts and materials.

If several countries are producing the same product, the country that uses substantially more energy is at a disadvantage. On a per-unit-of-output basis, some developing countries use two to four times more energy than industrial countries. High energy use offsets other advantages of a developing country, such as abundant raw materials and low-cost labor. If energy use is very inefficient, the country's products cannot compete in the international marketplace. At the extreme, they cannot compete with imports in the home market.

With the oil shock of 1979, developing countries, rather than importing more oil, were faced with cutting oil imports in half, just to stay even. But there was another possibility: they could cut fuel costs by improving energy efficiency. In addition, by using fuel more efficiently, they would create less pollution.

To support energy conservation, the Agency for International Development, over the 10 years following the oil crisis, launched some 20 energy conservation projects. Individual projects were relatively small, generally providing $1–3 million a year over three to five years.

All projects followed a similar approach. They used education-and-awareness campaigns to spur interest in energy conservation. They funded energy audits at factories to identify areas where savings were possible. They trained local energy conservation engineers and installed equipment at demonstration sites. And they supported local energy conservation institutions and worked to improve energy policies.

Factors Affecting Program Performance

Five major factors have affected the relative success of USAID energy conservation projects:

Energy Policy

Taxes, subsidies, and other energy *price policies* provide the market signals that determine how much fuel a factory uses and the type of production process it will invest in. When energy prices are "cheap," there is little interest in energy conservation, and conservation projects have limited success.

Countries have reasons for a cheap-energy policy. Most developing-country governments decided their countries could modernize through increased mechanization, as the United States and Western Europe had done decades earlier. These governments used cheap energy as a major policy tool to encourage investment in machinery.

In all the case studies, governments tried to keep energy prices low. When international prices increased, the governments provided subsidies. Even when international oil prices quadrupled (in 1973), and then doubled (in 1979), governments provided massive subsidies in an attempt to keep domestic energy prices "reasonable." Such subsidies, though, were unsustainable on a protracted basis. Eventually, most governments threw in the towel, allowing energy prices to rise to world levels.

Closely related to energy price policy is *privatization policy*. The evaluations found most state-owned firms have little interest in energy conservation. Once privatized, though, attitudes change. When owners have capital at risk, they are concerned about costs and view energy conservation as an important way to save money.

In almost every case energy providers (oil, gas, and electrical power companies) were state owned. A state-owned national electrical power company has a monopoly. It does not worry about costs or service quality. It has easy access to foreign exchange and government-guaranteed loans. This access and its monopoly position was, in effect, a large subsidy. Little incentive existed to keep prices down or to provide good service.

Beginning in the late 1980s, governments in many countries took steps to privatize these companies and state-owned factories as well. State-owned factories always had important political responsibilities. In addition to producing output, they were charged with such nonmarket objectives as keeping sales prices low and maximizing employment. Energy conservation was rarely a concern. Now with privatization, new factory owners are interested in something different—making a profit. This means keeping costs down, and energy can be a significant cost.

Investment and Business Climate

Energy conservation measures are, first and foremost, business investments. The type and level of investments a firm is willing to make depend on the investment and business climate. Inflation, interest rates, capital availability, growth prospects—all factor in to this consideration. An energy conservation program may be effective at reaching clients, and the technology may be sound, but if business managers are unwilling to invest, nothing is gained.

And businessmen are a cautious lot. A new government energy policy or new set of energy prices can be introduced quickly and change the investment incentives. But business attitudes develop over many years and change slowly. Even with the right policies in place, business managers may still take a wait-and-see attitude.

Political and economic uncertainty often permeates thinking in developing countries. In addition to normal commercial risks, business owners are unsure of future inflation rates, foreign exchange rates, and changes in government controls and regulations. When they make an investment, they seek a rate of return high enough to cover those uncertainties. They also prefer investments with a short payback period—say, six months.

Moreover, in most of the country cases, business managers expect a 20–40 percent rate of return on investments. If an investment in energy conservation cannot achieve that rate, it will not be made.

Until political and economic uncertainty ends, business managers will be cautious and it will be difficult to promote energy conservation investments.

Technology

USAID projects generally emphasized ways to make existing equipment work more efficiently and promoted relatively simple energy-saving technologies. This approach reflected both the difficulty of introducing high-cost, complex equipment and the importance of achieving results quickly.

Some technologies were very simple: insulating steam boilers and pipes; replacing defective valves, pumps, and steam traps; and tuning up boilers and furnaces. Other technologies were only slightly more complicated: installing meters and gauges, using correctly sized motors, and installing more efficient burners.

Since technologies were usually simple and not revolutionary, equipment could be purchased locally or ordered from a company in the United States. It was almost always "off the shelf" equipment, available from a number of different manufacturers. Local engineers usually knew about the technology, having read about it in trade journals or seen it in operation.

In some cases, technologies were more complicated. In Jamaica, for instance, USAID promoted solar collectors—rooftop water tanks that use sunlight to heat water. But five years after the project was completed, all of the collectors had been abandoned. All in all, the most successful projects were those promoting low-cost technologies with a prompt payback.

Energy Education and Awareness

Before the USAID projects, spending money to save energy was a novel concept for most businesses. Energy was cheap, markets were protected, and governments were willing to subsidize many industries. In some cases the government and public interest groups had been urging citizens to save energy to help the nation, but such public service pleas were usually ignored. Before the USAID projects could start in earnest, an awareness and demand for energy conservation had to be marketed and sold.

> ***"Projects have been sustained where factory managers have realized their financial stake in energy conservation."***

Although the projects did conduct some general public education, most efforts targeted energy users and those who could change energy practices. Those entities included business managers and engineers, trade and professional associations, government officials, lenders, and equipment suppliers. Marketing and outreach were carried out through seminars, publications, technical conferences, and direct calls on potential user companies.

Seminars and pamphlets are helpful, but nothing sells the idea of energy conservation better than equipment operating in a local factory and actually saving fuel and lowering costs. All of the projects funded demonstrations at a range of business sites.

To identify the most promising sites, specialists completed surveys at government and private factories and buildings. Then U.S. and local energy engineers conducted energy audits at selected sites. (An energy audit is a technical analysis by an engineer of how a factory uses energy.)

In all of the country cases, seminars, workshops, and training quickly raised interest in energy conservation. Managers of factories, office buildings, hospitals, and hotels who had never thought of energy in the past now looked at their energy budget to see what could be cut.

The interest was not, however, long lived. As USAID projects came to an end, energy awareness began to lag. That was largely because of a failure to develop the markets, incentives, and institutional mechanisms that promote and sell energy conservation.

Institutional Capacity

Institutions are the glue that holds together and manages the various actors and inputs needed to promote and sustain energy conservation. With a single exception (Hungary) the Agency supported institutions to help implement project activities. The institutions had to convince business managers that energy conservation makes financial sense. Institutions attuned to the needs of the private sector and responsive to market forces were, the evaluators found, the most successful.

Each project took a slightly different approach to institutional development. In three cases (Jamaica, Pakistan, and the Philippines) USAID supported a government ministry or agency. In Guatemala the project helped a regional institute develop technical capacity for energy conservation and environmental management. The Agency's project in the Czech Republic zeroed in on a highly motivated—and competent—local nongovernmental organization.

As a whole, the public sector approaches were less encouraging than the Czech initiative. Public sector institutions could conduct general public awareness campaigns but had difficulty designing cost-effective education and training programs that met the needs of private firms. They showed little promise of being able to sustain themselves indefinitely after assistance ended. Government institutions, by their nature, are not well attuned to changing commercial markets, new technology and investment opportunities, and market-driven profit maximization. That is not to say the public sector has no role in energy management or conservation. Among the things it can legitimately undertake are energy regulation and public education and awareness. Most commercial areas, though, seem better left to the private sector.

Program Impact

The evaluators assessed the effect of energy conservation through three criteria: economic impact, environmental impact, and sustainability and replication. The teams found the projects to have significant economic benefits and measurable environmental gains as well. Less clear was the outlook for institutions supporting energy conservation. And the biggest stumbling block was the spread of conservation technology.

Economic Impact

One can look at costs and benefits in two ways: first, from the perspective of the entire country and, second, from the perspective of the individual firm. This study primarily concerns the net benefits to the economy (including pollution reduction), so we examine *economic rates of return*—a measure of the net economic benefits to the country. The flow of benefits occurs for a number of years, and that flow, less all costs incurred in their generation, yields the net annual benefit.

The economic rates of return for the six country case studies are shown in table 1. Most economists agree that the minimum rate of return should be no lower than 15 percent. (That is distinct from the *financial rate of return*—a company's gain—which in this case is expected to be higher.) In most country cases the rate was above the minimum, though possibly not in Jamaica. Hungary and the Czech Republic had excellent returns. The others were lower.

Also shown are the *payback periods*, an indication of the effect on individual companies.

Table 1. Economic Rates of Return And Average Payback Periods

Country	Economic Rate of Return (%)	Average Payback Period To Firms (in months)
Czech Republic	50	9.8
Guatemala	not available	not available
Hungary	165	2.4
Jamaica	2–33	not available
Pakistan	19–25	24.0
Philippines	20–63	22.0

Table 2. Estimated One-Time Costs and Annual Benefits Of Air Pollution Reduction as a Result of USAID Projects			
Country	Original Investment in Energy Equipment ($)	Value to Country Of Annual Pollution Benefit ($)	Months to Recover Investment
Czech Republic	93,000	104,000	11.0
Hungary	203,000	552,000	4.5
Philippines	2,400,000	2,000,000	14.0

Payback period is the number of months it takes a firm to recover its investment costs through increased profits. A quick payback is clearly desirable. Most developing-country business owners are reluctant to make long-term investments. They generally would like to recover their investment in a few months, though they might be willing to wait a year or two. From the perspective of the business manager, the Czech and Hungarian programs have a quick payback and are clear winners, the Pakistan and Philippines programs are strong, and data are not available for Guatemala or Jamaica.

Environmental Impact

Energy efficiency and positive environmental effects go hand in hand. When factories use less electricity or burn less coal, less pollution goes up the smokestack. USAID energy conservation projects helped reduce energy consumption, which in turn reduced air pollution and the production of greenhouse gases. By improving energy efficiency, the projects reduced environmental damage at no additional cost.

Table 2 shows reduced pollution resulting from USAID energy conservation equipment installed at factories in the Czech Republic, Hungary, and the Philippines (data were not available for the other countries). The table links pollution benefits to energy equipment costs.

The value to the country of reducing annual emissions needs to be compared with the one-time investment costs to the firm. The simplest relationship is the amount of time required for pollution benefits to cover the cost of energy-saving equipment. But this tells only part of the story, as the Philippines case illustrates. Although pollution savings in the Philippines cover costs in 14 months, the equipment has a life of 5 to 10 years. *Every 14 months* it generates benefits equal to investment costs. Over the life of the equipment, pollution benefits equal four to eight times investment costs—a good return indeed.

But in a sense equipment costs are not really an environmental cost. *Pollution benefits are almost a gift,* since energy conservation equipment was installed by factory managers as a way to save on their fuel bill. From the manager's perspective, the equipment pays for itself in fuel savings, and the country receives the bonus of reduced air pollution.

Sustainability and Replication

A successful foreign aid project transfers resources and provides tangible benefits. However, of greater interest is what happens *after* a project ends. Have project benefits been sustained? Have they been replicated beyond the original demonstration sites? And what factors affected sustainability and replication?

In most cases energy benefits were sustained at the original project sites, even after USAID assistance ended. In factories and buildings outside the projects, though, replication was limited. Table 3 summarizes sustainability and replicability in the case countries.

Projects have been sustained where factory managers have realized their financial stake in energy conservation. In Hungary, for example, where privatization created profit incentives, all investments were generating a high rate of

Table 3. Program Sustainability and Replication		
Country	**Sustainable**	**Replicated**
Czech Republic	yes	no
Guatemala	?	no
Hungary	yes	no
Jamaica	no	no
Pakistan	?	?
Philippines	yes	?

return, and in several cases the plants were expanding their energy conservation efforts. Moreover, all the energy managers trained by USAID were still in the energy business, and all had received follow-on energy contracts and related engineering jobs. In the Czech Republic and the Philippines, evaluators found firms using equipment effectively, even installing new equipment. That was principally because managers saw higher profits from adopting the technologies.

In Pakistan sustainability suffers, primarily because the budget limits dissemination of technical information. In Guatemala the regional technology institute lacks plans to reach a broad spectrum of energy users. In Jamaica few government or business leaders appear interested in energy conservation, and there is little incentive to continue using energy-conserving technologies.

In no country has widespread replication taken place. Hungary, the Czech Republic, and the Philippines lack the private sector institutions that generally spread conservation technologies. The regional institute in Guatemala targeted large energy users, limiting replication by a broad range of smaller users. Lack of incentives and of energy institutions limited the spread of technologies generally.

Lessons Learned

USAID energy conservation projects in the six study countries had varying degrees of success, which allows us to understand what approaches work better than others. Do low energy prices drive industrial growth? Has privatization had a salutary effect on energy conservation? Which is more important—educating people in the benefits of energy conservation, or developing appropriate policies and institutions? What factor can most effectively persuade managers to embrace energy conservation? The evaluation shed light on such questions.

1. Energy Policy Reform

When energy is cheap, little incentive exists to use it efficiently. As long as there are major energy subsidies, broad-based energy conservation is difficult. Low energy prices, particularly for industry, appeal to politicians as a good way to spur industrial growth. However, in almost every case cheap energy had the opposite effect. It encouraged energy-intensive industries that were not internationally competitive.

Privatization affects how firms approach energy conservation. Managers at factories that are still state owned continue to emphasize production, not costs, and show little interest in energy conservation. Privatization brings in new capital, new management, and an interest in energy conservation. At private firms, managers are concerned about costs and see energy conservation as a key investment.

2. Economic and Business Climate

Higher energy prices and other incentives are needed to create a market for energy-efficient equipment. Without adequate incentives, it is difficult to find capital to fund energy-saving investments.

An uncertain economic climate will deter most investments, including those in energy conservation. There is a general reluctance to invest in an unpredictable economic climate. In most of the countries, firms tend to concentrate on short-term needs such as increasing production, not on investments in energy efficiency that generate longer term cost savings. Business managers want investments that have a high rate of return and a relatively quick payback.

3. Technology Transfer

Insofar as USAID projects succeeded, they did so by promoting relatively simple energy-saving technology and emphasizing ways to make existing equipment work more efficiently. Technologies were simple, not revolutionary, and almost always based on standard "off the shelf" equipment available from a number of different manufacturers. More sophisticated technologies had less salutary results.

4. Energy Education And Awareness

Good energy conservation technology is not enough; effective and continual dissemination also is needed. As long as USAID projects were being implemented and energy seminars and promotional activities were in full swing, engineers were interested in energy conservation. Once projects ended and promotional activities wound down, awareness and interest dropped off sharply. Lack of successful dissemination may be a design weakness in USAID energy projects. When USAID designs a project it should also develop a longer term (postproject) dissemination strategy that relies mainly on the private sector.

Education and awareness campaigns cannot overcome bad energy policies and weak institutions. Promotional activities are important in getting the process started, but success depends on having in place incentives, financing, supporting institutions, realistic energy prices, and cost-conscious factory owners who have a stake in making a profit.

5. Institutional Capacity

Development of market-driven institutions is critical to project success. To make energy conservation work, institutions have to be entrepreneurial and responsive to market needs. The performance of government agencies was disappointing. USAID should look for alternatives such as nongovernmental organizations or the private sector.

6. Economic and Financial Impact

The projects demonstrated that modest energy conservation investments provide countries a fair to excellent economic rate of return. They also rewarded individual companies with good financial returns.

Energy conservation investments require a rapid payback. In countries with a history of cheap energy, limited capital markets, and an uncertain economic environment, business managers are reluctant to risk long-term investments on any new technology. Managers will invest in energy-saving measures that pay for themselves in a few months or a year, but not investments with a two- to five-year payback.

7. Environmental Impact

Pollution benefits can be considered a gift, since managers install energy conservation equipment as a way to save on their fuel bills. From the manager's perspective, the equipment pays for itself in fuel savings, and the country receives the bonus of reduced air pollution for free. This is one of the most powerful justifications for energy efficiency.

8. Sustainability and Replication

Demonstration projects will not be replicated unless energy-saving technologies have broad application, are cost-effective, and are widely disseminated and marketed. In none of the case countries has there been an appreciable spread of information, technology, or equipment to other sites.

This Evaluation Highlights, *by Ross Bankson of Conwal, Inc., summarizes the findings of the study* Shining the Light on Energy Conservation: A Synthesis of Findings From Six Evaluations, *by Joseph Lieberson of USAID's Center for Development Information and Evaluation, USAID Program and Operations Assessment Report No. 19. This report and the individual country impact evaluations can be ordered from the Development Information Services Clearinghouse, 1611 North Kent St., Suite 200, Arlington, VA 22209–2111; telephone (703) 351–4006; fax (703) 351–4039; Internet docorder@disc.mhs.compuserve.com. They are also available electronically, without charts and graphs, from the Internet, at gopher.info.usaid.gov. Look under Documents and Publications, then under USAID Newsletters. Editorial and production services provided by Conwal, Inc.*