# LEARNING FROM INDIA:

# DEFINING PROFITABLE DSM AND ESCO PROGRAMS FOR A UTILITY

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***How would DSM be viewed if there were no regulatory requirements for it? Experience with a first of its kind DSM program in India has turned up some surprising results regarding the kinds of projects that can occur without utility or government subsidies. It also reveals the shortcomings of a US definition of demand management in which utility benefits and program planning are predicated on rate recovery mechanisms. Ironically, the US, which has proudly shared its "wisdom" with developing countries, could learn from some new paradigms emerging from places such as India.***

There is no question that India lags far behind most of the industrialized world in the area of energy efficiency. In fact there have only been three attempts at utility programs in India to date, and only one of them has been fully operational. The first and largest of these programs, at Ahmedabad Electric Company (AEC), has produced many surprises, and lessons applicable for private, profit-making utilities located elsewhere.

When the US Agency for International Development (USAID) initiated efforts to establish demand-side management (DSM) at AEC in 1994, the conventional wisdom was that developing countries were in the fortunate position of learning from a decade or more of experience with energy efficiency and DSM in the U.S. What was not anticipated at the time was that our collective wisdom about demand management in the US would be replaced by a more skeptical and businesslike approach to energy services within the next five years. (And of course along with that, the term DSM would go out of fashion.) This occurred for a number of reasons, including industry deregulation and business consumer backlash over rate impacts from mandated utility DSM programs.

Ironically, the newer, more economic-focused message was evident in India right from the start. There are no broad government-mandated utility programs, with energy-efficiency rebates or other incentives, nor are there any ratepayer-funding mechanisms. Thus, any DSM efforts there need to be justified by their own economic merits. In fact, we can learn an important lesson from India -- that a profit-motivated business model for utility DSM is possible. Our counterparts there can offer us a model of how utility programs can enhance profitable operations in a setting that is absent of any regulatory process to distort it. In other words, a setting not totally unlike the deregulated marketplace toward which we are moving.

This article describes how economically profitable concepts of DSM were developed and implemented in India, and how this process benefited from a phased testing process. There were also some problems with full scale program implementation there that -- while not undermining the core lesson -- are still important.

## I. CHALLENGES FACING INDIA

India is a complicated and diverse country, with tremendous potential and serious problems. Electricity is not unlike many services in this country—in some regions it is relatively reliable and in others daily disruptions are the norm. As a country, India is experiencing electric generation shortfalls on the order of 10% to 20%, a situation that is not expected to improve in the coming years. In fact many believe that as much as 30% of electric demand will go unmet over the next decade. This is a result of many interrelated problems that include inadequate generating capacity, power theft (an astounding 21% of load), poor voltage profiles, transmission and distribution constraints, and rapid demand growth.

The India government has established ambitious targets for meeting these challenges. Attention has been mainly focused on developing new generating capacity in the largely government-controlled electricity sector. Industry analysts, however, are skeptical that many of these plants will arrive on-line as scheduled. Similarly, it is unclear that India's T&D systems, in spite of planned upgrades, will be capable of handling India's future power needs. Further complicating this picture is electricity pricing that distort the cost of delivering energy to end users. Residential and agricultural consumers in India are charged prices that are well below the economic cost of power, with significant subsidization by industrial users that do not have the same voting representation.

Most of the utilities are State Electric Boards (SEBs), although some such as Ahmedabad Electric Co. are private shareholder companies. Recent amendments in India's Electricity Act are expected to change the way electricity to consumers is priced, shifting responsibility from the central government to the individual states. Independent state regulators, who will be vested with the authority to determine electricity tariffs, are currently being appointed throughout India. The expectation is that local utilities will establish tariffs that are guided by the cost of service.

## II. DSM IN INDIA—KEY MOTIVATIONS, OPPORTUNITIES AND CHALLENGES

SEBs and privately owned utilities have ample motivation to pursue demand management to the extent that it can improve service (e.g., through improving voltage profiles), increase revenue (e.g., through reducing power theft) or decrease cost (e.g., through reducing peak demand). It is very expensive for utilities in India to purchase power to serve peak demand, whether it be from outside suppliers (generally from other SEBs, although IPPs will be playing a larger role in the future) or oil-fired peaking units (which are still relatively uncommon). Throughout much of India, power to meet peak needs is sometimes not available and demand goes unmet, a situation that has unpleasant social and economic consequences. Elsewhere, peak demand is met but at a high financial cost.

Although DSM has potential to improve customer service, utility profitability and operational efficiency, neither the central nor state governments have been in a position to provide rebates or other direct incentives for such programs. There are currently a number of initiatives at many levels of government to increase customer awareness, but no mandated programs or mechanisms for cost recovery. Activity has been focused on reducing T&D losses and modernizing older generating plants. Over the period 1992-97, India has been able to avoid capacity additions on the order of 2,200 MW as a result of these activities.

Without direct government financial support or a rate mechanism through which utilities can recover costs, any DSM expenditures in India (beyond USAID support for a pilot program) must be funded from some combination of utility, customer or third party investment. This includes several options:

- ***Utility customers.*** Customers may offer to directly pay the cost of DSM in situations where it is clear that their investment will recouped through reduced consumption and/or enhanced equipment performance and useful life, as a result of improved power quality.

- ***Utility company.*** The cost of DSM may be funded by a utility if such investment produces a revenue benefit that offsets any costs. Benefits may accrue as a result of any actions that reduce peak demand (outside power purchases, investing in new power plants or curtailing power), reduce power theft, or increase revenue (from additional services provided or power sold).

- ***Third parties.*** The cost of DSM may be paid through investments by manufacturers or service providers in situations in which there is the prospect of a revenue benefit from expanded sales of their products or services to offset any expenditures.

The fact that the government is not in a position to underwrite DSM represents a paradigm shift from criteria that typically defined DSM in the US over the past decade. It is clear that we have much to learn from this change in paradigm.

## III. AHMEDABAD ELECTRIC COMPANY PROGRAM

The first pilot program for DSM in India was established at the nation's largest private electric utility company–Ahmedabad Electric Company (AEC) in Ahmedabad, India (population 3 million). As a relatively new concept in India, DSM had neither the positive nor negative connotations that it does in the U.S. The USAID has supported DSM as an economic tool, to promote economic growth through effective technology development in the energy sector. To maximize the value of its investment in DSM development in India, USAID asked its current contractor, IRG, Ltd., to review the status of its past efforts there, the lessons learned, and needs for successful technology transfer to other utilities in India. The AEC example illustrates the limitations inherent in the American definition of DSM, the limitations of an overly narrow definition of utility benefits, and the prospects that DSM can have for reducing power costs and increasing revenues and profits.

AEC supplies 820,000 customers with 2.5 billion kWh of electricity annually, meeting a peak demand of 575 MW. With a load factor of 70%, AEC's existing coal-fired power plants are sufficient to meet base load but fall short of meeting peak load requirements. Overall, AEC purchases 10% of its total power requirement from outside plants, mainly surrounding SEBs, at a premium price. AEC loses money on this supplemental power. Thus, the utility has a strong financial incentive to expand its effective capacity and reduce its peak power importing requirements while increasing its off-peak sales.

The evolution of DSM at AEC was comprised of four phases—(1) feasibility research, (2) initial testing and program design, (3) pilot programs and (4) full-scale program roll-out. Each of these phases has been characterized by a significant learning process and surprises for both the American consultants involved in the program and Indian administrators. This experience reinforces the need to pause and redefine objectives and priorities to adapt DSM to be economically viable in this setting.

**Phase 1: Feasibility research and targeting.**

The first phase, which occurred in 1994-1995, involved feasibility screening, load research and a market assessment. Using a common US screening model for DSM, a total of 31 potential programs were identified that met the screening criteria, mainly that they had a net positive benefit, could be implemented at modest cost and reach a sizeable market of customers. From the viewpoint of AEC, however, DSM activities that could improve the environment and improve customer well-being were attractive only as long as they also improved the company's own electricity system performance and its economic performance. Consequently, many of the rebate, giveaway and direct install program models (common in the US) were eliminated from further consideration.

Interestingly, the 72 load research (time-of-use) meters that were initially installed as part of the feasibility phase were ultimately found to be more useful for detection of power theft—one of AEC's major problems—than for their originally-intended use to collect load research data. Power theft is a significant problem for Indian utilities because it reduces effective system capacity available for sale to paying customers, adds to the peak power purchase requirements and fails to generate any offsetting revenue. The meters also helped AEC identify commercial and industrial customers who were not achieving the 0.85 power factor requirement and, as a result, were putting an additional strain on system capacity as a result of their reactive power demand. For such customers, AEC could add a power factor surcharge or require that necessary capacitor equipment to improve power factors.

The meters proved to be so successful at increasing AEC's potential revenue base that the company elected to purchase an additional 2,600 meters that were installed at commercial and industrial customer facilities. AEC plans to have 6,000 such meters in place for its effort to enhance both revenue and resource utilitization.

In this feasibility phase, AEC and its earlier consultants also assessed the extent to which various customers contribute to the company's peak load problems and, at the same time, represented a significant share of AEC's total power demand and reactive power requirement. They were determined to be: (1) High-rise apartment buildings (with water pumping to reserve tanks during the morning), (2) Flour mills (hundreds of local mills that had motors operating all day); and (3) the Municipal water system (with hundreds of pumps throughout the city).

All of these market applications involve motors -- a key point because higher reactive power requirement associated with motor operations are a primary factor raising AEC's distribution system losses, thus limiting the company's effective capacity and increasing peak period needs for purchasing outside power. This also causes customers to suffer more internal voltage drops (from motor startups), leading to hotter-running machinery with greater motor wear. Initial testing of these classes of targeted customers was then conducted as part of Phase 2—a decision that was found to be extremely important as many of the expected utility and customer savings were not borne out.

**Phase 2: Initial testing and program design.**

The second phase, which occurred in 1995-1996, was the initiation of small-scale testing to confirm the applicability of the program concepts. These were experimental efforts in which a product was offered to a small set of customers, to test whether there is customer interest in the offering, and whether installation or adoption of it has the expected impact. The testing efforts covered: (1) high efficiency water pump systems at high-rise apartment buildings, (2) high efficiency motors at flour mills, (3) high efficiency water pumps and capacitors at municipal wells, (4) lab testing of locally rewound motors and (5) energy audits industrial customers. This phase was valuable since it turned up a number of surprises:

***(1) High rise apartment water pump installations.*** Replacing pumps, pipes valves, and installing capacitors in high rise apartments demonstrated substantial energy savings (30% - 45%) and demand savings (35% - 63%), with payback of less than one year. However, while 75 buildings agreed to energy audits and completed them, only four buildings initially proceeded with the recommended retrofit installations. The main problem was the absence of financing to pay for the up-front cost faced by the cooperative associations operating the buildings. Although there is ample credit available in the Indian financial sector, there is little experience evaluating investments of this kind.

***(2) Flour mill installations***. Replacing motors and belts, installing capacitors and adjusting mill speeds at flour mills was of only limited customer interest (only four participants) and produced only modest energy savings (2% - 5% from maintenance, 1% - 10% from drive belts and 10% from motor replacement). Findings did not warrant additional efforts in this segment.

***(3) Municipal well installations.*** Replacing pumps and pipes, renovating bowls and installing capacitors in municipal well installations showed promising results (20% -30% improvement for the two well sites), with payback of less than one year. This caused the municipal water agency to initiate its own program for pump upgrading, working in conjunction with the utility and USAID's Sustainable Cities Program.

***(4) Motor testing.*** This showed that improved rewinding techniques could enhance the efficiency of rewound motors by a modest 2% - 4%, which was not enough to justify a program. The disappointing results were due in part to the age of the motors and number of prior rewindings.

***(5) Industrial energy audits.*** These audits revealed potential savings of 8% - 12% from a complex range of energy efficiency measures. That was not enough to justify rolling out an equipment replacement program, although the findings also indicated a broad need to address poor load factor. That led to the development of a program for assisting and enforcing expanded installation of capacitors.

It became clear that some programs which appeared good from market research, such as the motors and flour mill programs, should not be initial priorities after all. Other programs, such as the apartment building program, were only feasible when paired with financing. Other programs could be taken over solely by the customer, which was the case with the municipal water system. Interestingly, certain opportunities that were not originally identified as DSM, such as capacitor installation at industrial sites, could be justified on the basis of their system enhancement value to the utility.

### Phase 3: Pilot Programs

The third phase, implementation of pilot programs, took place over 1996-1997. AEC elected to engage in strategic partnerships with outside firms to carry out the marketing, equipment sales, installation and maintenance associated with energy efficiency. In particular, AEC pursued alliances with Energy Service Companies (ESCOs). The Indian ESCOs are somewhat different from ESCOs in the US, where we have a history of government-mandated DSM. In India, where there is no such precedent, ESCOs tend to be subsidiaries of equipment manufacturers rather than, for example, utility companies. Indian ESCOs have served different markets, focusing their efforts on selling their own products and services directly to customers. They represent part of a broader effort by equipment manufacturers in India to vertically integrate operations to offer energy audit, equipment sales, installation, maintenance and financing services.

With no constraint on the development of business partnership agreements between individual product manufacturers and private utilities, AEC was free to contact equipment providers and installers concerning their interest in participating in its pilot programs. The results were mixed:

- ***Reactive Power Management.*** AEC was successful in recruiting a manufacturer-owned ESCO to operate the capacitor program aimed at commercial and industrial customers. This in part because the equipment requirement was standardized and formally prescribed by customer size, and the market potential was broad (500 for the initial pilot, with a market potential of 36,000 customers). The program provided equipment leasing, installation, and maintenance of capacitors, with ownership reverting to the customer at the end of a three or five year lease period. AEC identified industrial firms with a low power factors and notified them of the need for them to acquire a capacitors. The ESCO then followed up with equipment offers, and the utility collected the lease payments (on behalf of the ESCO) through its customer billing system.

- ***Lighting.*** While lighting was not initially considered as a candidate program, a participating ESCO wanted to offer a lease/sale program for high efficiency fluorescent lighting to residents of subsidized housing. The lighting fixtures included a 38W lamp/electronic ballast combination with a leading (>1) power factor, in place of the standard 55W fluorescent unit. AEC developed a target customer list to the ESCO, which then followed up by these households were offered free installation and use of the lighting equipment for six months, after which time they would have lease payments assessed through their electricity bills. The pilot covered 200 households (out of a market base of 800,000 customers).

- ***High-Rise Apartments.*** AEC was not immediately able to find any equipment provider willing to take on the full marketing, sales, installation and financing due to the limited size of the market (75 in the initial pilot and a market base of 4,000) and the complex, customized nature of each installation. AEC did successfully find contractors to conduct the energy audit, specify equipment and then follow up by acquiring and installing new equipment. However, this meant that AEC needed to conduct the initial customer contact and supply financing. Unfortunately, AEC had only a small revolving loan fund for short-term financing and few financial institutions in India have the experience to recognize the value of energy-efficiency projects. Because of this constraint, only ten of the 75 apartment buildings elected to have their equipment upgraded as part of the pilot program.

The pilot programs gave AEC a wealth of practical experience. The High-Rise Apartment pilot provided the utility with experience working with contractors, developing audit procedures, and experience demonstrating the customer benefits in terms of bill reduction. It demonstrated the potential economic benefit to the utility, in terms of reducing reactive power load and increasing the effective morning peak capacity. It also helped to define remaining needs for a successful program–to address the economic barriers to enrollment of apartment buildings in that program, by providing multi-year financing in the future.

The Capacitor and Lighting pilots demonstrated that AEC could effectively work with manufacturer ESCOs on marketing, installation and leasing. For both programs, the pilots refined the utility's own procedures for customer targeting and lease billing, as well as the installation protocols and performance levels it required of the ESCOs. The pilots demonstrated customer interest, and the Capacitor Program showed the effectiveness of actively promoting customer compliance with power factor requirements. They further demonstrated the potential economic benefit to the utility from both programs, in terms of reducing reactive power load and increasing the effective mid-day and evening peak capacity, as well as generating fee revenue for billing on behalf of the ESCO.

**Phase 4: Full Program Rollout.**

As a result of the pilot program success, AEC signed agreements with ESCO subsidiaries of two international manufacturers for implementation of the lighting and capacitor programs over the 1998-1999 period. (Agreements for the high rise apartment program were still being sought.) The participating ESCOs agreed to take on the burden of marketing the designated equipment, offering a lease financing arrangement, installing equipment, maintain it over the 3 - 5 year lease period, and turning over ownership to the customer at the end of that period. AEC had relatively little financial risk – it agreed to provide customer lists to the ESCOs and collect the lease payments on behalf of the ESCO (with an administrative fee) through its customer billing process. The ESCOs accepted targets to install capacitors at 8,000 industrial and commercial sites and fluorescent fixtures at 50,000 residential sites over the two-year period.

There have been successes and difficulties with the transition to full program implementation by ESCOs:

- ***The Reactive Power Management program*** has experienced moderate success. This is thought to be due, at least in part, to heavy penalties by AEC for ESCO non-compliance in this program.

- ***The Lighting program*** for residential customers has had problems stemming from the failure of the participating ESCOs to deliver fluorescent lights of acceptable technical quality, and less-than-anticipated consumer interest.

- ***The High Rise Apartment program*** has encountered a lack of ESCO interest, due to the customized installation requirements and smaller total market. AEC is offering the program itself, but cannot offer longer-term financing as desired for the recommended improvements.

## IV. OTHER DSM PROGRAMS

Beyond the AEC program, there have been only two other DSM programs in India to date, one by the Orissa SEB and one by the Haryana SEB. Both programs involved World Bank funding and are still in the planning stages. The Orissa SEB program was initiated by the World Bank, which provided a loan to be spent on two areas—(1) restructuring the SEB, and (2) DSM. The program involves participation of the British aid agency DFID and its consultant to assist the Orissa SEB develop program proposals. The first milestone in this project, which began three years ago, will be eight DSM project proposals. These proposals are currently under development and no projects have been developed thus far.

The Haryana SEB project was also initiated by the World Bank, which is funding a major restructuring of this troubled SEB. In addition, USAID is assisting Haryana SEB in developing two pilot programs which may be funded through a World Bank loan: (1) reduction of line losses in four agricultural feeders and (2) agricultural pumps on these four feeders.

## V. ECONOMIC GAINS – WHO GETS THEM?

While only one private electric utility in India has programs now implemented, the development of those programs has demonstrated that various stakeholders can be enticed to implement programs on the basis of economic return:

- ***Utility Economic Benefits.*** Programs that address load management can reduce the excess costs associated with meeting peak requirements. All three of AEC's programs involve installation of end user equipment to reduce reactive power demand, thus reducing line loss and increasing effective system capacity. Two of the three programs also involve retrofits of end-user equipment that can reduce overall energy demand during peak periods. In each case, the utility can benefit financially, as it can sell more peak period electricity (due to effectively increased system capacity) and reduce its needs for importing expensive power during those periods. There is also a gain in fees paid to the utility for its billing collection on behalf of the ESCOs. These elements provide revenue to the utility, despite a loss of some energy sales attributable to more efficient lighting and water pumps.

- ***Customer Economic Benefits.*** While the customer pays costs for most of the installed equipment, the customer simultaneously benefits from savings associated with reduced energy consumption, better equipment performance and longer motor life. It is possible to directly calculate the customer operating cost savings associated with substitution of more efficient equipment. However, the additional customer benefits associated with capacitor installation –enhanced equipment performance and life from improved load factor for motors – have yet to be quantified.

- ***ESCO Economic Benefits.*** One of the attractive features of this kind of program, from the perspective of the utility, is that ESCOs assume the financial risks associated with their agreement to absorb costs of customer outreach, equipment installation and maintenance (during the lease period). Of course, the ESCOs expect to more than offset those costs through revenues generated by equipment sales and leasing.

## VI. LESSONS FOR US UTILITIES

The experience of AEC leads to four lessons for technology transfer and program replication at other utilities:

(1) ***Focus on Profits.*** Since there was no mechanism for recovery of DSM program costs in the electric rate base, nor any requirement to incur costs for social or environmental purposes alone, the utility focused on program activities that had economic value to the utility (as well as value to society). Such activities are possible. For AEC, they were measures focusing on increasing distribution system efficiency, revenue growth, and reducing peak demand to reduce costly purchases of outside power. These DSM activities did not focus solely on promotion of energy-efficient equipment, but included actions to reduce power theft, improve power factor and generate additional fees for billing services conducted on behalf of ESCOs.

(2) ***Use of a Phased Strategy.*** There is significant value in the incremental, phased approach adopted by AEC, in which there is a progression in program development — from research investigation to initial testing to pilot programs to full-scale implementation. This approach helped to prove the economic viability and value of DSM to the company, in terms of direct financial benefits (e.g., expanding effective system capacity) and spillover benefits (e.g., using load research meters to reduce theft of power). It also allowed the utility to make significant changes in the program mix and design, which ended up being very different from the set initially identified by screening and market assessments. The process of initial testing was particularly important in refining the set of appropriate programs for the local area, before moving to pilot programs (e.g., findings that the flour mills were not a high priority for program development, despite initial expectations that they would be a good target). The subsequent pilot program step was also important in

working out issues concerning program design and delivery, before moving on to large scale implementation (e.g., refinement of the financing arrangement for residential water pumps, as well as negotiation and testing of working relationships with ESCOs).

(3) ***Partnership with ESCOs.*** The outsourcing of program delivery to ESCOs was attractive to the utility because it minimizes the extent of utility staff and capital resources needed for program delivery. It also allowed the utility to achieve a more cost-effective and sophisticated approach to energy management by relying on the experience and expertise of the ESCO staff. The ESCOs were unlike American ESCOs insofar as they were all affiliated with manufacturers of energy efficiency equipment. By vertically integrating product sales, service and financing functions, these ESCOs can internalize costs of DSM program marketing and operation in return for potential revenue from equipment sales and leasing. AEC demonstrated that ESCO/utility partnerships can be made to implement large-scale programs with modest cost, standardized products. It is still unclear whether such partnerships can also be made to cover more expensive, customized measures for smaller markets.

(4) ***Offer of Financing.*** The programs showed that customer willingness to spend money on products and services to reduce energy costs, and ESCO interest in serving that demand, exists for all customer segments and all income levels. This was demonstrated by acceptance of AEC's programs reaching industrial and commercial customers, a government agency and residential customers in both moderate income and low income housing developments. For nearly all groups, financing equipment cost is a factor defining market acceptance, and the availability of lease/sale arrangements in two of the programs was an important factor in their viability. Conversely, the absence of available long-term financing was a major factor limiting acceptance of a third program.

While some electric companies in the U.S. have continued to sponsor energy efficiency programs, others have retrenched as a result of industry deregulation and cost cutting, combined with flagging support from state regulators as customers experience increased rates from earlier programs. This need not be the case. Demand-side management can be a source of profit for the utility and benefit to customers if it is designed with economic return in mind.

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