Taking the Pulse of Thailand's DSM Market Transformation Programs

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ABSTRACT

In late 1993, Thailand became the first nation in Asia to implement a comprehensive, national demand-side management (DSM) program. Our evaluation of four DSM market transformation programs included surveys of more than 2,000 residential customers, 200 non-residential customers, 50 importers and manufacturers, logging of the hours-of-operation of thin tube fluorescent lamps, compact fluorescent lamps, refrigerators and air conditioners; and detailed economic and environmental analyses. These four programs achieved peak demand savings of 243 MW and 1,548 GWh of electricity savings through the end of 1998. Market share for the energy-efficient appliances increased significantly when the prices of standard and energy-efficient technologies were similar, and the programs were cost-effective from the participant, utility and societal perspectives. Non-energy benefits examined included reductions in green-house (GHG) and non-green-house-gas (non-GHG) emissions, a greater tendency for energy-efficient appliance purchasers to link energy efficiency with the reliability or quality of the appliance, and increased energy efficient behavior of participants in the completely transformed fluorescent tube market.

Introduction

In 1991 Thailand became the first country in Asia to adopt a national demand-side management (DSM) Master Plan. The Demand Side Management Office (DSMO) was created within the Electricity Generating Authority of Thailand (EGAT) by a resolution of the Cabinet of the Royal Thai Government, to implement DSM programs in the electric power sector.

The Royal Thai Government approved a DSM program budget of US$ 189 million for DSM implementation, funded through a tariff adjustment mechanism. However, Thailand's high-profile DSM effort also received funding from two outside sources. The World Bank recognized the potential for the Thai DSM effort to serve as a model for energy conservation and efforts to reduce greenhouse gas (GHG) emissions, and provided a Global Environmental Fund (GEF) grant of US$ 9.5 million, supplemented by US$ 6 million in funding from the

government of Australia. These funds supported consultant studies, resident advisors and specific energy efficient measures. The Japan Overseas Economic Cooperation Fund also contributed to the overall DSM budget through a low-interest loan of US$ 25 million to support product testing, pilot testing and training. The target for the five-year pilot phase of the DSM program was 238 MW peak demand reduction and 1,427 GWh/year energy savings

In September 1993 the Thai DSM initiative was officially launched:

- To stimulate local manufacturers and importers to produce and import energy-saving and efficient appliances and equipment;
- To develop programs that educate consumers and raise awareness of energy conservation, and to provide financial incentives if necessary; and
- To support implementation of energy efficient and load management technologies to attain the maximum benefits for consumers and the country as a whole.

To date, Thailand's DSM efforts have concentrated on developing energy conservation attitudes and habits in consumers, and on market transformation programs for consumer appliances. Other programs in the DSM portfolio address non-residential customers and load management through the development of time-of-use tariffs and related measures.

To assess the extent to which its DSM programs were achieving the target reductions in energy use and greenhouse gas emissions, EGAT's DSM Office (DSMO) issued a Request for Proposals to conduct evaluations of the results of the five, fully implemented, DSM programs (AMI/BCHIL 2000). Project results presented below include evaluated reductions in peak demand and energy consumption, market effects, market shares, program cost effectiveness, evaluated reductions in greenhouse gas and other emissions, decision-making by appliance purchasers and increased energy efficiency behavior of thin tube participants. The four market transformation programs addressed in this paper are described below.

Energy efficient fluorescent (Thin Tube) program. The program objective was to transform the fluorescent lamp market from T12, 40 Watt (W) and 20 W (thick tubes) to thinner-diameter T8, 36 W and 18 W (thin tubes).

Compact fluorescent lamp (CFL) program. The program objective was to increase the saturation of CFLs through bulk purchase and resale of 13 W and 11 W CFLs with built-in magnetic and electronic ballasts. Bulk purchased CFLs were distributed through Seven-Eleven retail outlets.

High efficiency refrigerator program. The program objective was to transform the refrigerator market through labeling of energy-efficient refrigerators by manufacturers who voluntarily submitted appliances to the Thai Industrial Standards Institute (TISI) for energy performance testing.

High efficiency air conditioner program. The program objective was to transform the air conditioner market through labeling of energy-efficient air conditioners by manufacturers who voluntarily submitted appliances to TISI for energy performance testing. In addition, the Air Conditioner Program included a no-interest loan for consumers purchasing the highest-rated energy-efficient air conditioners.

The labels for appliances disclose for each relevant model the energy efficiency rating, estimated annual energy consumption, estimated annual cost of operation, the cooling capacity for air conditioners, and the volumetric size for refrigerators. The energy efficient rating or level provides a relative ranking of energy use for the air conditioner or refrigerator model. The ranking system is based on energy efficiency compared to other models tested at the beginning of the program: level 3 (standard) indicates models within 10% of the average; level 4 indicates models 10-25% more efficient than the average; and level 5 indicates models more than 25% more efficient than the average. Levels 1 and 2 are for models 10-15% and more than 25% less efficient, respectively, than the average.

Market Barriers The DSM Programs Were Designed To Address

In a perfect market economy, where prices for alternative fuels and energy-using technologies are set appropriately, and there are no information or transaction constraints, there would be no requirement for DSM programs. Individuals acting in their own self-interest would select the appropriate fuel and the most cost-effective technologies. However, experience has shown that there are a range of barriers that prevent markets from operating ideally. DSM market transformation programs were initiated in attempts to overcome these barriers. These market transformation programs were intended to intervene in the market for a relatively short period of time, and to provide permanent solutions to market barriers.

A simple definition is that a market failure or barriers exists when a choice that is economic from the perspective of society is not economic from the perspective of the participants. There are a range of market failures and barriers that affect the markets for energy-efficient products and services. All four programs addressed consumer information and product availability barriers, while the compact fluorescent lamp and air conditioner programs included components addressing the price barriers for these appliances.

Consumer information. The programs were explicitly designed to address consumer information barriers to the adoption of energy-efficient appliances. The consumer information barrier was addressed by comprehensive television advertising and promotion campaigns to increase consumer awareness of the benefits of energy efficiency and energy conservation. Overall, some US$ 8 million was spent on promotions, representing the largest consumer television advertising campaign in Thailand during that time period. In addition, in conjunction with testing (TISI) and labeling of energy-efficient air conditioners and refrigerators, educational campaigns were undertaken to encourage consumers to purchase the most efficient technologies (e.g., level 5 appliances).

Product availability. For these consumer programs the product availability barrier was addressed by negotiating voluntary agreements with manufacturers and importers to increase production or imports of energy-efficient appliances in exchange for the educational advertising and promotion campaigns. For the Thin Tube Program, five of six domestic manufacturers and the only importer agreed to switch entirely to thin tube production and imports. For the CFL Program, participating importers were encouraged to increase their imports through EGAT's bulk purchases and to distribute CFLs nationwide through Seven-

Eleven stores. For the Refrigerator and Air Conditioner Programs, manufacturers were encouraged to increase production of energy-efficient appliances (e.g., level 5 appliances).

Price. Two of the DSM programs addressed price barriers (CFL and air conditioner). When efficient technologies are introduced, they often are positioned as premium products with a relatively higher mark-up than the standard product. Similarly, when products are introduced, sales volumes are lower, and the fixed costs of production must be amortized over fewer units, which also results in higher prices than the standard products. Import duties are another source of price distortion if they result in the price of efficient technologies being artificially higher than the price of the standard product (e.g., CFL program). This higher price of efficient technologies tends to dampen the demand for energy-efficient products. In order to lower the retail price of CFLs, EGAT bulk purchased CFLs. The Air Conditioner Program included a no-interest loan component available for level 4 and level 5 models (the two most efficient categories).

The Evaluation Approach

The purpose of the evaluation was to determine program impact. That is, the objective was to evaluate reductions in electricity use and GHG emissions in order to gauge program success relative to EGAT's cost criteria, and to the climate change criteria of the Global Environment Facility, which provided grant funding to the DSM effort. The evaluation project included five major data collection initiatives, as noted below.

- Surveys of residential customers (n=2,111), including program participants and non-participants, as noted in Table 1.
- Surveys of non-residential customers (n=230), including program participants and non-participants (225 non-residential Thin Tube participants; 43 non-residential CFL participants and 179 non-residential CFL non-participants).
- In-person interviews (n=50) with manufacturers and importers of thin tubes, CFLs, air conditioners, and refrigerators.
- In-person interviews with EGAT DSMO and Systems Planning Department personnel.
- Metering of the hours-of-use of residential thin tubes and CFLs, and the hours-of-compressor-operation for air conditioners and refrigerators, as noted in Table 1. In addition, 104 non-residential thin tube and 17 non-residential CFL fixtures were metered.

Table 1. EGAT DSM Residential Program Participant and Non-Participant Samples

	Survey Samples		Hours-of-Use Samples	
Program	Participant	Non-Participant	Participant	Non-Participant
Thin Tube	253	Not Available	22	Not Available
CFL	277	199	19	Not Available
Refrigerator	247	229	75	52
Air Conditioner	216	209	64	65

Peak demand (megawatts, MW) and electricity consumption (gigawatt hours, GWh) savings were estimated for each program. Calculation of the evaluated reductions in electricity use for each program involved re-calibration of engineering estimates based on data and information collected during the evaluation, and secondary data and information provided by EGAT or available from existing reports.

EGAT estimated reductions in carbon dioxide emissions using a Tier 1 approach as defined by the Intergovernmental Panel on Climate Change (IPCC. Revised 1996). The emission factors based on the Tier 1 approach represent the average emissions per unit of fuel combusted based on estimated electricity consumption savings and are not technology specific. The evaluation approach used to determine emissions impacts for the four DSM programs moved toward a Tier 2 approach. This included reductions in a number of GHG and non-GHG emissions where national aggregate emission factors were applied to the national (evaluated) electricity savings data to determine emissions impacts. The evaluated reductions in GHG and non-GHG emissions were based on:

- The evaluated electricity consumption savings;
- Information about the fuel types for each EGAT generating facility (i.e., technology specific information);
- EGAT system operating conditions (historical dispatch); and
- Emissions factors derived from secondary data sources.

Project Results

Evaluated and Estimated Reductions in Electricity Use

DSMO estimated reductions in peak demand and electricity consumption savings for the programs in the DSM portfolio using engineering estimates based on program activity (e.g., number of labels issued, lamps sold) and estimated changes in unit energy consumption. Table 2 presents the evaluated and estimated reductions in electricity use associated with the four DSM programs for the period from program launch to the end of December 1998. For all four programs, cumulative total evaluated peak demand savings, assuming system peak hours between 14:00 and 17:00 hours on weekdays, were 243 MW. Cumulative total evaluated electricity consumption savings were 1,548 GWh.

Table 2. Evaluated and Estimated Reductions in Energy Use

	Peak Demand (MW)		Energy Consumption (GWh)	
Program	Evaluated Savings	Program Estimated Savings[1]	Evaluated Savings	Program Estimated Savings[1]
Thin Tube 1994-98	199	425	1,032	1,543
CFL 1996-98	12	6	71	81
Refrigerator 1995-98	14	NA	271	369
Air Conditioner 1996-98	18	24	174	371
Total	243	455	1,548	2,364

[1] DSMO, December 1998.

NA – Not available (DSMO did not estimate peak demand savings for this program).

For the three programs for which DSMO estimated peak demand savings, total evaluated peak demand savings accounted for 50% of estimated peak demand savings. For all four programs, total evaluated electricity consumption savings accounted for 66% of total estimated consumption savings. Differences between cumulative evaluated and estimated savings for each program are noted below. Note, historically DSMO estimated annual capacity savings for the Refrigerator Program, rather than the peak demand savings summarized in Table 2.

The major difference between evaluated and estimated savings for the Thin Tube Program is that estimated savings assumed relatively rapid economic growth and increasing thin tube sales. However, after years of rapid economic growth averaging 9% earlier this decade, the Thai economy contracted 0.4% in 1997 and shrunk another 8.5% in 1998. As a consequence, total domestic sales of thin tubes increased from 41 million in 1994 to a high of 48 million in 1996, and then decreased to an estimated 30 million in 1998. This economic contraction was not adequately reflected in EGAT's estimates of program savings.

The major differences between evaluated and estimated savings for the CFL Program were different coincidence factors for the peak demand savings, and different assumptions about the base wattage of the lighting the CFLs replaced, for the electricity consumption energy savings.

The major differences between evaluated and estimated savings for the Refrigerator Program included the introduction of refrigerators without chlorofluorocarbons (non-CFC refrigerators) starting in 1997, for the electricity consumption savings. The program estimates of annual capacity savings were not comparable to the peak demand savings calculated for the evaluation.

The major differences between evaluated and estimated savings for the Air Conditioner Program were different coincidence factors for the peak demand savings, and different assumptions about the average run-time of compressors for the electricity consumption savings.

Market Effects

Net impacts or reductions in electricity use are those impacts solely attributable to the implementation of the DSM program. Thus, net impacts are gross impacts minus the change in electricity use that naturally would have occurred in the absence of the program, or minus market distortion effects. Three market effects commonly examined are reviewed below.

Free ridership refers to the proportion of energy-efficient appliance purchasers who would have bought the energy-efficient appliance in the absence of a monetary incentive. There were no monetary incentives for the Thin Tube, CFL and Refrigerator Programs. Thus, free ridership was not estimated for these programs. The free ridership, for Air Conditioner Program participants who participated in the no-interest loan (only a very small proportion of air conditioner program participants), was estimated at 14%.

Persistence refers to the possibility that measured savings may not be realized over the longer term because of premature removal, performance degradation, or failure of the energy-efficient technology. It is somewhat early in the expected lifetime to assess persistence for CFLs, air conditioners, and refrigerators. Surveys of program participants, however, suggested that the energy-efficient appliances purchased during the four programs were still in use. In addition, high levels of satisfaction with the reliability of the efficient technologies suggested that premature removal is not a major issue.

Snapback occurs when DSM program participation results in a decline in a participant's energy costs, and the participant then engages in behavior that increases energy consumption and energy costs. The most common example is a person who purchases an energy-efficient air conditioner and then increases the amount of cooling used, thus reducing energy savings. Surveys of program participants suggested that significant snapback had not occurred.

Market Shares

The level, and sometimes the change in the level, of the market share for an efficient technology is a key indicator of market transformation.

The Thin Tube Program successfully and completely transformed the fluorescent tube market from thick to thin tubes. At program initiation 40% of the fluorescent tube market was thin tubes and the market was completely transformed (i.e., 100% thin tubes) by the end of December 1995.

While the CFL Program was one of the factors that ensured that high quality CFLs remained in the market during an economic downturn, the program did not significantly affect the market share of CFLs sales compared to incandescent sales (CFL sales are estimated to be between 6% to 10% of incandescent sales). However, because CFLs are not appropriate for every context where incandescent lamps are applied, it should be understood that CFLs are not expected to displace incandescent lamps entirely.

An unintended effect of the CFL Program was the increased sales of low-price, low-quality CFLs, primarily Chinese imports. Sales of low-price CFLs increased in part because of the widespread publicity campaign promoting the benefits of CFLs sold at Seven-Eleven stores nationwide, and offered at lower prices due to EGAT's bulk purchases. However, the lack of quality and performance standards for CFLs meant that low-quality imports were

available at a price even lower than the price offered at the Seven-Eleven stores. In addition, the Asian economic downturn of 1997-98 led to a huge glut of low-priced CFLs in Asia, due to China's increase in production to approximately 160 million units annually, combined with reduced demand in that region.

The Refrigerator Program has successfully transformed the single-door refrigerator market, increasing the market share of the most efficient units (level 5) from 12% in 1995 to 96% in 1998.

The Air Conditioner Program successfully increased the market share of energy-efficient air conditioners from 19% in 1996 to 38% in 1998. Given this rapid increase in the market share of energy-efficient units, a market share of 50% should be quite attainable.

Cost Effectiveness

For the four programs the benefit cost ratios were calculated from three perspectives: that of program participants or the Participant Test; that of the utility or Utility test; and that of the economy as a whole, or the Total Resource Cost Test. These alternative tests present information from the perspective of different economic actors or groups of economic actors. The net benefit is defined as the present value of relevant benefits and the net cost is defined as the present value of relevant costs. A benefit cost ratio greater than one indicates that, for that group of economic actors, the benefits outweigh the costs and the program can be considered cost-effective and successful.

Due to transformations of the fluorescent tube and refrigerator markets, benefits considerably outweigh costs and the Thin Tube and Refrigerator Programs can be considered cost-effective and successful, as noted in Table 3.

Table 3. EGAT DSM Program Cost Effectiveness

Program	Participant	Utility	Total Resource Cost
Thin Tube	70.3	52.7	23.0
CFL Program	3.3	5.2	1.3
Air Conditioner	1.4	5.2	0.7
Refrigerator	2.2	9.8	2.8

For the CFL Program, the benefits outweigh costs, thus indicating that the program was cost-effective. However, the program was not very successful at gaining market share for program CFLs, alienated conventional lighting distributors by excluding them from the program, and had the unintended effect of increasing sales of lower-priced, lower-quality CFLs.

The Air Conditioner Program was cost-effective from the participant and utility perspectives. While the program is not cost-effective from the societal perspective (Total Resource Cost Test), the program has been successful at capturing market share. In calculating the Total Resource Cost test all differences in the price of efficient and standard units were assumed to be due to differences in the energy efficiency of the unit. In fact, it is very likely that some portion of the price difference would be for extra features such as improved styling, longer lasting components and better non-energy related value. A

reduction in the value assumed as the incremental cost for an energy-efficient air conditioner could well lead to a positive TRC ratio.

Evaluated and Estimated Reductions in Carbon Dioxide (CO_2) Emissions

EGAT's approach to estimating the GHG emissions impacts associated with implementation of the DSM programs was based on DSM-related electricity savings data derived from an engineering analysis (estimated electricity savings), and represented a Tier 1 approach to emission factors as defined by the IPCC. The emission factors based on the Tier 1 approach represent the average emissions per unit of fuel combusted and are not technology specific. An estimate of the fuel required to generate the energy savings was determined by assuming that the generating units backed-off as a result of DSMO initiatives are oil fired thermal plants, and that the quantity of fuel-oil displaced in generation is equal to oil 0.244212 litres per kWh saved. To calculate emissions reductions associated with the fuel savings estimates, a 1994 U.S. EPA AP-42 CO_2 emissions factor of 34.6 kilograms of carbon per tonne of fuel oil combusted was used. The carbon content for fuel oil was assumed to be 88.3%, and carbon dioxide emissions were estimated using the equation noted below (DSMO January 1997).

CO_2 emissions = (GWh savings) (1,000,000) (0.244212/1,000) (34.6) (88.3)

The first two arguments in the equation represent a conversion of electricity savings expressed in GWh to electricity savings in kWh. The product of the first three arguments in the equation provide an estimate of fuel savings. Finally, the product of the fuel savings estimates and the emissions factor yields kilograms of CO_2.

Evaluated reductions in CO_2 emissions are based on the evaluated reductions in electricity consumption, fuel data for each EGAT generating facility, technology data for each generating facility, historical system operating parameters provided by EGAT, and emissions factors derived from secondary data sources. Based on the evaluated electricity consumption savings and using the approach described above, the evaluated reduction in CO_2 emissions was 1,045,827 tonnes. Evaluated reductions in CO_2 emissions accounted for 60% of the estimated reduction in CO_2 emissions (DSMO December 1998). Differences between evaluated and estimated reductions in CO_2 emissions are due to the use of different estimates of DSM electricity consumption savings and different methodologies.

Evaluated Reductions in GHG and Non-GHG Emissions

Based on evaluated electricity consumption savings, Table 4 indicates the impacts of the four DSM programs in terms of reductions in GHG carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions, and also for the non-GHG sulfur oxides (SO_x), nitrous oxides (NO_x) and particular matter (PM_{10}) emissions.

Table 4. DSM Related Emission Reduction (Based on Evaluated Energy Savings)

DSM Program	Emission Reductions					
	CO_2 (Tonnes)	CH_4 (Kgs.)	NO_x (Kgs.)	N_2O (Kgs.)	SO_x (Kgs.)	PM_{10} (Kgs.)
Thin Tube	697,488	24,109	1,719,802	4,792	9,923	7,950
CFL Program	48,209	1,666	118,868	331	686	549
Air Conditioners	117,322	4,055	289,283	806	1,669	1,337
Refrigerators	182,808	6,319	450,750	1,256	2,601	2,084
Total	1,045,827	36,149	2,578,703	7,185	14,879	11,920

Calculation of the emission reductions assumed that the energy savings that result from DSM programs are associated with a uniform reduction in generation from all of EGAT's facilities. That is, no one specific fuel was assumed to be backed out, rather reductions in generation requirements were achieved by reducing requirements from each facility in accordance with historic dispatch patterns. The estimates of reductions in emissions, including the reductions in CO_2, are somewhat lower than anticipated because some 75% of EGAT's peak generation requirements are provided by hydro-electric generation facilities, while generation facilities supporting the base load are fossil fuel fired.

Decision-Making By Air Conditioner and Refrigerator Purchasers

In markets where consumers are aware of the benefits of energy efficiency and such products are available, the critical factors purchasers of energy-efficient products are most likely to take into consideration during the selection decision include the reliability or quality (e.g., sturdiness, durability) of the product, the energy efficiency of the product (saving energy), the price, and the brand (Tiedemann & Nelson 1998). Table 5 indicates the percentage of recent Thai purchasers of air conditioners and refrigerators in 1997 and 1999 who indicated that quality, energy efficiency (saving energy), price or brand were among the three most important factors in their decision to purchase the appliance that they selected.

In 1997 consumers who had purchased an air conditioner or refrigerator within the last 60 days were most likely to indicate that brand was one of the three most important factors in their selection of the product they bought, followed by price and reliability (du Pont 1998a, 1998b). These consumers were more likely to mention the color of the appliance than to mention the energy efficiency of the selected product. In 1999 consumers who had bought a standard air conditioner or refrigerator within the last two years were most likely to indicate that price and reliability were the most important factors in their selection decision, followed by brand.

Table 5. Percent Mentioned as First, Second or Third Most Important Factor in Selecting the Product Bought

	Refrigerators			Air Conditioners		
	Part.[1] 1999	Non-Part.[1] 1999	1997[2]	Part.[1] 1999	Non-Part.[1] 1999	1997[2]
Energy Efficiency	78%	32%	28%	82%	33%	37%
Reliability/Quality	60%	52%	35%	66%	59%	42%
Price	46%	58%	54%	50%	72%	47%
Brand	32%	41%	61%	37%	39%	70%
Sample Size (n)	247	229	366	216	209	275

[1]AMI/BCHIL 2000. [2] du Pont 1998a.

Consumers buying energy-efficient product, however, were most likely to indicate that energy efficiency or that saving energy was one of the three most important factors in their selection decision, followed by reliability and price. That is, when energy-efficient product is readily available, advertising and promotion strategies that emphasize the reliability or quality of energy-efficient product appear to effectively compete with traditional strategies emphasizing product differentiation and branding (Tiedemann & Nelson 1998). Or from the consumer perspective, when information about the reliability or quality of a specific product is not available, consumers may use brand as a proxy indicator of the reliability or quality of the product.

Energy Efficient Behavior Of Thin Tube Participants

Logging of the hours-of-use of fluorescent fixtures in non-residential facilities revealed an energy conservation ethic among the Thai, whereby lights are turned off when the space is unoccupied, particularly over the lunch hour (see Figure 1). This energy conservation ethic is so strong that it is noticeable in the hourly demand load curve at the system level, presented in Figure 2.

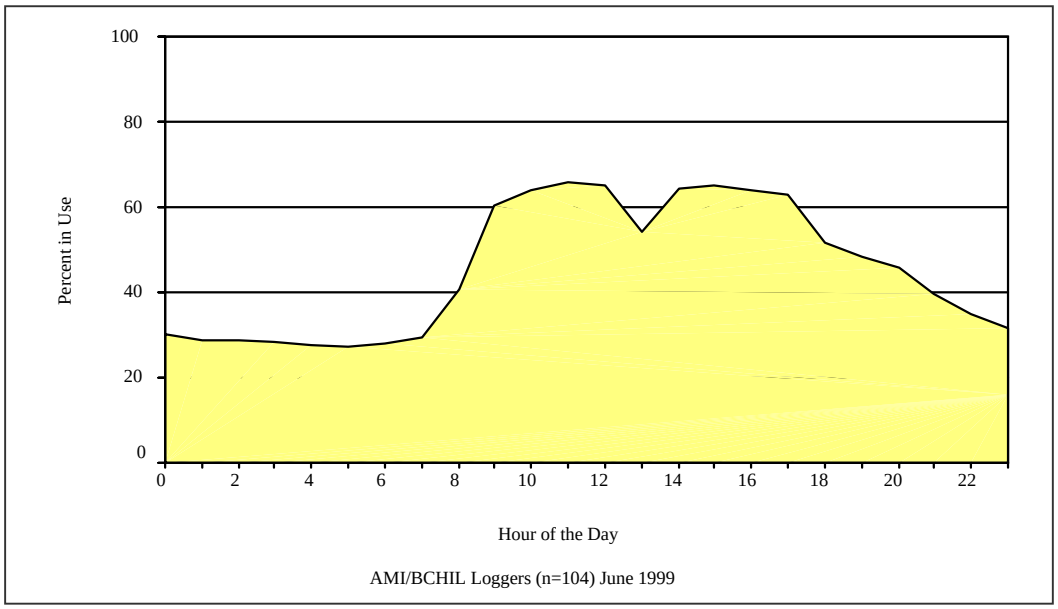

Figure 1. Non-Residential Thin Tubes: Percent of Fixtures In Use by Time of Day, Weekdays on EGAT System

The lunch-hour dip in the system hourly demand curve is most probably due to turning off both lighting and air conditioner systems. Nevertheless, the combination of advertising and promotions undertaken by EGAT as part of this program and other DSM activities, appears to have effectively convinced the Thai people of the benefits of energy conservation behaviors.

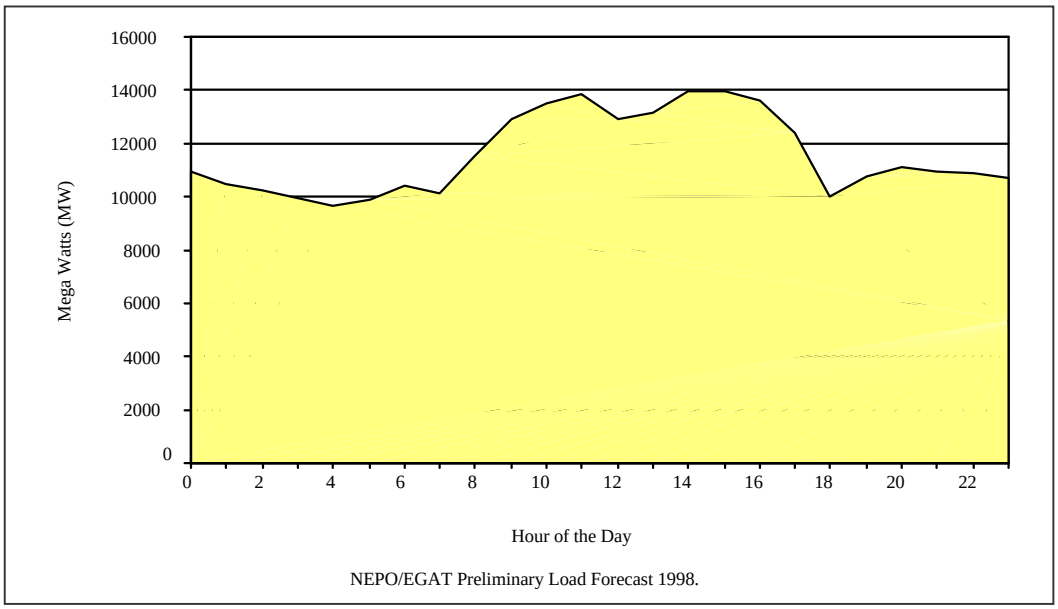

Figure 2. EGAT System Hourly Load Curve For The Peak Day, May 1998

Summary and Conclusions

Overall, the four DSM programs successfully invested in and addressed market barriers related to consumer information, the availability of energy-efficient products and price. Through voluntary agreements with the electric utility, manufacturers and importers increased the production and import of energy-efficient products in exchange for comprehensive advertising and promotion campaigns funded by EGAT DSMO. Investments to address price barriers to the adoption of energy-efficient appliances were less, and less successful (air conditioner no-interest loan and CFL price subsidy available through bulk purchase).

Thin tube program. The Thin Tube Program was very successful at meeting its objectives and transforming the fluorescent tube market. Through advertising and promotions, high consumer awareness of the benefits of energy-efficient thin tubes was established, as was satisfaction with the performance of the thin tubes from both consumers and manufacturers. Manufacturers were very satisfied with the program and the successful transformation of the fluorescent tube market, indicating the program has been a win-win-win situation for EGAT, consumers and manufacturers.

CFL program. The CFL Program successfully addressed consumer information barriers through advertising and promotions about the benefits of energy efficiency and energy conservation, and through bulk purchases ensured that CFLs remained in the market during an economic downturn (addressing the product availability barrier). The program, however, reached only a small proportion of consumers primarily because conventional lighting distributors were excluded from the program, and addressed only two sizes of CFLs. An unintended impact was the increase in sales of lower-priced, lower-quality CFLs. Unfortunately, consumers familiar with the poor performance of the lower-priced, lower-quality CFLs may assume that higher-priced, higher-quality CFLs are also unreliable (that is, may assume that CFLs do not provide the energy savings benefits claimed).

There is still a price barrier to the adoption of CFLs by consumers, as well as a number of opportunities to increase the size of the CFL market. Reduction of import duties and taxes would reduce the existing price barrier. Future efforts to affect the CFL market:

- must address the tradeoff between price and quality by educating consumers (e.g., 'pay less, get less' message);
- should use conventional lighting distribution channels where sales staff will be aware of and committed to consumer education; and
- should include the full range of types and sizes of CFLs.

Refrigerator program. The Refrigerator Program has successfully met its objectives and transformed the refrigerator market such that single-door high efficiency refrigerators are the norm some five years after program launch. In fact, the goal was achieved much earlier, since the highest level of efficiency (i.e., level 5) became the dominant unit on the market as early as the second year of the program.

Continued support for the Refrigerator Program is recommended including ongoing labeling of two-door models and expansion of the program to include larger refrigerators. Other methods to enhance the effectiveness of the Refrigerator Program include:

- improving the speed and accuracy of the testing process;
- increasing the energy efficiency level of each label to enable consumers to better distinguish the most energy-efficient refrigerators;
- continuing the marketing program, particularly if the energy efficiency level of each label is increased; and
- targeting promotions to sales people and providing more information about the relationship between CFCs and the environment.

Air conditioner program. The Air Conditioner Program has been quite successful in meeting its objectives. With voluntary support from the major manufacturers and effective promotional campaigns, consumer awareness and knowledge of labeled energy-efficient air conditioners has increased, the market share for energy-efficient units has increased, and peak demand and energy savings have been realized. In addition, should the peak switch back to the evening as is likely as Thailand recovers economically, peak demand savings will increase as many residential air conditioners are operating during the evening and only a very small portion are operating during the afternoon peak period (used to evaluate savings). There still remains, however, a price barrier and a number of opportunities to increase program impact, including:

- continuing the marketing program to further increase consumer awareness of the benefits of energy efficiency and to increase the purchase of labeled units;
- increasing the capacity of the testing process to shorten the time required by manufacturers to have models tested;
- promoting the establishment of minimum performance standards for all air conditioners sold in Thailand; and
- simplifying and modifying the loan program to reduce complexity and allow the use of a wider range of banks and credit cards, which could play a secondary, but real role in capturing cash constrained consumers.

Where there is little price difference between standard and energy-efficient technologies and a relatively small, easily identifiable group of manufacturers and importers that dominate a product market, comprehensive advertising and educational campaigns can cost-effectively transform the market. However, comprehensive advertising and educational campaigns will be less effective where there are significant cost differences between standard and energy-efficient technologies, and where the product market includes a large number of players (e.g., numerous importers, manufacturers, assemblers, retailers).

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