RMA/IND-EMCAT/DSM-D-03D

Energy Management Consultation and Training Project: Demand-Side Management Technical Assistance Component

Five-Year DSM Action Plan for Ahmedabad Electricity Company (Draft)

August 1995

Prepared by: Jennifer Fagan, Niels Wolter, and Ashok Sarkar
Resource Management Associates of Madison, Inc.

Prepared for : United States Agency for International Development (USAID)
New Delhi, India: Contract Number 386-0517-C-00-4100-00
and
Ahmedabad Electricity Company
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1. EXECUTIVE SUMMARY

In March 1994, the Ahmedabad Electricity Company (AEC) was identified as the demonstration site for a Demand-Side Management (DSM) Technical Assistance Program under the USAID-funded, three-year Energy Management Consultation and Training (EMCAT) Project. Resource Management Associates of Madison, Inc. (RMA) is working with AEC to recommend a set of Load and Market Research activities, design and implement a DSM Pilot Program, and develop a Five-Year DSM Action Plan. This report focuses on the Five-Year DSM Action Plan.

AEC is one of three privately owned utilities in India. It is relatively small, with an annual system peak demand of 540 MW. There is currently a large difference (about 100 MW) between AEC's daytime peak loads and nighttime loads. While AEC has enough generation to cover its nighttime loads, it does not have enough to serve its daytime loads and must purchase power from the State-owned Gujarat Electricity Board (GEB). AEC's purchased power cost is about 50% higher than if it were to supply an equivalent amount of power from its own plants. This deficit situation provides AEC with an excellent opportunity to promote DSM programs and activities to its customers in order to reduce the shortfall.

RMA and AEC used an approach called multiattribute decision analysis to select the DSM programs reflected in this Five-Year DSM Action Plan. Under this approach, a large number of DSM programs were evaluated qualitatively against a set of program objectives specified by AEC. The programs were then scored and ranked by a team of eight people from AEC and RMA. AEC's primary DSM program objectives were to:

- Enable AEC to reduce its purchases from the GEB (most important).
- Be highly visible to AEC's customers.
- Address all major customer sectors and end-uses.
- Be able to be implemented quickly.
- Be relatively easy to administer.
- Promote energy-efficient equipment which is available locally.
- Be replicable throughout India.
- Be easily understood by AEC's customers.

Using this selection process, the top-ranked programs are:

(1) Industrial Energy Audit/Feasibility Study and Dealer Incentive Program (the DSM Pilot Program).
(2) Residential Customer Education and Energy Audit Program.
(3) New Construction Education Program for Multifamily and Commercial buildings.
(4) Interruptible Tariff for Large Commercial and Industrial Customers.
(5) Backup Generator Peak Control Program.
(6) Commercial Retail Store Demonstration.

(7) Direct Load Control Program for Flour Mills (Commercial Sector).

RMA and AEC believe that these programs are appropriate for many reasons. First, they address important customer subgroups. Some programs focus on the most dominant customer subgroups (in terms of their shares of AEC's overall sales and revenues), while others are targeted toward categories which are contributing to extremely high energy growth for AEC. Second, most of these programs are relatively easy to implement, an important characteristic for AEC which has almost no experience to-date with DSM program implementation. This ease of implementation should enhance AEC's chances for early success with these programs. Third, they fully cover the range of DSM program designs applicable to AEC. With these programs, AEC will gain experience with a wide range of programs, including information-based programs, financial incentive-based programs, and pricing-based load management programs. This range of experience will provide AEC with a broad range of experience implementing various types of DSM programs. This experience will be valuable in the future, when AEC will develop and implement DSM programs on its own, without USAID's and RMA's assistance.

RMA has assessed the cost-effectiveness of all of the programs included in this Five-Year DSM Action Plan. Two of the programs, the Interruptible Tariff and the Direct Load Control Program for Flour Mills, are not cost-effective, given their current design. The Interruptible Tariff Program can be made cost-effective by reducing the level of the bill credit provided to program participants relative to the level reflected in the program budget. However, the Direct Load Control Program for Flour Mills is far from being cost-effective and needs to be substantially redesigned.

2. INTRODUCTION

AEC is located in the state of Gujarat in India and is engaged in the generation, transmission and distribution of electricity. In March 1994, AEC was selected for a Demand-Side Management (DSM) Technical Assistance Program under the USAID-funded, three-year Energy Management Consultation and Training (EMCAT) Project. Resource Management Associates of Madison, Inc. (RMA) is the prime contractor the EMCAT – Demand-Side Project, and the Industrial Development Bank of India (IDBI) is the lead Indian counterpart.

RMA is working with AEC to recommend a set of Load and Market Research activities to provide the information needed to develop DSM programs for AEC, as well as to assist with the development of a Five-Year DSM Action Plan. RMA is also providing technical assistance with designing, developing, and implementing a DSM Pilot Program. The purpose of this document is to describe in detail the DSM programs which comprise the Five-Year DSM Action Plan and to provide the necessary background materials which support the selection, development, and implementation of these programs.

3. Information About AEC

AEC is a relatively small, privately owned electric utility. In India, the private utilities are quite small, in contrast to the very large, government-run State Electricity Boards (SEBs) where most of India's power is generated and sold at retail. The private utilities are an ideal place to "jump-start" DSM programs because they are very responsive and can quickly adapt to changing circumstances, unlike the slower, more bureaucratic SEBs. For this reason, a private utility (AEC) was selected for this initiative.

3.1 System Load Characteristics

AEC's annual peak demand is about 540 MW, and its load factor averages around 70 percent. Presently, there is a 100 MW difference between daytime peak loads and nighttime loads. While AEC has enough generation to cover its nighttime loads, it cannot meet its daytime loads and must purchase power from the Gujarat Electricity Board (GEB) at a cost which is about 50 percent higher than AEC's own power. This deficit situation creates an incentive for AEC to promote peak (load) shaving, load shifting, and energy conservation. *Figure 3.1* provides AEC's load curves for typical day-types throughout the year. Day-types which are representative of the four seasons experienced by AEC (i.e., winter, summer, monsoon, and Diwali) are shown. The curves demonstrate the range of load levels and load shapes experienced by AEC throughout the year.

3.2 Sales to Various Customer Groups

During 1994-95, AEC sold 2,373 GWh of electricity to its customers. Industrial sales to High-Tension and Low-Tension customers accounted for the largest share of this total (over 60%, or 1,432 GWh). Commercial, municipal, and residential sales accounted for the remainder. These shares are changing over time as AEC's industrial base is relatively stagnant, while its residential and commercial customer groups are growing rapidly.

Overall, AEC's sales have been growing at between 4 and 5% every year. During 1994, its sales growth was much higher (about 10%) due to above-average growth in the commercial sector. AEC expects this higher growth rate to continue in the future.

The growth rate varies considerably by customer group. Residential and Commercial sales have been growing rapidly, because of significant growth in new end-use loads, new buildings and businesses, and the electrification of rural areas. In contrast, industrial sales have been relatively flat or declining in recent years, because of slumps or stagnation in important industry categories, such as textiles. In Ahmedabad, the textile industry underwent a major recession during the mid-to-late 1980s. Before this recession, industry accounted for more than 70% of AEC's sales and revenues and the majority of its annual sales growth.

Figure 3.1 Ahmedabad Electric Company Load Curves

3.3 Reliability and Losses

Most of AEC's distribution network is underground and therefore, its system reliability is very high. Its losses average 18-20%. Of this amount, 11-12% is from technical losses, and the remainder is attributed to theft and meter error. AEC expects its losses to be higher in the future, because of above-average growth from customers served at lower voltages and to an increase in theft, especially by commercial customers. AEC estimates that the percentage of losses from theft is about 3 to 4% and has undertaken a major initiative to detect and reduce theft. AEC is also researching options to reduce its technical losses.

3.4 Sources of Electricity Supply

AEC has a license to generate power in Ahmedabad and Ghandinagar, the capital of Gujarat. AEC operates two power stations, a newly-constructed, gas-fired combined cycle station rated at 100 MW, and an older, coal-fired generating station. This older station has a total of four generating units. Three of the four are pulverized coal units rated at 110 MW each, and the fourth unit is a 120 MW slag-coal plant, which is being refurbished to a pulverized coal unit. AEC presently operates all of these plants in base-load fashion, as they are not sufficient to cover its peak loads. When AEC's loads drop off at night, the older, more expensive coal-fired units are backed down partially.

Currently, AEC's new 100 MW, gas-fired, combined cycle plant is its most efficient and least cost-generating resource. However, this plant rarely operates above 75 MW because of an inadequate supply of natural gas. AEC is in the process of modifying this plant to add oil (naphtha) storage and dual-fuel capability and expects these modifications to be completed by the third quarter of 1995.

AEC estimates that it needs to add an additional 50 MW per year to address capacity deficiencies because of load growth and plant retirements. Currently, AEC plans to add a new integrated gasification combined cycle plant in 1997-98 at a cost of Rs. 1000 crore ($322.6 million).

As noted previously, AEC purchases a portion (about 12%) of its electricity supply needs from the GEB. These purchases are necessary because AEC lacks enough generation to reliably serve its own loads. However, AEC would prefer, if possible, to serve 100% of its customers' energy supply needs, using resources which are less expensive than purchasing power from the GEB.

AEC's purchased power cost averages 50% higher than its own costs of generation. However, the terms under which AEC purchases power are defined by a rather complex tariff schedule and amendments which include an excess demand charge. As a result, AEC's purchased power cost varies considerably by time-of-use. The charges in the GEB purchased power tariff are highest during the dry summer season when the GEB's peak loads are highest because of high agricultural pumping loads. During those hours of the month when AEC is subject to excess demand charges, its purchased power cost is several times higher than the other hours of the month. *Figure 3.2* presents the terms of AEC's purchased power tariff and amendments.

Figure 3.2 Terms of GEB Tariff

RATE EL-1 (GRID TARIFF) (Applicable to licensees and sanction holders permitted to supply power to public.)

DEMAND CHARGES - Effective from May to October every year.

(a) For supply at voltages 3.3 kv, 11 kv, 22 kv, and 33 kv.

(i) For Billing Demand up to the Contract Demand
$1.42 (Rs. 44) per KVA per month for the first 500 KVA of billing demand
$1.68 (Rs. 52) per KVA per month for the next 9500 KVA of billing demand
$1.81 (Rs. 56) per KVA per month for billing demand in excess of 10,000 KVA

(ii) For Billing Demand in excess of the Contract Demand
$2.65 (Rs. 82) per KVA per month

(b) For supply at voltages above 33 kv.

(i) For Billing Demand up to the Contract Demand
$1.48 (Rs. 46) per KVA per month for the first 500 KVA of billing demand
$1.65 (Rs. 51) per KVA per month for the next 9500 KVA of billing demand
$1.77 (Rs. 55) per KVA per month for billing demand in excess of 10,000 KVA

(ii) For Billing Demand in Excess of the Contract Demand
$2.65 (Rs. 82) per KVA per month

DEMAND CHARGES - Effective from November to April every year

(a) For supply at voltages 3.3 kv, 11 kv, 22 kv, and 33 kv.

(i) For Billing Demand up to the Contract Demand
$1.65 (Rs. 51) per KVA per month for the first 500 KVA of billing demand
$1.81 (Rs. 56) per KVA per month for the next 500 KVA of billing demand
$1.87 (Rs. 58) per KVA per month for the next 9000 KVA of billing demand
$2.00 (Rs. 62) per KVA per month for billing demand in excess of 10,000 KVA

(ii) For Billing Demand in excess of the Contract Demand
$4.10 (Rs.127) per KVA per month

(b) For supply at voltages above 33 kv.

(i) For Billing Demand up to the Contract Demand
$1.61 (Rs. 50) per KVA per month for the first 500 KVA of billing demand
$1.77 (Rs. 55) per KVA per month for the next 500 KVA of billing demand
$1.84 (Rs. 57) per KVA per month for the next 9000 KVA of billing demand
$1.97 (Rs. 61) per KVA per month for billing demand in excess of 10,000 KVA

(ii) For Billing Demand in Excess of the Contract Demand
$4.10 (Rs. 127) per KVA per month

Figure 3.2 Terms of GEB Tariff (continued)

In case of demand recorded over the contract demand fixed for a particular period, the excess demand charges will be payable as per the grid tariff EL-1 on the following basis:

	Number of days in a month for which contract demand is exceeded	Rate of excess demand charges payable
(a)	1 to 5 days	0.17 x excess demand charges of GEB's EL-1 tariff
(b)	6 to 10 days	0.33 x excess demand charges of GEB's EL-1 tariff
(c)	11 to 15 days	0.50 x excess demand charges of GEB's EL-1 tariff
(d)	16 to 20 days	0.66 x excess demand charges of GEB's EL-1 tariff
(e)	21 to 25 days	0.83 x excess demand charges of GEB's EL-1 tariff
(f)	More than 25 days	Full excess demand charges as per EL-1 tariff of GEB

<u>ENERGY CHARGES - Effective from May to October every year</u>

(a) For supply at voltages 3.3 kv, 11 kv, 22 kv, and 33 kv.

$.0116 (36 paise) per unit for the first 5000 units consumed during the month
$.0136 (42 paise) per unit for the next 200 units per month per KVA of billing demand
$.0129 (40 paise) per unit for the next 100 units per month per KVA of billing demand
$.0116 (36 paise) per unit for all additional units consumed during the month

(b) For supply voltages above 33 kv.
$.0116 (36.00 paise) per unit for the first 5000 units consumed during the month
$.0134 (41.50 paise) per unit for the next 200 units per month per KVA of billing demand
$.0127 (39.50 paise) per unit for the next 100 units per month per KVA of billing demand
$.0115 (35.50 paise) per unit for all additional units consumed during the month

<u>ENERGY CHARGES - Effective from November to April every year</u>

(a) For supply at voltages 3.3 kv, 11 kv, 22 kv, and 33 kv.

$.0123 (38 paise) per unit for the first 5000 units consumed during the month
$.0145 (45 paise) per unit for the next 200 units per month per KVA of billing demand
$.0123 (38 paise) per unit for the next 100 units per month per KVA of billing demand
$.0116 (36 paise) per unit for all additional units consumed during the month

(b) For supply voltages above 33 kv.
$.0123 (38.00 paise) per unit for the first 5000 units consumed during the month
$.0144 (44.50 paise) per unit for the next 200 units per month per KVA of billing demand
$.0137 (42.50 paise) per unit for the next 100 units per month per KVA of billing demand
$.0121 (37.50 paise) per unit for all additional units consumed during the month

3.5 Average Rate Levels

During 1994, AEC's customers paid an average of 1.96 Rupees (about 5.5 cents) for each kWh they consumed. However, average rate levels are significantly different by customer group. Residential rates average about 1.36 rupees per kWh (about 4 cents), while commercial and industrial rates are substantially higher (about 2 rupees or 6 cents per kWh). Agricultural rates are heavily subsidized and, consequently, very low (about 0.6 rupees or 2 cents per kWh).

Within several of AEC's tariffs, the energy charges are in increasing blocks. Or, as usage levels rise, average energy charges also rise. As a result, average rates differ for customers on the same tariff who consume different amounts of energy. The most variance is under the Residential (RGP) tariff, where the energy charge ranges from a low of 0.37 rupees (about 1 cent) per kWh for the first 25 kWh used per month to a high of 1.60 rupees (about 5 cents) per kWh for all kWh consumed in excess of the first 100 kWh. A summary of the specific charges contained in AEC's main tariffs is provided in *Table 3.1*.

Table 3.1 Summary of Charges in AEC's Main Tariffs

Note: 1 P = 1/100 R.

Tariff Schedule	Fixed Charge/Demand Charge		Energy Charge	
Residential - RGP	For single-phase supply For three-phase supply	$.064 (Rs. 2.00) / month per installation $.161 (Rs. 5.00) / month per installation	<u>(I) For a monthly consumption up to 200 units</u> For first 25 units consumed/month For next 25 units consumed /month For next 50 units consumed/month For next 100 units consumed/month <u>(ii) For a monthly consumption above 200 units</u> For first 100 units consumed/month For next 100 units consumed/month For next 100 units consumed/month Remaining units consumed/month	$.0119 (37.0P)/unit $.0126 (39.0 P)/unit $.02584(80.0 P)/unit $.0284 (88.0 P)/unit $.0258 (80.0 P)/unit $.0323(100.0 P)/unit $.0403(125.0 P)/unit $.0516(160.0 P)/unit
Commercial - CGP	For single-phase supply For three-phase supply	$.645 (Rs. 20.00)/ month per installation $1.45 (Rs. 45.00) / month per installation	For first 50 units consumed/month For next 50 units consumed/month For next 100 units consumed/month Remaining units consumed/month	$.0484(150.0 P)/unit $.0548(170.0 P)/unit $.0597(185.0 P)/unit $.0677(210.0 P)/unit
Small Motors - LTP (up to 5 B.HP.)	Fixed charges per month per B.HP. of connected load	$.387 (Rs. 12.00)/ B.HP./month	Flat rate of	$.0342(106.0 P)/unit
Small Motors - LTP (5 to 15 B.HP.)	Fixed charges per month per B.HP. of connected load	$.483 (Rs. 15.00)/ B.HP./month	Flat rate of	$.0342(106.0 P)/unit

Tariff Schedule	Fixed Charge/Demand Charge		Energy Charge	
Large Motors - LTMD (above 15 B.HP.)	a) For Billing Demand up to and including Contract Demand - First 50 kW of Billing Demand/ month - Next 30 kW of Billing Demand/ month - Rest of Billing Demand/ month b) For Billing Demand in Excess of the Contract Demand - Fixed Charge per kW of Billing Demand/ month	 $2.10 (Rs. 65.00)/kW $2.58 (Rs. 80.00)/kW $3.23(Rs.100.00)/kW $10.48(Rs. 325.00)/ kW	For the Billing Demand up to and including 50 KW For the Billing Demand above 50 kW	$.0390(121.0 P)/unit $.0439(136.0 P)/unit
High Tension HTMD-1 (Demand of 100 to 300 kW)	a) For Billing Demand up to and including Contract Demand Fixed charge per kW of Billing Demand/month b) For Billing Demand in excess of the Contract Demand Fixed charge per kW of Billing Demand/month	 $2.90 (Rs. 90.00)/kW $7.25 (Rs. 225.00)/kW	Flat Rate of Time of Use Charge for the consumption during specified hours as follows: Period Specified Hours March - Sept 10 a.m. - 6 p.m. Oct - Feb 2 p.m. - 10 p.m.	$.0445(138.0 P)/unit $.0032(10.0 P)/unit
High Tension HTMD-2 (Demand above 300 kW)	a) For Billing Demand up to and including Contract Demand - First 1000 kW of Billing Demand/ month - Next 2000 kW of Billing Demand/ month - Rest of the Billing Demand/month b) For Billing Demand in excess of the Contract Demand Fixed charge per kW of Billing Demand/month	 $2.97 (Rs. 92.00)/kW $2.94(Rs. 91.00)/kW $2.90(Rs. 90.00)/kW $6.45(Rs. 200.00)/kW	First 400 units consumed/month/kW of Billing Demand Remaining units consumed per month Time of Use Charge	$.0487(151.0 P)/unit $.0465(144.0 P)/unit $.0032 (10.0 P)/unit

Tariff Schedule	Fixed Charge/Demand Charge		Energy Charge	
High Tension Optional (Maximum Demand above 100 KVA)	a) For Billing Demand up to and including Contract Demand - First 1000 KVA of Billing Demand/month - Next 2000 KVA of Billing Demand/month - Rest of the Billing Demand/month b) For Billing Demand in excess of the Contract Demand Fixed charge per KVA of Billing Demand in excess of the Contract Demand/month	 $2.74(Rs. 85.00)/KVA $2.71(Rs. 84.00)/KVA $2.68(Rs. 83.00)/KVA $6.29(Rs. 195.00)/ KVA	First 380 units consumed/month/KVA of Billing Demand Remaining units consumed per month Time of Use Charge	$.084 (150.0 P)/unit $.046 (143.0 P)/unit $.0032 (10.0 P)/unit

Note: 1P = 1/100 R.

4. END-USE EQUIPMENT SATURATION SURVEY

Historically, AEC has done relatively little customer research, compared with similar utilities in the U.S. In 1991, AEC retained Span Associates, a local market research firm, to complete a detailed customer survey. This survey queried a cross-section of 10,000 to 15,000 of AEC's residential, commercial and industrial customers on the quality and reliability of electric service supplied by AEC and requested suggestions for improvements. Many of the recommendations in the survey have already been implemented by AEC. AEC has also undertaken a detailed analysis of its historical sales and demand data (from customer billing records) and has sorted this data by type of business or industry. The purpose of this analysis was to assist AEC with its theft detection efforts; however, this analysis is also very useful for the design of DSM programs, since customers within the same types of businesses or industries use energy in the same or similar ways.

While the results of these customer research efforts were helpful for the design of DSM programs, they, alone, were not adequate. Further research is needed to determine how AEC's customers are currently using electricity and, specifically, the characteristics of energy-using equipment presently used by the customer. Absent this information, RMA and AEC would need to rely on data from other research efforts (at other utilities in India), if it were available, and would need to assume that AEC's customers used energy in the same manner as these other utilities' customers. Such assumptions could lead to a DSM Pilot program which does not suit the needs of AEC's customers. If this were the case, AEC would lose credibility with its customers and would need to spend valuable time and money to redesign and reimplement the revised DSM Pilot program.

To avoid this undesirable outcome, AEC agreed to undertake detailed end-use equipment saturation surveys for all of its major customer groups. During 1994, RMA and AEC developed survey forms for the three major customer groups: residential, commercial and industrial. Survey forms for the industrial sector are provided in Appendix A.

In each of the surveys, AEC's customers provide three main types of information:

- Descriptive statistics about their businesses or homes (e.g. facility size, number of employees or residents, and hours of operation or occupancy)

- Data on end-use equipment operated by the customer (e.g. type of equipment, size, quantity, and rated capacity, etc.)

- Decision criteria which they use when purchasing energy-using equipment

Because the industrial sector is the dominant part of AEC's sales and revenues, AEC elected to administer this survey to its two categories of industrial customers first. AEC has been assisted with this effort by Professor Vyas, an engineering professor from the local university. AEC plans to eventually survey its residential and commercial customers as well.

The general findings from the industrial customer surveys returned to date are as follows:

Descriptive Statistics (LT and HT)

AEC TO PROVIDE

Major Types of Energy-Using Equipment (LT and HT)

AEC TO PROVIDE

Criteria for Purchasing Energy-Using Equipment (LT and HT)

AEC TO PROVIDE

Detailed reports on the survey findings and recommendations for LT and HT industrial customers are available from AEC.

5. PROCESS USED TO SELECT DSM PROGRAMS

5.1 Background

During RMA's second trip to AEC, in September 1994, a list of DSM objectives was jointly developed by RMA and AEC. Some of these objectives were based on AEC's corporate goals and their short-term and long-term plans, while others were more directly related to DSM program implementation requirements. RMA and AEC also prepared a list of DSM program alternatives for each major customer sector: residential, commercial, HT industrial, and LT industrial. These prototypical programs are candidates for eventual implementation by AEC during the next several years. The program designs for the DSM Pilot Program as well as the programs to be included in the Five-Year DSM Action Plan were selected from this list of prototypical programs.

The process of selecting a subset of DSM programs from this broader list requires the decision maker to trade-off fulfillment of one DSM objective against others. This is because alternative DSM programs have varied potential for fulfilling the DSM objectives. DSM programs that can fulfill one objective may fail to meet another. Normally, multiple objectives need to be considered as DSM program choices are made. An approach called multiattribute decision analysis allows one to systematically evaluate the trade-offs between multiple objectives as DSM programs are being evaluated.

Multiattribute decision analysis is an approach which involves qualitative rather than quantitative screening of alternatives. There are two reasons why it was necessary to use a qualitative method to select DSM programs for AEC:

(1) Many of AEC's DSM objectives are of a more qualitative nature.

(2) There is a general lack of quantitative data specific to AEC and its customers.

As discussed previously, AEC is presently involved in several research activities designed to provide quantitative data for future use in selecting, designing and implementing the DSM programs. The results of this research are being incorporated into the design of the DSM programs as they become available, but they were not available during the DSM program selection process.

5.2 Multiattribute Decision Analysis Method

Multiattribute decision analysis is used in situations where decisions must be made based on satisfying more than one objective and where some or all of the objectives are qualitative. The central focus of this approach is the quantification, display, and resolution of trade-offs that are required when objectives conflict.

The multiattribute decision analysis process (applied to DSM program selection) involves several steps:

- Identifying and defining attributes
- Mapping attributes to DSM programs
- Scoring DSM programs against each attribute
- Developing weights reflecting the relative importance of each attribute
- Calculating a weighted score for each program and each attribute and summing the weighted scores to calculate a total score

5.3 DSM Program Attributes

A total of twelve attributes were identified and discussed by AEC and RMA. Of these twelve, only nine were formally considered in the final multiattribute decision analysis process. The attributes are based on the requirements of AEC and USAID. AEC is most interested in reducing their purchased power costs and choosing DSM programs which are visible and relatively easy to implement. USAID is primarily interested in DSM programs which have rapid results, are highly visible, and have wide applicability. The three attributes not considered in the analysis – Cost of DSM Program to Utility, Cost of DSM to Customer, and Cost-Effectiveness of DSM Program to Utility – require quantitative data and a detailed program design before they can be formally considered in the decision process. At the time the DSM programs were selected, this data was not available.

The nine attributes that are considered in the decision process are as follows:

- *Power Purchases* – This attribute relates to AEC's number-one objective for DSM programs – namely, that they enable AEC to reduce its power purchases from GEB. For a program to score highly against this attribute, it must provide savings during those periods when AEC is experiencing a capacity deficit. However, the program should not save energy at other times (e.g., at night) when AEC does not need to purchase power from GEB.

- *Impact Visibility* – This objective reflects the desire of AEC and USAID to have the program be highly visible to its customers and the public in general.

- *Lead-Time* – This attribute concerns the time required before the program has a significant and visible savings impact. Some programs, such as direct load control, produce savings immediately, while others, such as information programs, take much longer to provide meaningful savings, and the savings cannot be easily quantified. Short lead-time programs are desired.

- *Implementation* – This objective refers to the ease of implementing and administering a program. This is an important attribute for a utility such as

AEC, which is relatively inexperienced with DSM program development and implementation activities. This attribute will be less important over time as AEC becomes more experienced with DSM program administration.

- *Equipment & Data* – This is one of the most important attributes. It encompasses both the ease of obtaining information about EEMs and the ease of purchasing EEMs locally. Programs which rely on locally available EEMs will fail if the equipment (and information about the equipment) is not readily available.

- *Replicability* – This attribute refers to the requirement that the DSM pilot program be applicable throughout India, so that its success can be repeated at other Indian utilities in the future. Programs which are not generic, but are specific to a particular type of business or customer, will not perform well against this attribute.

- *Understandability* – This objective relates to the need for DSM programs to be easily understood by customers to facilitate their acceptance of and participation in the programs. Again, as AEC and its customers gain experience with DSM, this attribute becomes less important.

- *Acceptance* – In general, programs which have a high probability of being widely accepted by customers should be chosen. As noted above, this attribute is partially a function of the program's understandability.

- *Snapback* – This attribute relates to the fact that a reduction in a consumer's energy costs, because of more efficient energy use, sometimes leads to a higher level of energy use by the customer. This reduces the program's energy savings and energy cost-related benefits. Certain types of DSM programs are vulnerable to snapback; these programs should be avoided by AEC.

5.4 Development of DSM Program Alternatives

The set of final DSM program designs to be considered in the multiattribute decision analysis process was developed over a six-month period. First, an extensive list of preliminary DSM program ideas was developed during RMA's second visit to AEC, in September 1994. Between four and eight DSM program concepts were developed for each major customer sector. Many of the initial program design selections were made based on the general preferences of AEC's staff, as well as the most important DSM objectives stated by AEC's management. This set of prototypical DSM programs was refined in late 1994 and early 1995, based on discussions between RMA and AEC.

During RMA's third visit to AEC, in February 1995, the set of DSM program designs was finalized and the multiattribute decision process was used to select the DSM Pilot Program and the programs to be contained in AEC's Five-Year DSM Action Plan. The final set of DSM programs considered was as follows:

Residential Sector:

- Customer Education and Energy Audit Program
- New Construction Education Program
- Customer Rebate Program for Purchases of High-Efficiency Refrigerators and Air Conditioners
- Dealer Incentive Program

Multi-Family Sector (Apartment Buildings):

- Customer Education Program
- Residential Manager Training and Contest Program
- Rebate Program for Equipment (such as Elevators) in Common Areas
- New Construction Education Program
- New Construction Rebate Program

Commercial Sector:

- Retail Store Demonstration Program
- Lighting Rebate Program
- Energy Audit/Feasibility Study Program
- New Construction Education Program
- New Construction Rebate Program
- Newsletter/Information Program
- Direct Install Program (Using ESCOs)

Industrial Sector (LT Customers):

- Energy Audit/Feasibility Study Program
- Custom Rebate Program
- Dealer Incentive

Industrial Sector (HT Customers)

- Energy Audit/Feasibility Study Program
- Major Accounts Program

- Custom Rebate Program
- Motor Rebate Program
- Dealer Incentive Program
- Efficient Motor Rewinding Dealer Incentive Program

Load Control and Pricing Programs:

- Backup Generator Peak Control (Industrial)
- Backup Generator Peak Control (Commercial)
- Direct Load Control of Flour Mills (Commercial)
- Direct Load Control of Air Conditioners and Evaporative Coolers (Commercial)
- Interruptible Tariff (Large Commercial and Industrial)
- Time-of -Day Rates (Large Commercial and Industrial)

Descriptions of the main features of these programs are provided in Appendix B.

5.5 DSM Program Selection Process

DSM programs were scored and ranked using the multiattribute decision analysis approach. Eight people were involved in the scoring and ranking process – four from RMA and four from AEC. Each person was asked to score each program against the nine qualitative attributes discussed earlier. In addition, persons were asked to assign weights to each of the nine attributes so that the relative value of each score could be quantified and a weighted score could be calculated.

Individual scores were developed based on each person's assessment of each program. To facilitate the scoring process and make it less subject to bias, five discrete values were used by the participants – 0, 0.25, 0.50, 0.75, and 1.0. To eliminate possible bias associated with differences in the number of responses from each organization, the scores were normalized on a scale of 1 to 100 so that the results could be combined and evaluated.

Table 5.1 reports the results of the multiattribute decision process. The first column (with quantitative results) contains the normalized scores. The second and third columns provide the ranking of each program and the overall rank, respectively, based on the normalized scores. In the fourth, fifth and sixth columns, sector weights have been assigned to reflect the relative importance of each sector to AEC's overall sales. The largest weight is assigned to the industrial sector, since it accounts for the largest proportion of AEC's total energy sales. Thus, columns five and six report sector-weighted scores and overall ranks.

5.6 Final Selection of DSM Programs in Five-Year DSM Action Plan

As the final results of the multiattribute ranking show, the industrial sector is the most important sector to target for DSM Pilot Program development and implementation. All programs for the Industrial - HT sector received the highest ranks, because the sector is the most dominant in terms of AEC's overall sales. The highest-ranked program is the Energy Audit/Feasibility Study program for Industrial HT customers. Also very highly ranked is the Dealer Incentive Program for both HT and LT industrial customers. These two programs have been combined to form a comprehensive DSM Pilot Program.

Since an important objective of the Five-Year DSM Action Plan was to include a broad set of programs which address all major sectors and end-uses, the remainder of the programs have been selected with this in mind. These programs are:

- Residential Customer Education and Energy Audit Program.
- New Construction Education Program for the Multifamily and Commercial Buildings.
- Interruptible Tariff for large Commercial and Industrial customers.
- Backup Generator Peak Control Program.
- Commercial Retail Store Demonstration.
- Direct Load Control Program for Flour Mills.

Table 5.1 Multiattribute Decision Analysis Results

DSM PROGRAM OPTIONS	**Total Value (Normalized)** scale: 1-100	**Rank within Sector**	**Overall Rank** sector-neutral	**Sector Weight (% sales)**	**Program Value** sector-weighted	**Overall Rank** sector-weighted
Residential						
Customer Education & Energy Audits	85.64	1	5	0.23	19.70	11
New Construction Education	85.20	2	6	0.23	19.60	12
Dealer/Retailers' Education	82.75	3	11	0.23	19.03	14
Dealer Incentive Rebate	77.11	4	15	0.23	17.73	16
Customer Rebate	65.35	5	24	0.23	15.03	17
Multi-Family (Apartment Buildings)						
New Construction Education	88.81	1	1	0.23	20.43	9
Residential Manager Training	87.71	2	2	0.23	20.17	10
Customer Education	84.41	3	7	0.23	19.41	13
Rebate (Common Use Systems)	77.47	4	14	0.23	17.82	15
New Construction Rebate	59.57	5	30	0.23	13.70	31
Commercial						
Retail Store Demonstration	87.58	1	3	0.10	8.76	23
New Construction Education	83.80	2	9	0.10	8.38	24
Newsletter / Information	83.29	3	10	0.10	8.33	25
Energy Audit / Feasibility Study	75.41	4	16	0.10	7.54	27
Lighting Rebate	73.60	5	17	0.10	7.36	28
Direct Install (through an ESCO)	61.59	6	25	0.10	6.16	29
New Construction Rebate	60.93	7	27	0.10	6.09	30
Industrial (Low-Tension)						
Energy Audit / Feasibility Study + Dealer Incentive	83.87	1	8	0.17	14.26	18
Customer Rebate Program	72.43	2	19	0.17	12.31	22
Industrial (High-Tension)						
Energy Audit / Feasibility Study	87.09	1	4	0.40	34.83	1
Motor Rewinding Rebate	72.80	2	18	0.40	29.12	3
Customer Rebate Program	70.48	3	20	0.40	28.19	4
Motor Rebate	65.97	4	23	0.40	34.83	7
Major Accounts Program	61.02	5	26	0.40	24.41	8
Load Control Strategies						
Back-Up Generator Peak Control (Industrial)	79.30	1	12	0.40	31.72	2
Stand-By Generator Peak Control (Commercial)	78.50	2	13	0.10	7.85	26
Time-of-Use Rates	70.29	3	21	0.40	28.11	5
Interruptible Tariff	70.13	4	22	0.40	28.05	6
Direct Load Control (Evaporation Cooling)	60.85	5	28	0.23	14.00	19

DSM PROGRAM OPTIONS	**Total Value (Normalized)** scale: 1-100	**Rank within Sector**	**Overall Rank** sector-neutral	**Sector Weight (% sales)**	**Program Value** sector-weighted	**Overall Rank** sector-weighted
Direct Load Control (Air Cond./Flour Mills)	60.43	6	29	0.23	13.90	20

6. DESCRIPTION OF DSM PROGRAMS IN FIVE-YEAR DSM ACTION PLAN

6.1 Industrial Energy Audit/Feasibility Study and Dealer Incentive Program (DSM Pilot Program)

The combination Energy Audit/Feasibility Study and Dealer Incentive program, targeted toward industrial customers, was chosen for the DSM Pilot Program. This program is described in detail in a companion report..

6.1.1 Brief Description of Program

The purposes of the energy audits provided through this program are to: (1) verify the information in the end-use survey regarding the customer's existing energy use (current equipment inventory, hours of operation, etc.) and (2) identify a wide range of energy-saving actions that the customer can take. These include: investments in energy saving equipment (upon burnout of existing equipment), improved operation and maintenance, and other changes in behavior (e.g., shutting off loads when not in use).

The purposes of the feasibility study are to: (1) analyze the economic viability of the actions recommended in the audit relative to the customer's economic requirements, (2) make specific recommendations regarding energy-efficient equipment which the customer should purchase, and (3) advise the customer about financing requirements.

While offering energy audits and feasibility studies to all of its industrial customers who express interest, AEC will specifically target the energy audits and feasibility studies to its Low-Tension industrial customers. AEC believes that these customers' loads are too small (30 to 70 kW) to benefit from the audit services offered by various outside firms. As a result, they do not take advantage of these services. AEC will provide these services to its customers at cost (i.e., the cost of its labor to perform the audit). Alternatively, AEC may elect to provide customers with audits and feasibility studies at no cost, provided the customer agrees to adopt the energy savings actions within a given time frame.

To increase the likelihood that customers will follow through on audit recommendations and install the equipment which is recommended, AEC will also provide an incentive to local equipment dealers. The purpose of the incentive is to reward equipment dealers who agree to supply and promote energy-efficient equipment to AEC's customers. Dealers who sell the types of energy-efficient equipment most likely to be recommended through the audits will be invited to participate in this aspect of the program. The dealers will then receive a financial incentive which is based on the volume of energy-efficient equipment they sell. The dealer incentive component will benefit all of AEC's industrial customers.

AEC will also provide an information package describing different financing options to customers who participate in this program. The following information will be included in this package: names of financial institutions, different loan options, terms of loans (interest rates, repayment schedule, etc.), and names and telephone numbers of persons at these institutions who can assist AEC's customers with their loans and loan applications.

It is believed that this combination of energy audit-based information, incentive to local equipment dealers, and financing information will result in an aggressive DSM program which addresses many of the barriers to implementation of energy efficiency which are currently present in Ahmedabad.

6.1.2 Advantages of this Program Design

There are several advantages to this combination Energy Audit/Feasibility Study - Dealer Incentive Program.

- It focuses on the customer sector which is the most dominant and has the highest potential for saving energy. Industrial customers consume about one-half of the energy sold by AEC and account for more than one-half of the energy savings potential. Within this sector, Low-Tension customers' shares of total energy use and energy savings potential are 30% and 33%, respectively.

- The audit services provided through this program will supply valuable information to AEC's customers concerning their facility's energy use and cost-effective energy efficiency investments. Since lack of this type of information is a common barrier to the installation of EEMs by these customers, the audit provided under this program is designed to directly address this barrier.

- The dealer incentive should result in EEMs being made available locally, thereby eliminating the barrier of lack of locally available EEMs. It is hoped that this incentive will also lead to a long-term change in the type of equipment supplied by local equipment dealers. This incentive may also lead to a reduction in the price of the equipment to the consumer. This will occur if dealers seek to maximize sales of EEMs to increase the total amount of incentive for which they qualify by lowering the price of the equipment. This is consistent with a strategy which splits the savings (i.e., the incentive) between the dealer and the customers so that both parties are better off.

- This program will provide an opportunity for AEC to strengthen its relationships with its industrial customers. This will foster loyalty on the part of AEC's customers, which will be especially important for AEC in the future when they face an increasing number of energy supply choices.

- This program is designed to be cost-effective for AEC compared to its other supply-side alternatives. It will also result in cost-effective investments for AEC's customers.

Both AEC and its customers will save money relative to "business as usual". In the long-run, this will benefit all of AEC’s customers.

6.2 Residential Customer Education and Energy Audits

6.2.1 Brief Description of Program

The purposes of this program are to provide customers with information about specific types of energy-efficient equipment and behaviors that can save them energy. The types of energy-efficient equipment to be addressed by this program are: 36-watt fluorescent lights, compact fluorescents, ceiling fans, evaporative coolers, efficient room air conditioners, refrigerators (one- and two-door), water pumps, horizontal axis washing machines and microwave clothes dryers. Behaviors to suggest are: shutting off lights and fans when not needed, cleaning refrigerator coils often, defrosting freezers, and controlling outdoor lighting with photocells.

AEC would also offer energy audits to high-use residential customers (at cost). The purposes of the audits are: (1) to determine what types of energy-using equipment these customers currently have, and (2) to make recommendations regarding new energy-using equipment and behaviors that could save customers energy and money.

6.2.2 Advantages of this Program Design

This program concept has several benefits:

- It is highly visible to AEC’s customers and, therefore, meets one of AEC’s key DSM program objectives. This high level of visibility is especially important for a utility, such as AEC, which is in the very early stages of DSM implementation. To date, AEC’s customers have had little exposure to information on how to save energy. As a result, they should respond more favorably to this type of program than would the customers of a utility which had been implementing DSM programs for a number of years.

- It is relatively easy to develop and administer. The program is small, its design is relatively simple, and the requirements for AEC to implement the program are not great. Again, since AEC is just getting started with DSM activities, this simplified type of program should be more likely to succeed with AEC and its customers than a more complex program design.

- Materials developed through this program are designed to begin the process of educating AEC’s residential customers to consider energy use and energy efficiency in appliance and energy equipment purchase decisions. It is hoped that after this type of program has been in effect for a few years, AEC’s customers will permanently change their buying habits to automatically consider energy use and energy efficiency in their future purchase decisions.

6.3 New Construction Education for Multifamily and Commercial

6.3.1 Brief Description of Program

The objective of this program is to educate architects, engineers, and developers of new multifamily and commercial buildings about energy-saving equipment and behaviors to incorporate in their new construction projects. This program would target multifamily buildings with first-floor commercial use.

The following types of equipment would be promoted: elevators with efficient motors, efficient water pumps, efficient hallway lighting and exit lights, efficient central air conditioning with variable speed fans, and efficient water heaters. A small financial incentive would be provided to developers who use this equipment in the construction of their new buildings. The incentive would be paid by AEC after the equipment is purchased.

To educate those involved in the building process on these types of energy-efficient equipment, both written materials (brochures) and educational videos would be provided at meetings with architects, engineers, and developers. These meetings would be held on a regular basis, at least every six months. AEC would then follow up with these individuals, either through regular telephone or written contacts, to find out what their plans are with respect to incorporating energy-efficient equipment into the construction of specific new buildings.

6.3.2 Advantages of this Program Design

This program design is highly beneficial because:

- It focuses on areas which are contributing to extremely high energy growth for AEC: namely, large residential and commercial buildings. This program is designed to teach builders and architects to "build-in" energy efficiency considerations at the front-end (as the buildings are being built). If these buildings are energy-efficient at the start, this will help to moderate the very high growth which AEC has been experiencing due to the addition of these newly-constructed buildings to its service area.

- It provides AEC with a very efficient approach for addressing the energy use of new buildings. This program would enable AEC, through relatively few contacts with builders and architects, to influence the future energy use of a large number of new buildings in Ahmedabad. This is far easier than interacting with each individual building owner/manager after the buildings are constructed.

- It provides AEC with a source of electricity savings which is highly coincident with AEC's daily and seasonal peaks, since the primary loads of these buildings are operated during AEC's on-peak periods. This helps to improve AEC's load factor and flatten its load shape. It also improves the cost-effectiveness of the program, since AEC's daytime peak loads are driving its need to purchase power from the GEB.

6.4 Interruptible Tariff

6.4.1 Brief Description of Program

Under an interruptible tariff, AEC's customers are provided with a reduced demand charge in exchange for the right to interrupt their loads during times when AEC must pay excess demand charges to the GEB. The objective of the interruptible rate is to reduce AEC's peak loads during these periods. Interruptible rates usually involve a "rider" which represents a set of provisions (e.g., demand charge discount or conditions which lead to an interruption) designed to modify the standard noninterruptible tariff. The interruptible tariff is voluntary. Customers can either receive firm (i.e., noninterruptible) service and pay the full demand charge under the standard rate, or receive interruptible service and pay a reduced demand charge.

Under the tariff, the customer either agrees to reduce load by a set amount or reduce load down to a designated firm service level. When an interruption is called for, customers who fail to produce the agreed-upon load reduction or reduction down to their firm service level pay a substantial penalty.

The customer can be notified of an interruption in one of two ways, either through a telephone call placed manually by the utility or through an automated interruption notification system where the utility sends a message through a computer-based system to each interruptible customer.

Usually, the utility and the interruptible customer execute a contract which lists the customer's obligations under the interruptible rate. The contract includes such customer-specific information as the customer's firm service level, and the length of time they agree to be served under the interruptible tariff.

6.4.2 Advantages of this Program Design

An interruptible program and tariff are potentially beneficial for both AEC and its customers. The benefits of the program are as follows:

- This program provides AEC with a source of energy and capacity savings which is very flexible and can be directly linked to the periods when AEC is experiencing a capacity shortage. This is because the program is operated and dispatched directly by AEC.

- AEC is able to achieve these savings by contacting a relatively few customers, since the interruptible program typically involves the utility's largest industrial customers. This makes it much easier to implement than a program which involves a much greater number of participants.

- Savings from the program are easy to document and evaluate, since the load reductions can be detected by AEC immediately at its dispatch center, as well as by examining customer's billing demand information. If the customer has a solid-state time-of-day meter, his billing demand information can be analyzed. Once the savings from the program are determined in this manner, the cost-effectiveness of the program can be determined immediately.

- The program is targeted toward AEC's most dominant customer group (industrial). This program will increase AEC's communications with these customers and will help AEC strengthen its relationship with them.

- From the customer's perspective, the interruptible program allows them to choose between higher-priced firm power and lower-priced interruptible power. The discounts provided to the customer through this program represent a significant benefit to participating customers.

6.5 Backup Generator Peak Control

6.5.1 Brief Description of Program

This program is based on the concept that it is less expensive for AEC to pay customers to operate their backup generators during periods of high demand and excess demand charges from the GEB, than it is for AEC to purchase power from the GEB. Under this program, AEC’s customers operate backup generators to serve their own loads and, therefore, reduce the amount of load which AEC must serve.

The level of incentive provided to customers through this program must be high enough to compensate customers for their fuel and operating costs. Also, the program will need to be designed to operate for a large enough number of hours per year to bring the customer’s backup generator costs down to a level which is cost-effective for AEC.

AEC estimates that its customers have approximately 200 MW of backup generation. Therefore, the potential for this type of program is great, provided the program is cost-effective for AEC and its customers. AEC needs to study the cost-effectiveness of this program through a detailed cost-benefit analysis. To do this, AEC needs to develop a detailed understanding of both its customers’ costs to operate their generators and its own costs when excess demand charges are present. AEC needs to collect detailed cost information from customers who are potential candidates for this program in order to assess the cost-effectiveness of this program.

This program would be implemented through a contract which is executed between AEC and each customer who agrees to participate. If the program is found to be cost-effective, AEC needs to develop a detailed contract form under which the customer agrees to operate their backup generators in response to a set of specific conditions, in exchange for payment by AEC.

6.5.2 Advantages of this Program Design

If AEC finds this program to be feasible and cost-effective for itself and its customers, the program can be designed so that it benefits both AEC and participating customers. The benefits are as follows:

- The primary benefit of the program is that it enables AEC to meet its capacity needs utilizing existing generation rather than constructing new generating facilities. Assuming this can be done cost-effectively, there are obvious cost benefits. In addition, there are important environmental benefits, because of the reduced need to construct and operate new generating facilities.

- Participating customers benefit financially from the payment they receive from AEC in exchange for their agreement to operate their generators after being notified by AEC. This payment compensates them for both their variable costs of operating the generators as well as a portion of their fixed costs (of which they would otherwise need to pay 100%).

- The savings attributable to the program are very easy to determine and document, since they are based on the output of the generator during the time period in which it is dispatched by AEC. This also makes it easy for AEC to determine actual program benefits and cost-effectiveness.

6.6 Commercial Retail Store Demonstration

6.6.1 Brief Description of Program

The objective of this program is to demonstrate energy-efficient technologies in a visible setting. A typical retail store would be chosen so that the results could be generalized to other stores within Ahmedabad. The store should be one which uses a large amount of energy. A chain store is ideal. The closest to this concept in Ahmedabad is a store selling saris or a shoe store (such as the Bata shoe store chain). For a second demonstration project, hotels could also be used and their results compared. The energy use of the demonstration facility could then be compared to other businesses which are similar, but without energy-efficient equipment, to determine the energy savings.

After the facility to be used in the demonstration has been identified, an energy audit will be done to determine which types of actions should be taken. Low-cost actions would be taken first. This equipment could be installed in several stages over many months. Lighting could be done first, since it is the easiest equipment to install. This could then be followed by air conditioning upgrades. Also, load control equipment may be included in the demonstration. A second demonstration project could demonstrate thermal cooling and ice storage.

After two or three months, the energy use per square meter of the demonstration store would be compared to a similar store in Ahmedabad. The energy savings would be calculated as well as the value of the energy which is saved. The value of the saved energy would be incorporated into a calculation of the profits for the two stores. An ad would then be published in the local newspaper which includes information on the demonstration store (what equipment is being demonstrated) and a comparison of the energy use and profits of the two stores.

6.6.2 Advantages of this Program Design

The advantages of this program are very similar to those for the Residential Customer Education and Energy Audit Program. They are as follows:

- It is highly visible to AEC’s customers, and therefore meets one of AEC’s key DSM program objectives.

- It is relatively easy to develop and administer. The program is small, its design is relatively simple and the requirements for AEC to implement the program are not great.

- Because this program is designed to evince energy savings through demonstrations of energy-efficient equipment in actual businesses throughout Ahmedabad, AEC's customers will be able to identify directly with its results and may be more likely to take similar actions in their own facilities as a result.

- Materials developed through this program are designed to begin the process of educating AEC’s smaller commercial customers on the notion of considering energy use and energy efficiency in energy equipment purchase decisions. It is hoped that after this type of program has been in effect for a few years, AEC’s customers will permanently change their buying habits to automatically consider energy use and energy efficiency in their future purchase decisions.

6.7 Direct Load Control of Flour Mills

6.7.1 Brief Description of Program

The purpose of this program is to reduce AEC's peak loads, especially during hours when AEC must pay excess demand charges to the GEB. Under this program, switches are installed on flour mills operated by AEC's customers who agree to participate in the program. AEC then sends a signal to the switch to cycle these loads off during hours of excess demand. In exchange for this load shedding, the customer receives a small bill credit each time the program is operated.

AEC has approximately 800 customers who have flour mills. The average size of the motor for each flour mill is 7.5 to 15 horsepower. These mills are typically operated during the weekday mornings and afternoons, during hours which directly coincide with AEC's peaks. The mills are not operated continuously, but on demand. Their nonintermittent operation makes them good candidates for direct load control.

The benefits of this program to AEC are greatest if the program is operated during those hours when AEC faces excess demand charges from the GEB. This program should not be operated constantly but only intermittently, or else customers will not participate.

To set the level of bill credit, AEC will determine how much it can afford to pay customers, which is based on the benefits of the program minus equipment costs. The benefits of the program are defined by the amount of excess demand charges which can be saved. These should be calculated assuming a typical year's conditions. AEC can also survey a small sample of its customers to determine what level of bill credit they would require to participate in this program.

6.7.2 Advantages of this Program Design

This program has several benefits for AEC and its customers:

- From AEC's perspective, it provides a source of energy and capacity savings which is highly coincident with AEC's daytime peak loads. The loads to be controlled through this program are generally on during weekday mornings and afternoons, when AEC's system peak loads are highest. Since AEC is able, through this program, to dispatch the program during those hours when it is facing excess demand charges, it should be able to achieve a reduction in its own peak load through control of these customers' loads.

- From the participating customers' perspective, the program provides them with a way of reducing their electricity bills without experiencing a loss of comfort or convenience. (Regarding the latter benefit, AEC should design this program in such a manner that the load reductions are not instigated during an excessive number of hours, or else customers will not participate.)

- The load reductions due to the program are easy to document and the program's cost-effectiveness is easy to determine. Load decreases can be determined almost immediately after loads have been controlled, by examining AEC's overall load data, as well as participating customers' billing demand data, and calculating the amount of the reduction before and after loads are cycled off. Once the amount of load reduction has been determined, the program's actual cost-effectiveness can be easily assessed.

- After the initial start-up phase, the program is fairly easy to operate. Load reductions are achieved through a signal sent by the utility to switches which are installed on participating customers' flour mills.

7. BUDGET FOR DSM PROGRAMS IN FIVE-YEAR DSM ACTION PLAN

A five-year budget has been developed for each of these DSM programs except for the Backup Generator Peak Control Program. No budget was prepared for that program because RMA and AEC did not have enough information from which to develop one. (This information will be developed by AEC during the next several months). For the other programs, the budget includes only those expenses which are directly attributable to the program. Therefore, these represent costs associated with resources which cannot be shifted to another area of the company if the programs are. (For example, the costs associated with the start-up of the DSM Cell have not been included since these resources can be reassigned to another department in the future.

The budget for these DSM programs was developed jointly by RMA and AEC. These budgets were developed using a "bottoms-up" approach and using local labor rates, equipment costs, and fees charged by other firms involved (such as the energy auditing firm or an advertising agency), where appropriate. For some expense categories, it was necessary to use expert judgment to estimate the expense level because there is no history to draw upon. The goal was to develop budgets which were as realistic as possible and would serve as a tool for AEC management to make decisions regarding the various DSM program expenditures.

In order to develop the program budgets for subsequent years, it was necessary to classify the expenses as one-time (i.e., first-year) or recurring. For example, training costs are only incurred during the first program year. In addition, equipment-related expenses (such as the cost of the energy audit van) were depreciated over the life of the equipment so there is a depreciation-related expense during each year of the program.

An annual escalation rate of 10% was used to estimate recurring program expenses for future years. A 15% annual interest rate was used to estimate financing costs for capital equipment such as the audit equipment and van. Finally, the total program budgets were inflated by 10% at the end of this process to account for uncertainty in the estimates.

Tables 7.1 through *7.6* contain the estimated budgets for each DSM Program for the first several years of the program. It should be noted that the overall budget for each of the programs is highest during years three through five, after all of the programs have been implemented. *Table 7.7* provides the complete DSM budget for all of the DSM programs contained in the Five-Year DSM Action Plan, except for the Backup Generator Peak Control Program (for which no budget has yet been developed).

The following observations can be made from these tables:

- The overall budget ranges from a low of 3.4 million rupees in the first year of the program to a high of 14.1 million rupees during the fifth year.

- The overall budget increases significantly during the third year, because of the addition of the interruptible program. While the budget for this program is significant, this budget and program design reflect the assumption that the program will reduce AEC's load by 10 MW. This is substantially more than the load reductions associated with any of the other programs. Also, the majority of the interruptible program budget is the value of the demand charge discounts which AEC must provide its customers each month in order to get them to participate in the interruptible program. These discounts greatly inflate the cost of the program (reflected in the budget).

Table 7.1 Estimated Budget for the Industrial Energy Audit/Feasibility Study Program & Dealer Incentive Program (in Rupees)

Table 7.2 Estimated Budget for the Residential Customer Education and Energy Audit Program
(in Rupees)

Table 7.3 Estimated Budget for the New Construction Education Program for Multifamily and Commercial Buildings (in Rupees)

Table 7.4 Estimated Budget for the Interruptible Tariff Program for Large Commercial and Industrial Customers (in Rupees)

Table 7.5 Estimated Budget for the Backup Generator Peak Control Program (in Rupees)

Table 7.6 Estimated Budget for the Direct Load Control Program for Flour Mills-Commercial Sector (in Rupees)

Table 7.7 5-Year DSM Budget

8. Cost-Effectiveness of DSM Programs: Analysis and Results

8.1 Introduction

Since a qualitative, rather than quantitative, screening process was used to select these DSM programs, cost-effectiveness has not yet been considered in the formal program screening process. In this section, the costs and benefits of the DSM programs are quantified and the results of this analysis are presented. Cost-effectiveness is assessed from three different points of view: end-users (participating customers), the utility, and society.

8.2 Cost-Benefit Perspectives

It is important to evaluate the cost-effectiveness of the DSM programs from multiple perspectives, to assess whether or not the program is beneficial to all affected parties. There are three key groups affected by each DSM program: participating customers, society, and the utility. Three cost-benefit perspectives, reflecting the financial impacts of the program on these three key groups, were assessed. These perspectives are discussed below.

Participant Perspective - The Participant perspective (or "test") measures the quantifiable benefits and costs to the customers resulting from their participation in a DSM program. Since many customers do not base their decision to participate in a DSM program entirely on quantifiable information, this perspective does not provide a complete measure of all of the benefits and costs of a program which accrue to the customer.

The *benefits* to the participating customer include the reduction in the customer's energy bills, as well as any financial incentives or tax credits accrued by the customer. The *costs* to the customers are their out-of-pocket expenses incurred because of their participation in the program. These include the cost of EEMs, equipment removal costs net of its salvage value (if applicable), and installation costs.

Because the Participant Perspective considers all of the pertinent costs and benefits involved over the life cycle of the equipment involved, it is important to consider its results. However, it alone is not sufficient, as it does not capture all of the information considered in the customer's decision-making process. A second, equally important index is the simple payback period of the EEM. The simple payback period indicates how long (in months or years) it takes for the customer's initial investment to be repaid through bill reductions following their investment in EEMs. In general, most customers require a simple payback period of three years or less in order to invest in EEMs.

Total Resource Cost Perspective - This perspective evaluates the program as a resource option for society as a whole. Essentially, this perspective compares the cost of the demand-side alternative with the cost of the supply-side alternative (i.e., "business as usual"). This test captures all of the costs and benefits involved in the decision to implement a DSM program over other supply-side alternatives and, as such is very important to consider. It should be noted that, in general, this perspective is the most difficult for DSM programs to pass.

The *benefits* to society are the avoided costs of the supply alternative. For AEC, these are defined by their savings in purchased power costs (because of the program) over the DSM program life cycle. These are calculated using the tariff which AEC pays the GEB. In some variants of this test, the benefits are expanded to include the value of reduced pollution because of the DSM program. This variant has not been considered in this report because of the difficulty of quantifying the value of reduced air pollution.

The *costs* in this case are the expenses associated with the resources directly involved with the DSM program. These include the cost of EEMs, EEM installation costs, the cost of equipment removal less its salvage value, and DSM program administrative costs.

The value of the Total Resource Cost Test derives from its very broad scope. The Total Resource Cost perspective is the only test in which costs and benefits from multiple parties' perspectives are captured. Because of this, it is important that the DSM programs be screened first against this perspective for their cost-effectiveness before they are considered any further.

Utility Cost Perspective - The Utility Cost perspective evaluates the costs and benefits of a DSM program from the standpoint of the program's impact on the utility's revenue requirement. For the utility, this test is key because it provides information regarding whether the DSM program is less costly that other supply-side alternatives.

The *costs* to the utility are the direct DSM program-related expenses. Virtually all of these are captured in the utility's budget for the DSM program which includes financial incentives (if any), equipment costs, administrative costs, advertising expenses, marketing costs, and other types of costs directly associated with the implementation of the program.

The *benefits* to the utility are a function of the cost it avoids by reducing its use of its supply-side resources (for AEC, purchases from the GEB). Thus, the benefits under this perspective are identical to those considered in the Total Resource Cost test.

Table 8.1 presents the cost and benefit terms for each of these perspectives in tabular format.

Table 8.1 Costs and Benefits Used in Various Perspectives

Costs	PERSPECTIVES		
	Participant	**Total Resource Cost**	**Utility Cost**
1. Energy-Efficient Equipment Cost			
2. Installation Cost			
3. Operations & Management			
4. Removal Costs Less Salvage Value			
5. DSM Program Administrative Costs			
6. Financial Incentives			
Benefits			
1. Avoided Purchased Power Costs			
2. Financial Incentives			
3. Bill Savings			

8.3 Cost-Benefit Analysis of DSM Programs in Five-Year DSM Action Plan

To compute the costs and benefits of the DSM programs under these three perspectives, RMA developed a simplified cost-benefit screening model using a PC-based spreadsheet program (Quattro Pro for Windows™). For AEC, it was not necessary to do this analysis using an hourly cost-benefit model such as those commonly used by U.S. electric utilities (for example, DS Manager™ or COMPASS™) since AEC has only one avoided resource cost: purchased power. As long as AEC’s purchased power cost tariff can be accurately characterized on a simpler spreadsheet-based model, it is possible to analyze each DSM program’s costs and benefits using this much simpler tool. This spreadsheet-based, cost-benefit tool will be turned over to AEC staff and be used to provide user-friendly training of DSM staff on cost-benefit analysis of DSM programs.

8.3.1 Avoided (Purchased Power) Cost Determination

To compute the value of purchased power saved by various types of EEMs, RMA performed a detailed analysis of AEC’s purchased power tariff as well as its purchased power costs during the last 18 months. Purchased power costs were separated into energy and demand-related charges and stratified by on-peak and off-peak periods. AEC provided:

- Its current purchased power tariff from the GEB, plus various amendments it has negotiated to the tariff.
- Its purchased power bills for the past 18 months.
- Its escalation in the average cost of purchased power during the past 24 months.

The following observations, pertinent to DSM programs, can be made from the detailed analysis of AEC's purchased power costs during the last 18 months:

- Energy charges are a very dominant part (about 85%) of AEC’s total purchased power cost; this will tend to favor DSM programs which save both energy and demand over those which save demand only.
- Based on AEC's monthly average purchased-power cost, per-kWh costs increase significantly during those months when its own generating units are off-line. During these months, the demand component of its purchased-power cost increases substantially, rising to up to 40% of its total cost. AEC should develop energy efficiency programs and load management programs which effectively provide load relief during these periods, so that it can avoid paying these excessive charges.

- Overall, AEC's purchased power costs are increasing very rapidly. This means that future DSM programs should be even more cost-effective than they are today. According to AEC, this is due, in part, to the fact that both coal and rail costs are rising rapidly nationwide. Both of these costs account for a significant proportion of the overall power supply cost structure of AEC's power supplier, the GEB.

From this information, RMA was able to prepare a schedule of AEC's purchased power cost savings for EEMs with different hardware lives (*Table 8.2*). This schedule reflects the current structure of AEC's purchased power tariff and the various charges within the tariff. Purchased power cost savings are provided for a generic 1 kW, 100% load factor reduction in load; these can be scaled to the actual savings and actual load factor of the technology being considered. The values in this analysis reflect a nominal escalation rate of 20.5% per year and an annual discount rate of 11% (or a real escalation rate of 9.5%).

Table 8.2 Calculation of Life Cycle Purchased Power Cost Savings (For EEMs with Different Lives)

Note: 1 Paise = 1/100 Rupee

Table 8.2 (Continued)

Note: 1 Paise = 1/100 Rupee

8.3.2. Escalation and Discount Rate Assumptions

RMA used an escalation rate of 11% per year to inflate all costs, other than purchased power, out to future years. As noted above, purchased power costs were inflated at 20.5% per year, based on AEC's recent experience. All costs (expressed in future value) were then discounted at 11% per year. These values were all set based on discussions with AEC regarding its actual experience in each of these areas. All costs were expressed in base year (1995) dollars.

8.3.3. DSM Program Costs

Cost factors for the DSM programs were developed from the Program budgets discussed in Section 7. These represent expenses which are directly assignable to each DSM program The following expenses are included in this category:

- Labor-related costs for such activities as performing audits and administering the program
- Equipment-related costs for equipment required by the program, such as EEMs, energy auditing equipment, and load control transmitters and switches.
- Expenses related to training AEC staff
- The cost of any incentives provided through the program
- Advertising expenses

RMA needed to analyze the cost-effectiveness of each DSM program in the context of various actions taken by participating customers, such as replacing worn-out equipment with energy-efficient equipment or improving operations and management (O&M) procedures. Thus, it was necessary to develop a method for allocating the costs of the program back to these customer actions. To make this allocation, RMA developed a formula for each program which expresses the costs of the program as a function of the energy and demand savings resulting from these customer actions. (To compute the per-kWh and per-kW factors contained in the formula, RMA used the annual energy and demand savings goals discussed in Section 9 in the calculation.) The resulting formulas are presented in *Figure 8.1*.

The advantages of this approach to determining program cost factors are two-fold: (1) it ties the costs to the program cost budget and therefore provides some assurance that the cost-benefit analysis of the program will fully consider all pertinent program costs in the calculations, and (2) the use of a formula makes it relatively easy to analyze the sensitivity of the results to program revisions (e.g., changes to the annual budget or annual energy/demand savings goals).

Figure 8.1   DSM Program Cost (Including Administrative Cost) Factors

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1 Industrial Energy Audit/Feasibility Study and Dealer Incentive Program (DSM Pilot Program)

(.41 Rs./kWh x EEM Life) + (32 Rs./kW/month x 12 months x EEM Life)

2. New Construction Education for Multifamily and Commercial Buildings and Commercial Retail Store Demonstration Program

(.48 Rs./kWh x EEM Life) + (285 Rs./kW/month x 12 months x EEM Life)

3. Interruptible Tariff

82 Rs./kW/month x 12 months x kW reduced

4. Direct Load Control of Flour Mills

212 Rs./kW/month x 12 months x kW reduced

Formulas were not specified for either the Backup Generator Peak Control Program or the Residential Customer Education & Energy Audit Program, because of lack of budget and kW/kWh savings information, respectively.

8.3.4. *Energy-Efficient Equipment Costs*

During 1994-1995, RMA and AEC researched the present state of EEMs supplied in India. The objectives of this research were to:

- Confirm that a wide range of EEMs, addressing all major end-use and technology categories is available in-country.

- Provide data needed for the cost-effectiveness analysis of the DSM Pilot Program, such as the equipment cost, energy/demand savings, and the equipment life.

- Provide information on the general business climate for EEMs in India which could be shared with U.S. businesses interested in partnering and joint-venture opportunities.

A detailed Business Focus Report will be completed by the end of the year which summarizes the findings of this research effort. (This report is being developed through the Energy Audit Improvement component of the EMCAT Project.) However, information pertinent to the cost-benefit analysis of the DSM Pilot program will be presented in this report.

Through this research, RMA and AEC have found that a wide range of EEMs is presently available in India. In general, the efficiency of the EEMs available in India is lower than those available in the U.S., Europe, or Japan. To simplify the data collection process, RMA and AEC's research tended to focus on the very large equipment manufacturers, such as Crompton-Greaves, Philips-India, and Kirloskar. All of these firms produce an energy-efficient product line for the end-use(s) in which they specialize. RMA assumed that their products were representative of the EEMs typically available in India and utilized data related to these products in its cost-benefit analysis. *Table 8.3* summarizes the EEM data used by RMA to analyze the cost-effectiveness of several of the DSM programs contained in this Five-Year DSM Action Plan.

8.4 Results of Cost-Benefit Analysis of DSM Programs

RMA found most of the DSM programs to be cost-effective overall and for a wide range of EEMs likely to be promoted through the programs. In order for a program and a measure associated with the program to be cost-effective, it was required to satisfy the following criteria:

- Pass the Total Resource Cost Test (i.e., have a Benefit-Cost ratio of one or greater)
- Pass the Utility Cost Test
- Pass the Participant Test

- Have a simple payback period of three years or less

The vast majority of the DSM programs and EEMs promoted through the program satisfied the above criteria. For the industrial sector (the subject of the DSM Pilot Program), a large number of EEMs addressing the motors end-use were cost-effective, as were many EEMs for the lighting end-use. For the commercial sector, EEMs for lighting, HVAC, and pumping were cost-effective for the two DSM programs promoting the use of these measures.

As *Table 8.4.c* and *8.4d* show, neither the Interruptible Tariff nor the Direct Load Control of Flour Mills programs are cost-effective as presently designed, since neither program passes the Utility Cost Test. The Interruptible Tariff can be made cost-effective by reducing the level of the demand charge discount by 25% from the level assumed in the program budget. This implies a discount of 450 Rs.($14.50) per kW per year, rather than the 600 Rs.($19.35) per kW per year reflected in the current program budget. Even this reduced level brings the program only to a break-even level. Should AEC desire to reduce its costs through use of this program, they will need to consider further cuts in the demand charge discount beyond what is suggested here. AEC will also need to determine whether or not it can generate sufficient customer interest in this program, given the reduced level of discount.

Unfortunately, the Direct Load Control of Flour Mills program is far from being cost-effective. The reason for this is that there are too few customers participating in this program to bring the load control equipment costs (per customer) down to a reasonable level. Under the current program design, two hundred customers are assumed to participate. However, AEC will need to expand this program (by adding additional end-uses to be controlled) so that it involves a few thousand participants, in order to make the program cost-effective. In the U.S., the most common types of equipment involved in direct load control programs are central air conditioners and electric water heaters. (Window air conditioners are not generally cost-effective.) AEC will need to investigate whether or not it has a sufficient number of customers with these types of equipment who are interested in participating in this program in order to determine whether or not the program can be made cost-effective.

Tables 8.4a-d and *8.5a-b* present the quantitative results of the cost-benefit analysis performed by RMA for the DSM programs and EEMs which were analyzed. In *Table 8.4a-d*, the Benefit-Cost Ratios and Simple Payback periods are presented for each DSM program and, where appropriate, each of the EEMs promoted through the program. *Tables 8.5a-b* contain additional information on the energy saved by the measure as well as the cost savings resulting from the installation of each EEM. In the next section of this report, the results of this economic screening will be presented in another way, as estimates of economic energy savings potential.

Table 8.3 Energy-Efficient Measures Data

Table 8.3 (continued)

Table 8.4a Industrial Energy Audit/Feasibility Study & Dealer Incentive Program - Cost-Benefit Ratios and Simple Paybacks

Table 8.4b New Construction Education Program for Multifamily & Commercial and Retail Store Demonstration Program - Cost-Benefit Ratios and Simple Paybacks

Table 8.4c Interruptible Tariff - Cost-Benefit Ratios

Sector	Simple Payback	Technical Savings	Total Resource Cost	Utility
Large Commercial and Industrial	0.00	1,000.0	37.04	0.85

Table 8.4d Direct Load Control of Flour Mills - Cost-Benefit Ratios

Sector	Simple Payback	Technical Savings	Total Resource Cost	Utility
Commercial	0.00	0.42	0.42	0.33

Table 8.5a Industrial Energy Audit/Feasibility Study and Dealer Incentive Program - Other Cost-Benefit Information

Table 8.5b New Construction Education Program for Multifamily & Commercial Buildings and Commercial Retail Store Demonstration Program-Other Cost-Benefit Information

9. ANNUAL ENERGY AND DEMAND SAVINGS GOALS

Annual energy and demand savings goals are estimates of the amounts of electricity (kWh and kW) which AEC can expect to save through the implementation of these DSM programs. For AEC, every kWh and kW saved is one less kWh and kW they would need to purchase from the GEB. RMA used a two-step process to estimate savings goals for AEC. First, RMA estimated technical and economic savings potential for AEC overall. These estimates provide a useful starting point for the development of DSM program-specific energy and demand savings goals. Second, savings attributable to the program were estimated based on the specific design of each program. The following sections provide a detailed description of this process.

9.1 Calculation of Technical and Economic Savings Potential

Technical savings potential is defined as the net electricity savings which could be achieved by replacing all existing end-use technologies with the most energy-efficient equipment whenever it is technically feasible as the standard technologies wear out.. Efficient measures are installed irrespective of their cost. It is assumed that unlimited quantities of energy-efficient devices are available and a large engineering staff is readily available to install the devices. Estimates of technical potential provide an absolute upper-bound on the amount of energy savings which could be achieved by the utility under the most favorable of circumstances, but they are not practical for any other use. *Economic savings potential* represents energy savings which is both technically and economically feasible for a utility and its customers. Estimates of economic savings potential are far more useful as they are based on normal equipment replacement intervals and cost-effectiveness constraints. Economic potential calculations can also incorporate other barriers in the marketplace, such as lack of energy-efficient equipment and lack of available financing.

In order to estimate technical and economic electricity savings potential, RMA developed the End-Use Technology DSM (ETD) Model. The ETD Model is a tool which allows the user to identify cost-effective EEMs and forecast the measures' potential savings and penetrations for various customer subgroups. The model has two main components: the Technical Assessment Module and the Economic Assessment Module. Technical savings potential is estimated within the first component of the model and economic savings potential is computed within the second component. Each of these components are discussed below.

The ETD Model performs the following functions:

- It calculates the technical energy savings potential based on the level of activity in each customer subgroup and the number of eligible equipment applications for the years 1995 to 2010.

- It computes both the total and incremental capital cost over the life of the EEMs.

- It performs a cost-benefit screening of the EEMs from the point of view of the participant, the utility, and society.

- It estimates economic savings potential based on the results of the cost-benefit screening, the number of eligible applications, and the rate at which equipment is normally replaced.

- It ranks the EEMs in the order of increasing cost per kWh saved, generates energy efficiency supply curves, and selects the least-cost set of EEMs based on this ranking.

9.1.1 Energy-Efficient Measures Cost and Savings Analysis

A five-step process was used to identify appropriate EEMs and compute their life cycle cost and energy savings levels as well as the per-unit cost of saved energy over the equipment's life.

First, criteria were used to identify the set of EEMs which would be considered as candidates for promotion through a DSM program. The EEMs had to be available in India. Only EEMs for major end-use categories were considered. In the industrial sector, motor and lighting end-use categories were considered. Together, these account for about 85% of the usage for the industrial sector. For the residential sector, efficient lighting systems, HVAC measures (window air conditioners and evaporative coolers) and appliances (i.e., refrigerators, hot water heaters, and fans), which account for about 85% of total consumption, were analyzed. The lighting, HVAC, and pumping end-uses were included in this study for the service sector, since they address about 95% of the sector's energy needs. The pumping and lighting end-uses were addressed for the agricultural sector as they comprise nearly 100% of the sector's electricity requirements.

Second, data characterizing existing conditions <u>before</u> application of the EEM, were compiled for each potential application. The following types of data were needed: the saturation of various types of electricity-using equipment; annual electricity consumption associated with each type of equipment, the capital and operating costs of the existing (standard-efficiency) equipment, and the life of the existing equipment. Because this analysis presumes that energy savings will occur as existing standard efficiency equipment is replaced by EEMs, it is also useful to know the age of the existing equipment in order to predict when the equipment replacements will occur.

Third, the total and incremental costs of the EEMs were computed. The total capital cost is defined as the cost to purchase, install, and maintain the EEM over its useful life. Incremental cost represents the difference between the total costs of the EEM and the total costs of the standard- efficiency technology. When both installation and maintenance costs for the standard-efficiency technology and the EEM are similar, they were not included. In cases where the EEM is a control system or device which is added (such as an adjustable speed drive), the total and incremental costs are the same because nothing is being replaced. Additionally, the incremental costs are negative in some instances, for example, when conversion to energy-efficient equipment is paired with downsizing of the equipment, in which case, there is an overall cost savings.

Fourth, the annual and life cycle energy savings of the EEM was calculated. The annual energy savings represents the difference between the estimated annual electricity consumption of the standard-efficiency equipment, with line losses included, and that of the EEM. Thus, the resulting energy savings figures represent energy saved at the point of generation, rather than at the end-user level.

Fifth, the cost-effectiveness of the EEMs was computed. Benefit-cost ratios were calculated for the three perspectives described earlier, and the simple payback period of the EEM for the end-user was calculated. In addition, the cost of saved energy was computed. The cost of saved energy equals the 15-year net present value of the incremental cost of the EEM (which includes installation, maintenance, and replacements as needed) divided by the 15-year discounted kWh savings. Utility administrative cost and incentives or rebates are not included in the calculation. Because the cost of saved energy has been calculated at the power supply level, it is directly comparable to AEC's avoided costs (i.e., their purchased-power costs) discussed in Section 8.

9.1.2 Estimates of Technical and Economic Potential

Table 9.1 presents a summary of RMA's estimates of Technical and Economic electricity savings potential for AEC. Several important observations can be made from the data in this table.

For the estimates of Technical Potential:

- The energy (kWh) savings represents about 17% of AEC's annual sales, while demand (kW) savings represents a much smaller fraction, about 7%, of AEC's annual system peak demand.

- Most of the Technical electricity savings potential is associated with the lighting end-use. A much smaller fraction is for the motors and appliances end-uses. This is because EEM lighting savings per replacement can be as great as 75%, while, per replacement, motor savings are typically less than 5%. Also, lamps have a far shorter life than motors, thus a larger fraction of their total number can be replaced each year.

- Most of the Technical savings potential is concentrated in the residential sector and the lighting end-use within that sector. This is not surprising, given the large number of residential customers served by AEC and the large amount of inefficient lighting used by residential customers.

Table 9.1 Summary of Energy & Demand Savings Goals from Programs in Five-Year DSM Action Plan

PROGRAM	SAVINGS GOALS		
	Energy (kWh/year)	Demand (kW)	Program Years
1. Industrial Energy Audit & Dealer Incentive (DSM Pilot)	399,395	75.2	1 - 5
2. New Construction Education for Commercial Buildings	303,710	84.9	2 - 5
3. Interruptible Tariff	-	7,500.0	3 - 5
4. Backup Genearator Peak Control	NE	NE	NE
5. Commercial Retail Store Demonstration	70,075	25.8	2 - 5
6. Residential Customer Education & Energy Audits	NE	NE	1 - 5
7. Direct Load Control of Flour Mills	-	600.0	2 - 5

For the estimates of Economic Potential:

- The energy (kWh) savings potential represents about 5% of AEC's annual sales, while demand savings potential is only about 2%. The reduction in these values reflects the results of the cost-effectiveness screening, the normal replacement cycle of inefficient devices, and RMA's judgment that the pool of eligible customers in certain sectors (e.g., residential) would be limited by the customers' lack of income to purchase EEMs.

- The breakdown of Economic savings potential by major end-use and customer group follows the same pattern as for Technical potential (and for the same reasons). Lighting is the dominant end-use and residential is the dominant customer sector.

In general, these estimates suggest that the Economic savings potential within a given year is small. This is partly because the ETD model assumes that all currently operating devices are as efficient as new standard-efficiency devices. Actual savings will be greater as old, inefficient devices (operating well below the efficiency of today's standard technologies) are replaced by EEMs. (However, not all of these savings are attributable to the DSM program. Since the program encourages customers to install EEMs instead of standard efficiency equipment, the calculations were done with this in mind.) It should also be noted that the savings potential is much greater over many years, because of the cumulative effect of equipment replacements. Savings will also accrue through time as new and more efficient EEMs enter the Indian market and as low- and no-cost ECOs and new technologies are recognized and implemented.

Appendix C provides detailed work papers which support and explain these calculations of Technical and Economic Savings Potential.

9.2 Development of Annual Energy and Demand Savings Goals

Annual energy and demand savings goals are estimates of the amount by which AEC’s energy and capacity supply requirements could reasonably be reduced because of the DSM program. They are tied to the level of EEMs which are purchased and installed in a given year and are typically expressed as energy (kWh) and peak demand (kW) saved within a given year. These goals are valuable for:

- Rationalizing the DSM program budget to senior management who may wonder "what are we getting for what we’re spending?"

- Analyzing the cost-effectiveness of the proposed program(s).

- Providing a basis for acquiring human and financial resources to support the program, such as staff, equipment, and promotional materials.

- Supporting the company’s integrated resource planning efforts.

The magnitude of the company’s annual energy and demand savings goals is influenced by a number of factors. The most significant influences are the customers’ current energy-use levels and potential for saving energy, the specific design and incentive level of the DSM program, the aggressiveness with which the program is promoted by the utility, the level of energy prices, the degree to which energy-efficient devices and practices have been installed and implemented absent a DSM program, the availability of EEMs locally, and the availability of local financing.

Annual Energy and Demand Savings Goals

For each DSM program, energy and demand savings goals were estimated based on the specific design of the program. For some programs, such as the Industrial Energy Audit/Feasibility Study and Dealer Incentive Program and the New Construction Education Program for Multifamily and Commercial Buildings, goals were based on the types of equipment likely to be replaced through the program, the number of units of equipment eligible for replacement each year, and an estimate of the proportion of eligible units likely to be replaced by EEMs because of the program. For other programs, such as the Interruptible Tariff, the Commercial Retail Store Demonstration and the Direct Load Control Program for Flour Mills, goals were based entirely on the specific design of the program and the level of customer participation assumed in the program budgets. For still other programs, namely the Residential Customer Education and Energy Audits and the Backup Generator Peak Control Programs, savings goals were not estimated because of the high degree of speculation that would have been required. For those programs for which savings goals were quantified, the following procedures were used.

For the Industrial Energy Audit/Feasibility Study and Dealer Incentive Program (the DSM Pilot Program), the following general procedure was used to compute program goals: (A more detailed description of the goal-setting process for the DSM Pilot program can be found in the detailed report on that program.)

- First, the motors and lighting end-uses were identified as those most likely to be addressed by the program.

- Second, from the assessment of technical and economic potential, kWh/year and kW savings amounts were identified for the motors and lighting end-uses (within the industrial sector). These amounts represent the savings which could be achieved if 100 percent of the units eligible for replacement are replaced with EEMs during 1995.

- Third, these savings potentials were scaled down substantially to reflect the level of activity possible through the DSM Pilot Program during the first year.

- Fourth, RMA estimated that the Pilot Program would be able to capture two percent of the scaled-down savings potential during the first year of the program

For the New Construction Education Program for Multifamily and Commercial Buildings, a slightly different process was used, as follows:

- First, four end-uses were identified as those most likely to be addressed by the program: lighting, central air conditioning, elevator (motors) and water pumps.

- Next, EEMs associated with each of these four end-use categories were identified and the energy savings (kWh/year and kW) for each EEM was estimated. The energy savings data was derived from the assessment of technical and economic savings potential.

- Third, RMA and AEC projected that ten buildings per year would participate in the program and install these EEMs. This figure is based on judgment, as there is no history to utilize.

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Fourth, RMA calculated the annual energy and demand savings for the ten buildings and the EEMs promoted through the program. The resulting figures represent the annual energy and demand savings goals for this DSM program.

Energy and demand savings goals for the Interruptible Tariff, the Commercial Retail Store Demonstration and the Direct Load Control of Flour Mills Programs were derived as follows:

- First, the level of participation (number of customers or kW controlled) and the number of EEMs installed per year were obtained from the program budgets. These figures are as follows: for the Interruptible Tariff, 10 MW of interruptible load; for the Commercial Retail Store Demonstration, 5 participating stores; and for the Direct Load Control of Flour Mills Program, 200 participating customers. For the Commercial Retail Store Demonstration, the number of EEMs per participating store was also derived from the program budget.

- Next, the level of energy and demand savings per participant and per EEM was estimated. Values for the EEMs promoted through the Commercial Retail Store Demonstration Program were obtained from the assessment of technical and economic savings potential. For the Direct Load Control Program, a value of 3 kW of savings per customer was selected, based on the size of a typical motor (7.5 to 15 hp) and the degree of coincidence with AEC's peak. For the Interruptible Tariff, the 10 MW of participating load was reduced to 7.5 MW based on an assumed coincidence factor of 75 percent.

- Finally, the annual energy and/or demand savings goals for each program were computed by multiplying the energy and/or demand savings per participant times the assumed number of participants.

Table 9.2 provides a summary of the energy and demand savings goals for these five programs.

Table 9.2 Summary of Energy & Demand Savings Goals from Programs in Five-Year DSM Action Plan

PROGRAM	SAVINGS GOALS		
	Energy (kWh/year)	**Demand (kW)**	**Program Years**
1. Industrial Energy Audit & Dealer Incentive (DSM Pilot)	399,395	75.2	1 - 5
2. New Construction Education for Commercial Buildings	303,710	84.9	2 - 5
3. Interruptible Tariff	-	7,500.0*	3 - 5
4. Backup Generator Peak Control	NE	NE	NE
5. Commercial Retail Store Demonstration	70,075	25.8	2 - 5
6. Residential Customer Education & Energy Audits	NE	NE	1 - 5
7. Direct Load Control of Flour Mills	-	600.0*	2 - 5

Notes: NE = Not Estimated
* provided program can be made cost-effective

10. IMPLEMENTATION REQUIREMENTS

10.1 Industrial Energy Audit/Feasibility Study and Dealer Incentive Program (DSM Pilot Program)

10.1.1 Training of AEC Staff

Initially, AEC is contracting with an outside firm, PDTC based in Rajkot, to accompany their staff to customer sites and perform energy audits. Through this approach, AEC staff will be trained on audit techniques on-the-job as audits are being performed. AEC expects PDTC to provide standard software, report formats, industry information and other pertinent information. PDTC will also provide audit equipment, energy buses, etc. that they use normally. At the end of 12 months, AEC staff will be self-sufficient and in a position to perform these audits on their own.

Additionally, engineers in AEC's Power Services Division (PSD) are being trained to perform energy audits and feasibility studies for AEC's customers. These engineers are being trained on-the-job through an outside firm (as discussed above) as well as through the formal classroom-based Energy Auditor training provided through the EMCAT project. Once they are trained, these PSD engineers are available for hire by AEC or outside firms.

10.1.2 Equipment Requirements

Within 6 months of the start of this program, AEC plans to purchase a complete set of standard audit equipment as well as an energy auditing van. AEC is in the process of procuring many of the energy auditing instruments through the Energy Audit Improvement component of the EMCAT project.

10.1.3 Staff Requirements

A minimum of two trained auditors are required to implement this program. These trained auditors need to be skilled in both engineering and financial analysis. They also need to be trained in energy auditing techniques, both through formal classroom training and on-the-job as previously mentioned. AEC also plans to assign an Electrician/Driver to this program.

10.1.4 Marketing Approach

Initially, AEC plans to use industrial customers’ responses from the end-use survey to identify customers to market this program toward. Through the survey process, eighteen of AEC’s HT industrial customers have already expressed interest in having an energy audit done. AEC is presently negotiating with all of these customers and plans to carry out audits for all of them, provided the negotiations are successful. Following this, AEC will review individual customers' specific responses and identify high energy users within the LT-P and LT-MD tariff categories. AEC will supplement this review with an analysis of its billing data for LT customers to identify additional candidates for the program. These high energy users are the first priority for marketing.

After these high-priority customers have been identified, AEC will contact them in writing to explain the program and how the customer would benefit. If customers indicate they are interested in having an audit done, AEC will contact them directly and set up an appointment for an audit. If AEC gets low or no responses from the postcard they will need to follow up with personal phone calls.

AEC also intends to contract local trade associations such as Gujarat Chamber of Commerce, ATMA, ATIRA, Industrial Estate Associations, CII, Ice Manufacturers and Cold Storage Associations, etc. to find out when their meetings are. AEC will then attend meetings on a regular basis and use these as a vehicle for publicizing their programs.

10.1.5 Advertising

AEC is developing a set of written materials (flyers and brochures) to explain the program to customers and equipment dealers. After the program has been in effect for about one year, AEC will develop marketing materials which describe success stories (i.e., experiences of individual customers) to further promote the program. AEC also plans to develop a videotape explaining the program which can be used at trade association meetings.

10.2 Residential Customer Education and Energy Audits

10.2.1 Equipment Requirement

AEC would perform research on energy-efficient equipment for residential customers so that it knows what to recommend to its customers.

10.2.2 Marketing Approach

Brochures and materials would be prepared by AEC. A request form would be included with the customer's bill. The customer would then submit the request form to AEC for the materials. Request forms could be noted on customer account records so that the effectiveness of these materials could be assessed and documented.

Audits would be performed for the highest-use customers only (perhaps the top 50). Energy analyses would be done for the customers, assuming they replaced certain types of equipment or reduced the hours of operation of their equipment.

10.2.3 Lead Time for Implementation

About four months would be required to develop the brochures and marketing materials, once the detailed program concept is developed.

10.2.4 Advertising (Media to be used, Slogan or Message, etc.)

All forms of advertising would be considered, including newspapers, TV, magazines, kiosks, billboards, etc. Also, brochures or newsletters could be distributed along with customer bills. Some information can also be printed on the bill itself. Other types of promotional materials include: bumper stickers, videos for display on local newscasts, etc. AEC would also prepare some articles on energy conservation for the local newspaper.

10.3 New Construction Education for Multifamily and Commercial Buildings

10.3.1 Equipment Requirements

AEC would perform research on the types of energy-efficient equipment to be promoted in new buildings to determine what types of equipment to promote to builders. AEC would determine the cost and energy use of this equipment as well as who distributes it locally or regionally. If none of this equipment is available locally or regionally, AEC would need to provide a dealer incentive to local/regional equipment dealers who agree to stock the efficient equipment.

10.3.2 Marketing Approach

AEC would draw up a list of the architects and builders it has worked with in the past. If this is not a complete list, AEC may be able to supplement it by contacting the local builders' association. Local banks may also be a source of information since builders would need to go through them for financing these projects.

10.3.3 Advertising (Media to be used, Slogan or Message, etc.)

Since this program will be promoted through personal contacts by AEC, no additional advertising should be needed.

10.4 Interruptible Tariff

10.4.1 Equipment Requirements

No equipment is required if customers are to be notified manually of interruptions. If an automated interruption notification system is used, AEC would need to procure the necessary communications equipment.

10.4.2 Marketing Approach

AEC would evaluate its HT customers to see if they are good candidates for the tariff. At a minimum, this means talking with the customers over the telephone or in person, explaining the program, and determining whether or not they can tolerate the potential inconvenience caused by the interruptions.

10.4.3 Advertising (Media to be used, Slogan or Message, etc.)

None.

10.5 Backup Generator Peak Control

10.5.1 Equipment Requirements

None.

10.5.2 Marketing Approach

AEC would assess customer interest in this program as the program is being designed. After the details of the program are known, AEC would recontact each of its customers with backup generation to see if they are interested in participating.

10.5.3 Advertising (Media to be used, Slogan or Message, etc.)

None.

10.6 Commercial Retail Store Demonstration

10.6.1 Equipment Requirements

The demonstration project would involve energy-efficient equipment which is available locally or within India. Ideally, equipment which is high-technology would be selected as this may be more appealing to the general public. In general, this would include lighting equipment, cooling equipment and other types of equipment which are fairly easy to install. The equipment would be provided by AEC at no cost to the facility owner.

10.6.2 Marketing Approach

Energy use and savings (in rupees) would be monitored for a few months. The use and profits of the demonstration facility would then be compared with a similar business. The results would be published in an ad in the local newspaper.

10.6.3 Lead Time for Implementation

This program could be implemented very quickly if the equipment is available and the businesses are willing. The equipment could be installed within 1 to 2 months and some results could be available within 4 to 6 months.

10.7 Direct Load Control of Flour Mills

10.7.1 Equipment Requirements

The equipment requirements for this program are considerable. AEC would need to purchase both the direct load control switches (which are installed on the flour mills) and the transmitters (which send a signal to the mills to cycle them off and on). There are two types of technologies which can be used to send the signal : power line carrier and radio control. Most of this equipment is made by companies based in Europe or the U.S. Some of these companies may have equipment distributors in India.

10.7.2 Marketing Approach

AEC would develop a list of all of its customers who operate flour mills. AEC would then contact each of these customers to see whether or not they are interested in participating in a direct load control program.

10.7.3 Lead Time for Implementation

At least 12 months would be required to: design the program and tariff; recruit customers; and procure, install and test equipment before the program can be implemented.

11. MONITORING AND EVALUATION

Monitoring and evaluation activities are needed to: determine whether the DSM programs are working as designed and verify the estimates or energy and demand savings as well as the cost-effectiveness of each DSM program. The proposed monitoring and evaluation tasks are designed to be relatively simple and straightforward, so that they can be easily conducted by AEC staff without a lot of technical training. Information obtained through these activities will provide AEC insight into the effectiveness and success of each DSM Program at various stages of its implementation. From these tasks, AEC should have enough information to verify the effectiveness of the program. The suggested tasks for monitoring and evaluating each DSM program are described below.

11.1 Industrial Energy Audit/Feasibility Study and Dealer Incentive

AEC will contact customers whose facilities are audited at least once per month after the audit and feasibility study have been completed. The purpose of these contacts is two-fold: to promote the recommendations made in the audits (for those that the customer has not yet acted upon) and to collect information on actions the customer has already taken. If the customer indicates that they have taken some or all of the actions recommended in the feasibility study, AEC will collect information from them describing the characteristics of three types of equipment: that which was previously used by the customer, the new energy-efficient equipment, and the equipment the customer would have purchased absent the program. This information, plus data from the energy audits and feasibility studies (such as hours of use for the equipment) should allow AEC to compute the energy and demand savings due to the program for each action taken.

AEC will contact the local equipment dealers and motor rewinding firm participating in the dealer incentive at least monthly to collect information about their actual sales of EEMs. This activity not only helps with the monitoring and evaluation of the program, it also provides information needed for the administration of the dealer incentive. AEC will be able to use the data from these contacts with equipment dealers to assess the effectiveness of the dealer incentive in promoting sales of EEMs to all of AEC's industrial customers and not just those customers who have had their facilities audited.

11.2 Residential Customer Education and Energy Audit Program

To assess the effectiveness of the educational component of the program on the average residential customer, AEC can either conduct a written or telephone survey or convene focus groups. Either of these should be done within a very short time after the advertising is completed (i.e., within one to two weeks). Using either technique, AEC should ask its customers a series of questions designed to determine how well the customer understood and retained the information contained in the advertising. AEC should also query these customers on what, if any, actions they plan to take in order to save energy. To determine the amount of energy savings actually induced by the program through the advertising, AEC should repeat this second block of questions at least every three months in order to identify what specific energy saving actions customers have taken in response to the program. Regarding actions the customer has already taken, AEC should collect information on the characteristics of: the types of equipment previously used by the customer, the new energy-efficient equipment, and the equipment the customer would have purchased absent the audit. AEC should also query audited customers on low and no-cost actions taken, such as shutting off lights when not in use, improved O&M of major appliances (e.g., refrigerators), and so forth.

For the audit component of the program, AEC should also follow up with the audited customers, at least monthly, after the audit has been completed in similar fashion to its follow-up for the information component of this program.

11.3 New Construction Education for Multifamily and Commercial Buildings

AEC can collect information regarding what was purchased and installed, what would have been purchased otherwise, etc. at the time the developer applies to AEC for a financial incentive. (The incentive is given out after the equipment has been purchased).

11.4 Interruptible Tariff

After AEC calls for an interruption, it will be able to immediately see a drop in total load at its Power Control center which is due to the program. In addition, each customer's meter can be read immediately after the interruption is called for (to assess the amount demand is reduced) or, if electronic metering is used, the consumption data can be analyzed after-the-fact to determine demand savings.

11.5 Backup Generator Peak Control

The backup generators can be metered directly and the meters can be read before and after the equipment is operated to determine the amount of energy and capacity saved under the program.

11.6 Commercial Retail Store Demonstration

For the stores involved in the demonstration, AEC can do spot metering and engineering calculations before and after the EEMs are installed to determine the level of energy saved at the stores. To see whether other, similar stores in Ahmedabad have installed similar equipment and experienced a comparable amount of energy savings, AEC can do a written or telephone survey of stores in the area. If they indicate they have taken similar actions, AEC can do the same kind of spot metering and engineering calculations to compute savings.

11.7. Direct Load Control of Flour Mills

After AEC cycles customers loads off, it may be able to monitor savings by detecting a drop in total load at its Power Control Center which is due to the program. In addition, AEC may use its meter readers to read the demand meters of a sample of customers on this program both before and during a load control period. From this data, AEC can calculate the savings in demand for the average customer. AEC should also interview a sample of customers whose loads have been controlled to determine whether or not they experienced any loss of business or complaints by their customers.

APPENDIX A
AEC Survey Forms

APPENDIX B
DSM Program Ideas

APPENDIX C
Work Papers Used to Develop Estimates of Technical and Economic Potential