Promoting Energy Efficiency in Asia: A Compendium of Asian Success Stories

Ted Flanigan, IRT Environment/The Results Center
Peter Rumsey, International Institute for Energy Conservation, Bangkok

Energy efficiency is a topic of vital importance to Asia. The largest of the continents, Asia is home to half the world's population. Urbanization, the rise of manufacturing, dramatic electrification, and the emergence of a new middle class thirsty for the amenities enjoyed by developed countries are driving an explosive increase in energy consumption in many parts of Asia.

IRT Environment and the Bangkok office of The International Institute for Energy Conservation recently undertook an extensive review of past experiences with promoting energy efficiency in Asia. The designs, impacts, and key lessons from 15 initiatives were closely examined, including programs implemented in China, India, Indonesia, Japan, Malaysia, Pakistan, the Philippines, Singapore, South Korea, and Thailand.

This paper, a synopsis of the full 50-page report available from both IIEC and The Results Center, highlights several notable Asian energy efficiency success stories in six primary categories: 1) Energy conservation centers; 2) Technical assistance and audit programs; 3) Standards and labeling program; 4) Commercial building codes; 5) Industrial energy-use regulations; and 6) Utility-driven market transformation initiatives.

The programs reported in this paper have a dual role. First and foremost, their combined success serves as a powerful tool within the region for further efficiency efforts. Future success will depend on creating programs that are suited to Asian markets and cultures and that build on past experiences. Second, Asian initiatives tend to be overlooked by Western energy experts working within Asia as well as North America and Europe. This is largely due to a lack of information on Asian programs. But in the last 20 years following the oil shocks of the 1970s, Asia has undertaken many exciting and truly innovative energy efficiency programs well worthy of international examination if not acclaim.

INTRODUCTION

This compendium of Asian success stories is intended to highlight some of the most exemplary energy efficiency case studies from Asia, to acknowledge their import as early examples of what can be done in the region, to celebrate their successes and lessons learned, and to catalyze similar efforts throughout Asia.

Too often energy efficiency programs from North America and Europe are presented to Asian countries as examples of the potential in Asian countries for similar efforts. While these programs are often well worthy of examination, Asians rightfully note that Asia is different and that programs cannot simply be transferred from developed countries in the West to developing countries in the East. By focusing on Asia, this report bridges the current information gap and serves a useful tool in planning a viable and least-cost energy future for Asia.

Noticeably absent from the roster of case studies presented in this report are the wide range of utility-driven incentive programs that characterize ''conventional DSM'' from North America. Most Asian utilities have not been involved with promoting energy efficiency through incentives such as consumer rebates. Instead, energy efficiency has been largely driven by government initiatives. Now as integrated resource planning practices are becoming institutionalized Asian utilities are finding new roles in the promotion of customer energy efficiency and are finding it in their financial interests to do so.

THE ASIAN ENERGY CONTEXT

Asia provides a fascinating if not daunting challenge for energy efficiency. Throughout the region, industrialization, urbanization, and the emergence of a new middle class are driving increased energy consumption. The region is also characterized by rapid economic growth. Some Asian countries, notably China, use relatively large amounts of energy per unit of GDP, indicating a high level of energy inefficiency, for instance in outdated industrial facilities.

Asian energy demand is increasing at a rate almost twice as fast as the rest of the world. Much of the region is

dependent on imported fossil fuel, leading many countries to seek to develop ''alternative'' power sources. Growth in Asian electricity demand is especially high, with annual growth rates of 7–15%. And as electrification progresses in the less developed countries, demand will rise further still. In many countries like the Philippines demand for air conditioning is putting further pressure on electrification.

The need to meet the growing demand for energy in Asia presents a window of opportunity to incorporate efficiency in new appliances, facilities, and energy systems. In addition to stemming the demand for new power plants, energy efficiency can provide numerous benefits to Asian countries including reduced expenditures for imported fuels, improved air quality, heightened competitiveness of local industry, and increased social equity.

EXEMPLARY ENERGY EFFICIENCY PROGRAMS

The Philippines: Technology Transfer for Energy Management

While industrial energy audits and training sessions form the core of current Department of Energy (DOE) industrial initiatives in the Philippines, there is no question that a pinnacle of industrial energy assistance came towards the end of the past decade when DOE administered the Technology Transfer for Energy Management (TTEM) program. TTEM not only provided information and technical assistance for Filipino, foreign, and multinational industrial and commercial establishments, but backed these services with financing at below-market interest rates.

The centerpiece of the four-year TTEM program was the Demonstration Loan Fund which was established with $2.4 million to finance energy efficiency. The fund was intended to demonstrate efficiency technologies and practices not widely used in the Philippines. While all types of industrial and commercial establishments were eligible for the program, recipients of loans had to agree to share their experiences with other industries and to allow for tours of their facilities, thereby enabling their projects to serve as catalysts for similar efforts. The demonstration projects addressed two major constraints to implementation of energy efficiency in the Philippines: the lack of reliable information on efficient technologies and the reluctance on the part of management and financiers to provide funding for efficiency upgrades.

The Demonstration Loan Fund began in 1988 and within two and a half years had committed over 95% of its resources. Eligible projects could receive a maximum of $200,000 as long as the loan did not exceed 75% of the total project cost. Most recipients were large companies.

The U.S. Agency for International Development provided the initial seed money for the program to the Central Bank of the Philippines which in turn provided the money to nine regional banks that were accredited for the program, relieving the Central Bank of all collection responsibilities. Moreover, by using its institutionalized credit/debit relationships with the accredited banks the Central Bank was assured of collecting 100% of the funds that it provided. By the end of 1995, all 16 of the program's outstanding loans were repaid. The program has experienced no defaults and all the money has been paid back with interest to government's Bureau of Treasury where it was earmarked for subsequent projects.

One of the most important features of the program was its focus on building institutional capabilities in the Philippines. Within the DOE, staff received technical training domestically and abroad and a library was created to track efficient technologies. A pool of foreign and domestic experts was assembled to assist with the technical aspects of the projects. Monitoring instruments were purchased, many of which are still being used for other programs. Nearly 1,100 participants attended 25 seminars to familiarize energy users and the financial sector with energy efficiency opportunities. Ten trainees traveled to the United States for intensive training programs. Brochures and a newsletter were produced to promote the program and energy efficiency, as was an audiovisual presentation.

The TTEM program provided free technical assistance to over 120 companies, including 25 audits, 8 feasibility studies, 16 technical research efforts, and 40 consultancy services. From these activities, TTEM was able to identify about 100 potential projects; thirty demonstrations were carried out, with 16 of these funded using the program's financial assistance component. Many of the remaining projects identified were financed internally by the companies involved, an example of how the program was able to leverage greater savings.

The Demonstration Loan Fund was a pronounced success, providing capital to 16 projects with an average payback of 2.5 years and an average internal rate of return of 40.7%. On an aggregate basis, the 16 projects funded resulted in annual energy savings equivalent to 78,000 barrels of fuel oil worth $2.5 million annually. Though all savings were all converted to barrels of oil equivalent, actual savings were: wood and bagasse (24,000 megatonnes); coal (3,750 megatonnes); diesel (427,300 liters); grade C bunker oil (1,872,000 liters); LPG (310,250 kg); and electricity (10,055 MWh). Electricity demand was also reduced by 2.0 MW and 1.3 MW of cogeneration capacity was created.

The success of the pilot program has encouraged DOE to establish and institutionalize a similar program. To date, however, the program remains unfunded despite repeated requests to the Department of Budget Management to appropriate the ''dedicated'' funds for the program, underscoring an important difficulty with revolving loan mechanisms.

South Korea: Energy Efficiency Management System

For several years, South Korea has run one of Asia's most aggressive energy conservation programs. Since the mid-1970s there have been over one hundred separate conservation initiatives across all energy end-use sectors in the country.

The ''Energy Efficiency Management System in South Korea—Standards and Labeling'' program was started in 1992. The energy efficiency regulations implemented by KEMCO, a public agency, can be grouped into three components: Efficiency Standards, the Commercial Efficiency Labeling program, and the Efficiency Rating Labeling program for consumer goods. Together, the elements create both a ''market push'' and a ''market pull'' for efficiency. The standards generate a push, requiring manufacturers to produce products that adhere to minimum efficiency levels. The labeling generates a pull, educating consumers on the economic benefits of efficient equipment so that they will demand these products from manufacturers.

The Efficiency Standards Program establishes efficiency levels for electric refrigerators, air conditioners, lighting equipment (incandescents, fluorescents, and ballasts), and passenger cars. The government introduced these levels in two phases beginning with a ''minimum efficiency level'' that improved the efficiency of program products by up to 7% followed by a ''target efficiency level'' aimed to reduce energy consumption by 10–30%.

The Commercial Efficiency Labeling Program requires that labels indicating energy efficiency be placed on many kinds of commercial equipment including steel boilers, cast iron boilers, oil heaters, hot water boilers, instantaneous water heaters, lighting equipment, and passenger cars. Importers of foreign products and domestic manufacturers are required to submit designated products for testing by authorized agencies, the results of which must be clearly indicated on the product label. Although the labels do not provide information on the relative energy efficiency of a particular product compared to others in its class, the information does allow consumers to compare products.

Efficiency Rating Labeling Program involves labeling consumer goods, specifically refrigerators, air conditioners, lighting equipment, and passenger cars. Under this scheme, all product models are given an efficiency rating on a scale from one to five, with the most efficient products receiving a rating of ''one.'' Similar to the commercial program component, all products' energy efficiency ratings must be mentioned in any and all product advertising.

KEMCO manages the energy efficiency rating and labeling. Eight different laboratories and research institutes provide testing services. Domestic manufacturers and importers of foreign products request that a cooperating laboratory test their products. Upon testing the product, the testing laboratory provides the manufacturer or importer with an official efficiency level which the manufacturer or importer then reports to KEMCO.

KEMCO conducts regular monitoring of efficiency claims. The agency is required to undertake random inspections of factory or marketplace samples up to three times a year. KEMCO verifies that all products covered by the law are labeled and that the labels accurately reflect the product's energy usage.

The South Korean program has achieved impressive results. Studies by KEMCO show that the energy efficiency for products covered has increased while the overall energy consumption for these products has decreased. KEMCO also found that sales of energy-efficient equipment rose in proportion to sales of standard equipment. In part, this reflects the success of the program in raising consumer awareness. As consumers have developed a preference for energy-efficient products, manufacturers have increased the efficiency of their products to capitalize on consumers' demand. This market push/market pull effect is the key reason that standards and labeling programs have been such powerful tools for promoting energy efficiency in Asia.

Energy Conservation Centers

Many Asian countries established energy conservation centers (ECCs) in response to growing concerns over energy use and particularly oil dependence in the 1970s and 1980s. The most notable of these centers is the Energy Conservation Center of Japan. Developing countries in Asia, with the assistance of foreign donors, have aimed to emulate the success of the Japanese center. Among the countries undertaking such efforts are China, India, Indonesia, Pakistan, South Korea, and Thailand. While none of the centers can be regarded as an unqualified success, each center has had elements of success that collectively warrant a discussion of energy centers as potentially powerful energy efficiency strategies. This program summary reviews ECCs in China, Indonesia, Japan, Pakistan, and Thailand.

The ECC is the most common type of energy program in Asia, excluding government information campaigns, thanks

to the relative ease and low cost of establishing such centers. ECCs can also be established as semi-autonomous entities overseeing several types of conservation activities. ECCs typically carry out several basic functions: educating the public about the benefits of energy conservation; conducting energy audits or feasibility studies for large businesses; and training professionals such as engineers and plant managers whose work has a direct impact on energy use. As a single unit and tangible center, ECC activities are easy to track and assess, making them convenient recipients of foreign donor support. And from the customer perspective, ECCs can provide convenient one-stop shopping for energy efficiency services.

The Beijing Energy Efficiency Center. The Beijing Energy Efficiency Center (BECon) was established in 1993 through a cooperative agreement between the Energy Research Institute of the Chinese State Planning Commission, the U.S. Pacific Northwest Laboratory, and the Lawrence Berkeley Laboratory of the U.S. Department of Energy. BECon has a staff of eight professionals who work to promote energy efficiency through four program activities: 1) policy research; 2) business development; 3) training; and 4) information dissemination. Most recently, BECon developed an integrated resource plan for Shenzhen City. BECon's policy program also addresses transportation policy and has conducted extensive research on the Beijing area. The second activity area, business development, is BECon's most innovative and unique element. It includes market research for private companies, consulting services, technology demonstrations, and project financing. These are intended to be income-generating activities for the Center, an important part of BECon's goal for financial sustainability.

Indonesia: P.T. Konservasi Energi Abadi. P.T. Konservasi Energi Abadi (the Indonesian Industrial Energy Conservation Corporation or KONEBA) was established as a quasi-private industrial energy conservation corporation in 1984. In an unusual arrangement, KONEBA was established by Indonesia's largest government-owned fertilizer company, PURSI, and was intended to be a profit-making venture. The Center intended to generate income to pay back a $4.5 million loan from The World Bank. Thus KONEBA's first activities focused profit-making energy services for large industrial customers including facility energy audits, engineering design, and in a few cases, financing complete with shared-savings arrangements.

The Center's original mission came to an abrupt end in 1991 because KONEBA was far from generating sufficient income to cover its loan repayment installments. As a result, one year before the end of the loan period, the Indonesian government assumed control of KONEBA and its debt obligations. Failing its original mission, KONEBA was radically transformed and internalized within the Indonesian government. It is now a department of the national Ministry of Mines and Energy and primarily focuses on serving facilities owned and operated by the Ministry. Recent projects include power plant efficiency improvements, analyses of efficiency potentials of state-owned refineries, and retrofits of the district offices of Indonesia's generation utility.

The Energy Conservation Center, Japan. The Energy Conservation Center, Japan (ECCJ) was established in 1978 with the authorization of the Ministry of International Trade and Industry (MITI) and is one of the oldest and most respected energy centers in Asia. Energy conservation in Japan, however, far predates the Center. Shortly after the Second World War, a series of ''Heat Management Regulations'' were enacted in Japan to encourage industry to reduce manufacturing costs. Then energy efficiency came to the electric power sector in 1963 when the National Coordination Committee for the Rational Use of Electricity was established. Within this energy-conscious environment, ECCJ enforces and supports Japan's energy conservation regulations and provides services such as energy manager training and certification as well as public information dissemination.

ECCJ has eight regional offices and Tokyo headquarters. It employs over 80 people and is a integral and respected part of Japan's energy conservation effort. The Center offers a comprehensive package of energy conservation services with the exception of financing assistance which is available through various government-controlled loan facilities established as part of the national energy conservation policy. ECCJ's finances are very stable. In FY 1994, the Center's budget was 3.0 billion yen (roughly 30 million US$), with 73% of the funds generated from services provided to customers.

The National Energy Conservation Center of Pakistan. The National Energy Conservation Center of Pakistan (ENERCON) was established as an independent office under the Ministry of Water and Power in 1986. Funding for the Center came from a $9.1 million start-up grant from U.S. Agency for International Development (USAID). The grant enabled a large team of experts from the U.S. to work hand-in-hand with ENERCON staff over a four-and-a-half-year period from 1986 to 1990. In 1990 the Government of Pakistan took over funding for ENERCON.

Thanks to USAID support ENERCON offered a full set of energy conservation services including industrial energy audits; boiler and furnace tune-ups; commercial building energy analysis, computer modeling, and retrofit assistance; detailed weather data for the three primary cities in Pakistan; agricultural well efficiency measurements, audits, and retrofits; tractor efficiency measurements and recommendations; auto tune-up demonstrations; and an outreach and information campaign. In addition to these services, ENERCON

provided critical support to the development of commercial building energy codes in Pakistan.

At the height of its activities ENERCON employed over 120 staff; today it operates with about 100 employees who continue to carry out projects such as boiler tune-ups and energy audits. These activities, however, are not yet financially self-sustaining. ENERCON continues to be dependent on donor and government funding to sustain its activities. Staff hope to receive additional World Bank funding for power plant and transmission efficiency improvements as well as energy efficiency services for Pakistan's largest industries.

The Energy Conservation Center of Thailand. The Energy Conservation Center of Thailand (ECCT) was established in 1988 and was modeled after the Energy Conservation Center, Japan. It was created as a joint project of the Thai government and the Federation of Thai Industries (FTI). After an initial Thai government grant of $3.2 million, by 1993 ECCT had achieved financial self-sufficiency and in 1995 the center was expected to show its first operating profit. Today ECCT has a forty-person staff that includes 20 professionals.

All of ECCT's services are income-generating. They fall into four categories: 1) Assistance to the government Department of Energy Development and Promotion (DEDP) with energy audit training, industrial efficiency feasibility studies, and industrial energy audits. 2) Fee for Services to industry and commercial buildings including boiler tuning, load management, air compressor maintenance, detailed feasibility study preparation of efficiency improvements or cogeneration systems. 3) Contracts with foreign organizations for projects in Thailand and region. 4) Independently organized training courses for the private sector.

One of ECCT's largest hurdles has been the requirement that it follow government regulations due to its initial government funding. This has made it difficult to enter into contracts with private businesses as well as to pay salaries competitive with private industry. In Thailand government-mandated pay scales are several-fold lower than private sector salaries.

There is little data on energy savings achieved by energy conservation centers. Studies tend to measure centers' impacts in terms of participants, audits and projects completed and the number persons trained. Little information exists on the number of kilowatt-hours or tonnes of oil equivalent saved as a result of energy center projects. This is true for energy centers in the United States and Europe as well. Energy centers are inherently short on quantifiable savings while strong on qualitative impacts.

A summary of the Energy Conservation Center, Japan's activities for 1994 provides an indication of the program's impacts. In that year alone 300,000 pieces of informational materials were published; 78,000 people visited the annual energy conservation exhibition; 3,000 energy managers attended ECCJ training courses; 200 energy audits were conducted; and 4,400 people took the energy management examination.

China's BECon Center was founded in 1993 and thus its energy savings impacts have yet to be realized. Since its inception, however, BECon has held a workshop for over 100 appliance standards experts, conducted several market research and energy policy studies, and produced a report on energy-saving technologies. KONEBA's impact is even harder to ascertain though there are records of 35 industrial energy audits completed from 1984 to 1989.

In Pakistan, the impacts of the USAID-sponsored component of the ENERCON program are well documented. Not only is there information on the number of audits, retrofits, and training, but efforts were made to quantify the impact on consumer energy bills. During the USAID sponsorship, the Center's accomplishments included reducing customer energy bills by $5.45 million/year; 248 energy audits, including one-sixth of all industrial plants in the country; retrofitting 115 tubewells in the agricultural sector, creating average savings of 15 percent; 600 boiler and furnace tune-ups; training 3,500 engineers in workshops; and training 4,000 women in half-day seminars.

Since its inception in 1988, the Thai energy center has kept track of its accomplishments. So far it has completed 400 industrial audits and 100 commercial building audits. It has tuned 200 boilers; 15 factories have taken advantage of an ongoing annual service for electrical load management and compressor maintenance. ECCT has also conducted 12 trainings per year and helped establish an Energy Managers Club. Nevertheless, like the other Centers there are few data on the actual amount of energy saved from ECCT's activities.

ASEAN Commercial Building Codes

The seven Association of Southeast Asian (ASEAN) countries of Brunei, Indonesia, Malaysia, the Philippines, Thailand, Singapore, and recently admitted, Vietnam are home to over 350 million people and comprise one of the fastest growing economic regions in the world. With this prosperity has come explosive growth in energy use. While ASEAN has not taken a prominent role in promoting energy efficiency it did get a chance to get involved through a joint building energy codes project. This project was carried out in the 1980s with assistance from USAID and experts from Lawrence Berkeley National Laboratory.

The building codes were developed to regulate, in commercial buildings, the building ''envelope'' (also known as the shell or exterior), the lighting system, and the cooling equipment. The code used the Overall Thermal Transmittance Value (OTTV) system similar to the early iterations of California's Title 24. OTTV is a simplified performance-based standard that offers flexibility to designers. In addition to the envelope guidelines, most versions of the ASEAN codes include requirements for maximum light intensity and equipment efficiencies.

Due to the lack of familiarity with building energy codes in the region, the ASEAN codes were designed to be relatively simple.

Singapore. Singapore first implemented its code in 1979 for both new and existing commercial buildings. New buildings are required to comply with the energy code prior to the issuance of a building permit. Existing buildings were given two years to reach compliance. In order to ensure rapid implementation of the code, Singapore has used a ''carrot and stick'' approach, offering an incentive for complying with the code and penalizing non-compliant buildings. The government used building permits as an effective stick for dealing with new construction.

Forcing compliance of existing building was more difficult. As an incentive to owners of existing buildings, the Singapore government allowed 40% of the total retrofit cost to be claimed as a tax deduction followed by an ''accelerated depreciation allowance'' permitting companies to depreciate the equipment over a three-year period to gain additional tax benefits.

To penalize the owners of existing buildings that failed to meet the code, after a two-year grace period the government assessed a 20% surcharge on the building's electricity bill. As hoped, most buildings were upgraded by 1981, two years after the code's enactment. The surcharge was imposed on 52 buildings and by January 1984 all but nine had met the requirement and at that time the surcharge was raised to 50%. This was sufficient encouragement and all buildings were upgraded by 1987.

Indonesia. Indonesia initially introduced its building energy code in 1990 in the form of guidelines which were essentially voluntary. In 1992, several government ministries held a conference to discuss improvements to the code. One year later an updated code was published. Today, compliance with the code remains voluntary and there are no definite plans to make it mandatory. It is believed that the code is relatively unknown in the private-sector building-design community and that no privately owned buildings have purposely been built to meet the code. Even government buildings do not meet the code though the Public Works Department has attempted to design its buildings to meet the code when possible. The cost of education and enforcement is a major reason for the government's hesitation to implement a mandatory code.

Malaysia. Malaysia launched a ''guideline'' (i.e. voluntary) building energy code in 1989. In an effort to improve upon the 1979 Singapore regulations, the Malaysian OTTV incorporates chiller load into the formula. As of this writing, the Malaysian Standards Institution is developing mandatory Building Energy Standards based on the guidelines which are expected to be implemented sometime after 1997. Nevertheless, some engineers and government departments are reportedly already using the code and it is believed that the code has helped eliminate some of the most inefficient building energy use in Malaysia.

The Philippines. The first mandatory commercial building code in the Philippines came into effect in late 1994, but by the mid-1995 the code had yet to be fully implemented. Education of building code inspectors and building design professionals did not begin until late 1994. Most people believe that implementation of the code will not begin until 1996. The code's success will depend on how well government inspectors have been educated and on the rigor with which penalties are imposed on building owners who refuse to comply. As of August 1995, penalties have not been specified in the code literature.

Thailand. Thailand has finalized its building energy code and submitted it for ministerial approval in mid-1995. The code is part of a larger energy conservation act passed in 1992 that includes a provision for energy conservation in industrial and commercial facilities and also calls for the creation of an energy conservation fund to be used to help finance energy conservation projects.

The Thai Department of Energy Development and Promotion introduced the code on a voluntary basis as a guideline in 1994, well before it was mandatory. The ''introduction'' included press coverage and seminars for building professionals. Unlike the Philippines' code, which became mandatory before it was well known, Thailand has educated and prepared the public for the new codes.

The commercial building code will apply to both new and existing buildings with an actual or expected peak electricity demand greater than 1,000 kilowatts. Existing buildings will be given three years to comply with the code and improve the building shell performance to a level of 55 watts per square meter. All new buildings will be required to have a shell performance of 45 watts per square meter or less. The code also includes provisions for lighting and cooling systems. Beginning after 1999, non-compliance will be penalized by a surcharge on electricity bills.

Since Indonesia, Malaysia, the Philippines, and Thailand have yet to enact or have only recently enacted their codes, few energy savings have been realized in these four countries. Meanwhile, no analysis of the energy savings created by Singapore's code has been conducted. The original ASEAN-USAID estimate contends that the codes would lower energy consumption by 19–24% over typical ASEAN buildings. The report also stated that tighter codes, designed to encourage all cost-effective conservation measures, could result in savings of as much as 50%.

Electrical Generating Authority of Thailand Fluorescent Lamp Campaign

The Electricity Generating Authority of Thailand (EGAT) is a nationally owned corporation responsible for generating power for the entire country. Rapid growth in electricity demand in the country has given demand-side management a new sense of urgency and importance in Thailand. EGAT leads this charge and has programs or planned activities for a range of technologies including fluorescent lamps, ballasts, air conditioners, refrigerators, thermal energy storage, and industrial motors. EGAT's ''pilot'' DSM program started in 1993 and will last for five years. The utility has dedicated $188 million (85% funded by EGAT/15% funded by The World Bank) to DSM, a budget that is among the largest among Asian nations.

EGAT's first focus has been fluorescent lamps, 36-watt four-foot tubes in particular. The 36-watt lamps produce as much light output as their 40-watt counterparts by using a thinner-diameter tube. The T8 lamps can replace T12s without changing the ballast. Furthermore, they cost the same or less than their T12 counterparts as their smaller size requires less materials during production.

EGAT began the Fluorescent Lamp Campaign in 1993. At that time the 36-watt lamps held a 35% market share but a perception persisted that the lamps were unreliable and that a thinner tubed lamp would emit less light. Thus after a series of negotiations, in September of 1993 a Memorandum of Understanding was signed between EGAT management, Thai government officials, and fluorescent lamp manufacturers. The Thai Prime Minister, the Chairman of EGAT, and presidents of each of the five manufacturing firms were signatories to the compact. The manufacturers agreed to completely change over their production within two years. EGAT, in turn, agreed to undertake a 220 million baht ($8.8 million) advertising and awareness building campaign over a two-year period. By September 1995, only 36-watt lamps will be manufactured in Thailand although manufacturers will, of course, be welcome to produce even more efficient lamps such as 32-watt tristimulus phosphor lamps.

EGAT has supplemented its broad-based television and radio promotion effort with demonstrations and campaigns in each of the country's 26 provinces. Around the country, sixteen city halls and 45 schools have been retrofitted with the lamps. Lectures and seminars on the new lamps have reinforced the value of these demonstrations, while marches with schoolchildren have raised awareness of the program and its national importance. Through this campaign, EGAT is setting the stage for subsequent energy efficiency initiatives, building on its early success.

The Fluorescent Lamp Campaign is in mid-stream but its success in accelerating the adoption of more efficient fluorescent tubes is already apparent. While Philips had retooled to produce the lamps prior to the program, Toshiba (which also commands a 35 percent market share) terminated production of 40-watt lamps ten months in advance of the program's cut-off date because of the market acceptance that the program had created. As of this writing, three other domestic manufacturers are also producing 36-watt lamps, with current production split between the two varieties. In approximately eighteen months, the market share for the T8 lamps has increased to nearly 90 percent.

A national survey commissioned by EGAT was very encouraging. Ninety-seven percent of the 3,000 people surveyed were aware of the ''thin tube'' technology, and 90 percent said they would purchase the lamps the next time they needed a four-foot lamp. Only five percent were hesitant, commenting that they would purchase the T8 lamp depending on its price. Of course, the T8 lamps are no more expensive than the T12 lamps. Another indicator of the program's success is that manufacturers are using the energy efficiency aspect of their products as a marketing tool. In their advertisements, Philips, Toshiba, and Osram all claim their lamps to be energy-efficient, a testament to the program's success in raising awareness of the value of energy-saving lamps.

When all lamps in Thai society are replaced, however, the program's effect will be huge. Since lighting accounts for roughly 25% of electricity use in Thailand, and most lighting is fluorescent, the program has the potential to save roughly 2% of national electricity use. EGAT officials suggest that when national power demand grows from the current 11,000 MW to 15,000 MW in the next four years, 300 MW will be saved through the program at a fraction of the cost of additional capacity.

Chinese Industrial Energy Efficiency Regulations

Asia's most populous nation, China, is also the continent's largest energy user. Furthermore, the country uses more energy per unit of gross domestic product than any other Asian nation. In an attempt to reduce this inordinate demand

for energy, during the 1980s China developed a comprehensive set of policy directives, procedures, regulations, technical assistance programs, and project financing initiatives to promote energy efficiency. In addition, an extensive network of energy conservation offices was established throughout the country.

While elements of China's comprehensive efficiency program have succeeded, there are certainly aspects of the program that would be difficult, if not impossible, to reproduce in a market-oriented economy. In particular, the electricity quota aspect of China's energy conservation program would be impractical in other countries. Nevertheless, the quota system (in which electricity use beyond a user's prescribed allotment is priced substantially higher) could be transformed to market-based energy pricing systems such as time-of-use tariffs. Regardless of the transferability of the components of China's conservation efforts, China's programs have been by far Asia's most successful in achieving actual energy savings, both in gross amount and in percentage savings.

The Chinese government's energy conservation program focuses on improving industrial energy efficiency. The program includes major policy directives, procedures, regulations, technical assistance programs, and project financing initiatives. When compared to other the efforts undertaken by other developing countries in Asia, China's program is notable for its comprehensive network of energy conservation centers, its monitoring and tracking of energy use, and its promotion of energy awareness.

The Chinese government develops detailed targets, guidelines, and standards on industrial energy consumption and energy conservation. The primary responsibility for the implementation of the program lies with local government institutions. Provincial governments oversee energy conservation efforts with a network of energy conservation offices at the prefecture and county level. A total of 200 energy conservation service centers are reported to be operating nationwide. Individual industrial enterprises are required to report back to the government on their energy use and efficiency improvements.

Each enterprise is given an energy use quota. In order to encourage enterprises to remain within their quota, prices for energy use above the given quota are substantially higher than prices up to the quota. In some cases, the cost of ''out-of-plan'' energy can be double that of ''in-plan'' energy. This system is China's favored method for pushing enterprises to aggressively pursue energy savings. In addition to penalizing above quota energy use, the Chinese government also provides a reward to enterprises which successfully undertake energy efficiency measures. Energy conservation efforts are a key criterion selecting winners of enterprise performance awards.

Standards for energy consumption per unit of production have been established in several industries. Local government energy offices monitor compliance through a detailed reporting system and occasional field tests. Some enterprises set standards for individual machines or production lines and then base worker bonuses on their ability to achieve the standards.

In addition, energy standards have been developed for several electricity-using appliances. While most of the standards are mandatory, some are used as guidelines. Compliance is strengthened by the publication of lists of banned as well as energy-saving appliances. The standards cover residential appliances as well as machine tools and other industrial equipment. Power transformers are also covered by the regulations.

Investment funds for energy efficiency improvements have been established both by the national government and by local governments. The funds are provided to enterprises as loans at subsidized interest rates. The primary criterion in reviewing loan applications is the investment cost per unit of energy savings. In some states, regulations require that a minimum of 20% of depreciation funds should be invested in energy conservation projects. Funds also are available through commercial banks and from the enterprises themselves. The total investment in energy conservation between 1980 and 1991 was about 27 billion yuan, approximately $5.7 billion.

An extensive network of energy conservation service centers has been established throughout the country to help enterprises in their energy conservation efforts. The network includes seven comprehensive training and technical assistance facilities. In addition, every province has local centers as well as local testing and measurement stations.

There is unfortunately little data on the program. The World Bank reports that the Chinese economy experienced a 20% reduction in energy intensity from 1980 to 1990. This translates into a savings of roughly 300 million tons of coal equivalent. Since 35–45% of the reduction is attributable to technical improvements, efficiency measures likely saved 100–140 million tons of coal equivalent. Since the total national energy consumption in China in 1989 was roughly 1,000 million tons of coal equivalent, energy efficiency resulted in savings of 10–14% of national energy consumption.

The Philippines Residential ''AirCon'' Standards and Labeling Program

One of the greatest accomplishments of the Philippines Department of Energy (DOE) with energy efficiency is the Residential Air Conditioner (AirCon) Standards and Label-

ing program. After years of coordination with manufacturers and the Department of Trade and Industry's Bureau of Product Standards, DOE launched the program in early 1994. The program has the potential to become a powerful platform for subsequent energy efficiency efforts not only in the Philippines but also in other Asian countries.

The Energy Efficiency Ratio (EER), a measure of the efficiency of an air conditioner based on output cooling capacity and energy consumption, is a critical feature of the program. The minimum standards established through the program set a floor EER for all aircon systems. The EER also serves a key labeling function. Prominently displayed on a certified yellow card on every residential air conditioner sold, the EER can be a means for manufacturers to promote their high efficiency units. In the competitive Philippine aircon market, the EER can be a powerful advertising tool.

The Philippines AirCon program is administered by two government agencies, the Department of Energy and the Department of Trade and Industry. DOE administers the program and runs the Fuels and Appliances Testing Laboratory, an independent testing laboratory to verify manufacturers' assertions of the efficiency of their units. The Department of Trade and Industry's Bureau of Product Standards is responsible for enforcing the standard. Initially covering only domestically produced units, the program was modified recently to cover imported air conditioners as well.

In 1995 there were over 95,000 window and ''split'' air conditioners sold annually in the Philippines. All of these units must comply with the standards and labeling program. FATL analysts suggest that prior to the initiation of the program, only half of the annual sales volume for small-sized, window-type air conditioners met the standard, while none of the larger units did. By forcing these units off the market, the program had an immediate and pronounced effect in the overall efficiency of air conditioners sold in the Philippines. When the standards are made more stringent in 1996, the least efficient units will once again be eliminated.

The program can also promote efficiency improvements among units already complying with the minimum standard. As the program's labeling component increases consumer awareness—and a recent campaign has played an important role in raising the awareness of both consumers and distributors—manufacturers will have an additional incentive to market efficient units. Energy-conscious consumers will, in effect, drive manufacturers to produce the equipment with the highest levels of energy efficiency that can be cost-effectively achieved. FATL analysis indicates that due to the ''push'' of standards and the ''pull'' of labeling, the Philippines aircon program has resulted in efficiency gains across all aircon units on the order of 25%.

Preliminary estimates suggest that the program resulted in first-year capacity savings of roughly 6 MW of capacity and energy savings of roughly 17 GWh. The impact of the program will increase with time because the number of air conditioners in the country is rising dramatically. Manufacturers conservatively estimate that the market will grow by 20% annually for the foreseeable future. In 1994 for example, demand for window-type units increased by nearly 40%. Based on this demand growth program analysts believe that by the year 2012 the program will have saved over 400 MW of peak capacity and will have resulted in cumulative energy savings of 780 GWh.

CONCLUSIONS

There is a rich but largely unknown experience of energy efficiency in Asia. With Asian energy efficiency programs, the old adage ''the further you look the more you find'' describes the situation well. As this report shows, the Asian experience with energy efficiency has been largely successful. It is hoped that the programs presented can serve as models to use, replicate, and build upon in the future.

Asian energy policy makers are eager to learn what their neighbors are doing to promote energy efficiency but have had trouble getting up-to-date information. Asian policy makers are more and more turning to their neighbors for ''Asian solutions to Asian problems.'' One common theme uncovered by this research is that there has been surprisingly little sharing of the best programs among the Asian countries themselves, not to mention with countries around the world. As energy demand continues to grow in Asia, the importance of sharing information on energy efficiency programs will also grow.

Government initiatives are more common than utility initiatives. Most Asian success stories have been driven by government initiatives and regulations rather than by utility demand-side management programs. Of the case studies presented in this text, only one program is specifically utility-driven. Clearly the North American DSM model, while itself undergoing a dramatic evolution, has not been widely employed in Asia. This is interesting given the high prices for electricity in the region, most Asian countries' high level of dependence on imported fuels, the dramatic load growth specifically related to electrification, and these countries' needs to address and mitigate air pollution.

Government programs can be successful, but tend to be slow and under-funded, and improve baseline conditions rather than pushing the markets at the upper margins of efficiency. Many government-driven efficiency programs in Asia have been bogged down in bureaucracy and plagued by insufficient funding. Unlike

private utilities which can fund, design, and implement customer energy efficiency programs rather quickly, government programs tend to be the products of lengthy legislative processes. Government programs also often require yearly appropriations of funds, making multi-year efforts difficult. While noble and necessary, government initiatives tend to gradually improve the bottom end of the market, gradually improving baseline efficiency rather than promoting the state of the art.

In theory, standards and codes can be ratcheted upwards, but in practice, such revisions are difficult if not impossible to execute. Singapore's commercial building code has many merits, including the ''teeth'' that it has for non-complying developers and building owners. The code, however, has not been improved since it was established in 1979 and proposals to improve the code have not yet been adopted. In the Philippines, air conditioner standards were expected to be raised rather rapidly, pushing manufacturers to continue to develop and market more energy-efficient products. The need to build consensus and to collaborate closely with manufacturers, however, has caused the standards improvements to be delayed, lessening the impact of the program.

Many Asian countries have implemented codes, but without a specific and rigorous enforcement mechanism, the programs can be less than effective. Another key issue to be addressed when implementing codes is their enforcement. Who will enforce the codes and how? Without clear means for enforcement, codes become worthless, and a disappointing indicator of a country's lack of commitment to efficiency. Building codes in the Philippines, for example, have neither been widely publicized nor enforced, diminishing the import and significance of these efforts.

The most successful programs are internally funded. While foreign investments in energy efficiency in Asia have supported many efforts, it appears that domestic financial commitments to energy efficiency will be key to sustaining energy efficiency in the long-term. TTEM serves as a case in point. The program was generously funded as a pilot program in the late 1980s. An exemplary program, it died when foreign funds ran out. Today, the Philippine Department of Energy is attempting to revitalize the program but is having difficulty convincing the government to fund the program. On the other hand, the Thai DSM program, which is 85% internally funded, is highly successful, stable, and potentially long-lasting despite a rather slow start. Singapore's building codes have been primarily internally funded as well and are still in full force.

The challenge for effective foreign assistance is to strategically provide aid to create strong local energy efficiency capabilities. A key challenge for outside funders is how to best promote energy efficiency, to leverage change, and to build capabilities in Asian countries without directing policies and plans in ways that are not sensitive to local conditions. This report has found that foreign initiatives, while well-intentioned and apparently well-designed, often are not as appropriate to the local situation as they could be. Analysts in both the Philippines and Thailand expressed these concerns during our interviews with them. Some analysts in Asia suggest that the best way to support energy efficiency is to (a) support local initiatives and (b) build capabilities within the private sector.

REFERENCES

Extensive references as well as explicit program contacts are contained in the full reports prepared by the International Institute for Energy Conservation and The Results Center. In addition to this, Peter Rumsey and Ted Flanigan conducted research in Asia to develop the report.