Demand Side Management: Augmenting Tool in Energy Security And Climate Change

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ABSTRACT -
Demand-side management (DSM) proved to be a conventional concept emanates from the need seen as a means of reducing peak electricity demand and in which a power utility, such as a vertically integrated utility or State Electricity Boards (SEB) manages the demand for power among its customers to meet its current and future needs, so that the utilities can adjourn building further capacity. The two pronged approach of DSM one by reducing the overall load, secondly due to various beneficial outputs makes DSM significant scope for contributing towards the increase of efficiency of the system investment. The benefits of DSM program includes alleviating electrical system emergencies, decrementing blackouts, increasing system reliability and most importantly independency on expensive imports of fuel in the view of limited reserves and high energy prices. DSM encompasses a variety of utility activities designed to change the level or timing of customer’s electricity demand. DSM has a major role to play in procrastinating bundles investment in generation, transmission and distribution networks with a common initiative of reducing GHG emission on a large scale. DSM is either implemented directly through utility sponsored programs or through market intermediaries like Energy Service Companies (ESCOs). In India, DSM can be achieved through energy efficiency, which is the reduction of kilowatt hours (kWh) of energy consumption or demand load management, which is the reduction of kilowatts (kW) of power demand or the displacement of demand to off-peak times. In the former category are programs such as awareness generation programs, customer or vendor rebates for efficient equipment, etc, while the latter includes time-of-use tariffs, interruptible tariffs, direct load control, etc. Specific type of programs depends on the utility objective: peak clipping, load shifting, strategic conservation or strategic load growth. This paper, will concisely discuss the major benefits and challenges that are faced while implementing electricity (DSM) and why Indian context is different from rest of the world and the conclusions derived for elsewhere cannot be extrapolated for India. Simultaneously examine the DSM measures which can be undertaken to reduce energy demand and restructure more efficient and sustainable energy use in the context of the Indian electricity system.

I. INTRODUCTION
Demand Side Management as applied to energy efficiency measures that modify the consumption patterns at user end and reduces the energy demand. Conventionally it was applied to electricity loads but now is effectively used for change that can be made to demands of all types of energy. Electrical energy cannot be effectively stored in the form of inventory, it is distributed and consumed soon its generated. But load on the power plant is variable in nature in order to meet the maximum demand for which the power plant is generally designed. However, there is large difference between peak demand and average demand which results in high generation cost per unit. Sharply increasing peak demand requires installation of large capacity of power generation. It is not possible for developing countries to meet the targeted capacity by installing new power plants. Since electricity is an essential input in all the sectors of any country, DSM hence emanates as a alternating means by which electricity can be saved and effectively utilized. India’s power sector is a leaking bucket; the holes deliberately crafted and the leaks carefully collected as economic rents by various stakeholders that control the system. The logical thing to do would be to fix the bucket rather than to persistently emphasize shortages of power and forever make exaggerated estimates of future demands for power. India’s transmission and distribution losses are among the highest in the world. When non-technical losses such as
energy theft are included in the total, losses go as high as 65% in some states and average about 35-40%. The financial loss has been estimated at 1.5% of the national GDP. These act as a major deterrent to the private as well as global investments in the sector. To address the issue of Aggregate Transmission and Commercial (AT&C) losses funding mechanism was introduced in the form of the Accelerated Power Development Reforms Programme (APDRP). Its key objectives were to reduce AT&C losses, improve customer satisfaction as well as financial viability of the State Distribution Companies (SDCs), by adopting a systems approach and introduce greater transparency. [1,5,7,8]

II. DEMAND SIDE MANAGEMENT: THE HISTORICAL CONTEXT


A demand side management plan for the high tension industrial segment in Maharashtra was chalked up by Banerjee and Parikh (1994) in 1993. Details of the plan are reported in Parikh, et al, 1994. There have been a number of other studies to determine the potential for specific DSM options or DSM potentials for a consumer class or a region studies by various consultants, Institution like The Energy Research Institute, International Energy Initiative, non-governmental organizations like Prayas (Sant and Dikshit, 1994).

However even years after the publications of these studies, very little has been done in terms of implemented DSM programs it is often felt that this is caused by the supply bias of the utility. In the current power scenario it will be worthwhile to examine the utility response to DSM.[3]

III. INDIAN POWER SECTOR: REFORMS BY DSM

Power planning in India has been supply oriented. Conventionally the power sector is dominated by the government undertaken utilities and presently it is the hands of private investors. SEB are the agencies which are responsible for generation and distribution in the country, and the decisions related to inter-state transfers are in the custody of Regional Electricity Boards (REBs).

Both REB and SEB function under the supervision of Central Electricity Authority (CEA), which is the regulatory body for the Indian Power sector. DSM involves co-operative action by the utility and the customer, to achieve customer load modifications resulting in savings to customer utility and society.

DSM includes energy efficiency, energy conservation as well as utility load shape objectives like load shifting, valley filling and peak clipping. In the case of India, the installed capacity was only about 1,362 MW in 1947 and has grown to about 173,626 MW by March 2011.

It is primarily thermal (65 percent) with maximum capacity from coal. The share of hydro is only about 22 percent despite the fact that hydro potential in India is about 84,000 MW at 60 percent load factor. Share of nuclear and renewables is small at 2.8 percent and 10.6 percent, respectively (Figure 1.1). These percentages, however, undergo a change when viewed in terms of energy generation, especially for hydro and renewables.

Though hydro installed capacity is 23 percent of the total, its share in energy generation is only 14 percent. Similarly, renewable though having a share of almost 10 percent in capacity, its share in energy generation is only 2.4 percent. The reason is that the capacity factor for hydro and renewables is much below thermal plants.

Figure 1.1 Share of installed capacity from different sources as in March 2011 (in percentages)
DSM and energy efficiency has the inherent potential to mitigate the rising impact of such politically sensitive tariffs through an integrated program of metering, installation of energy conservation devices, efficient system operation and maintenance. Reductions in energy demand and consumption at the end user’s premises can free up electricity generation, transmission and distribution capacity at a fraction of the costs required to provide new capacity. The cost of saved energy has been estimated to be as low as 10% of the cost of added capacity for some DSM measures. In addition to avoided and deferred capacity costs, support for energy efficiency at its customers installations brings a utility into closer contact with its clients, often resulting in better service, and allowing a more efficient future planning process.

The actual capacity addition during the 11th Plan was about 50 GW, which was still the largest addition ever during all five-year plan periods. Almost 86% of added capacity is thermal based, which highlights the importance of securing coal and gas supply for the new plants. The contribution of the private sector to the capacity addition, nearly 37%, is also noteworthy (Figure 2). Despite this record capacity addition, India still had a shortage of 9.8% of electricity supply during peak time in 2010 and 2011, as only 110 GW of demand was met out of a peak demand of 122 GW.

Fig 2: Installed capacity addition by Fuel 1992-2012 (GW)

Source CEA 2012.
Utility-driven DSM applications in India have been limited largely to non-agricultural sectors. In one of the first DSM programs in India, the Ahmedabad Electricity Company (AEC), a DSM cell was set up in 1994 that has worked with customers to develop a research data, screen alternative energy efficiency measures and implement some of those measures through the involvement of ESCOs. Two ESCOs have worked with AEC to implement efficient lighting and reactive power compensation (though capacitor installations) measures at its HT and LT customers that has led to peak load savings of about 10% thereby reducing the need for expensive imported power in peak load hours. The ESCOs have raised finances from institutions like IREDA and have installed the efficient equipment at customer premises on a guaranteed performance basis. The utility, AEC, escrows the savings which are used for loan repayments and ESCO charges.

Demand-side management measures take advantage of opportunities to increase the efficiency of energy service delivery; To make use of DSM measures requires special programs that try to mobilize cost-effective savings in electricity and peak demand. These programs help overcome various barriers that prevent many cost effective DSM measures from being adopted; these barriers exist even in countries with fully developed market economies. Without DSM programs, these energy and peak demand savings would not occur or would materialize only after significant delay, and in any case could not be relied upon, forcing utilities to construct expensive back-up capacity and causing higher rates. Numerous studies in China and other countries have found that cost-effective DSM programs can reduce electricity use and peak demand by approximately 20 to 40 percent.

DSM benefits households, enterprises, utilities, and society including, reduces customer energy bills and the need for power plant, transmission, and distribution construction this also stimulates economic development and creates long-term jobs that benefit the economy. It increases the competitiveness of local enterprises, and reduce maintenance and equipment replacement costs. DSM also reduces local air pollution by reducing the emissions that contribute to national and international environmental problems such as acid rain and global warming.

Utility DSM programs generally fall into three main categories:

1. **Conservation programs**: Reduce energy use, e.g., programs to improve the efficiency of equipment (lighting and motors, for example), buildings, and industrial processes.
2. **Load management programs**: Redistribute energy demand to spread it more evenly throughout the day, e.g., load shifting programs (reducing air conditioning loads during periods of peak demand and shifting these loads to less critical periods), time-of-use rates (charging more for electricity during periods of peak demand), and interruptible rates (providing rate discounts in exchange for the right to reduce customers electricity allocation during the few hours each year with the highest electricity demand).
3. **Strategic load growth programs**: Increase energy use during some periods, e.g., programs that encourage cost-effective electrical technologies that operate primarily during periods of low electricity demand.[ 1,2,6,7]

**IV. THE COMPARATIVE ANALYSIS:**

Many successful examples of DSM exist throughout the world. Utility DSM programs were developed in the United States during the 1980s and have since been used in Canada and Australia. The International Energy Agency (IEA) acts as energy policy advisor for its 26 member countries in their effort to ensure reliable, affordable and clean energy for their citizens. This section covers the best practices adopted to implement Demand Side Management projects by the utilities in India and worldwide. More than 30 countries globally have adopted DSM measures to overcome the obstacles standing in the way of rational energy utilization. Specific DSM applications differ in each country depending on the Programme drivers and the local conditions. In India, the DSM industry is still a nascent stage. Most of the projects implemented by the distribution utilities are at pilot level trying to establish a market and reduce the uncertainty in energy savings. The case studies presented in this section can be broadly categorized under the following sectors:

1. Residential
2. Municipal
3. Commercial
4. Agriculture
5. Industrial
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Both International and Indian case studies have been prepared in a standard format so that the readers can analyze the information provided under key parameters of different projects and arrive at appropriate conclusions. This format will also facilitate for a comprehensive comparative analysis between the DSM Programmes implemented in India and worldwide.

According to the North American Electric Reliability Corporation (NERC), demand response is “a subset of the broader category of end-use customer energy solutions known as Demand-Side Management.” Even the Federal Energy Regulatory Commission (FERC) finds that “the rapid evolution of demand response programs, rules and names increases confusion among respondents and staff alike. FERC lists 14 demand response programs — from direct load control (DLC) to real-time pricing and system peak response transmission tariff. While many of these methods have been tried over the years, utilities have often been stymied in their efforts to make them cost - effective and to employ them as dependable methods for controlling peak energy needs.

In India, utility DSM programs relied on incentive options, mechanical, switching, or one-way load control transmitters — with unverifiable results. Due to the unavailability of DSM tools which provide greater verifiability, reliability, and quality to meet urgent needs like peak demand management, grid reliability support and managing energy expense, for targeted control and cost savings the DSM measures which are opted by developed countries could not be extrapolated. The installation of Advanced metering infrastructure (AMI) and other smart grid technologies offer new ways for utilities to gain the real-time visibility and intelligence they need to monitor and control millions of devices over a wide network so that avoidable losses can be minimized. For instance The use of distribution voltage control for load management is not new. Because U.S. utilities are required to comply with ANSI requirements for voltage variation — a nominal voltage of 120 volts with a +/- 6-volt variance, or 114 to 26 volts at the customer site — utilities have monitored and controlled voltage at substations and some feeder locations for many years. Prior to the introduction of advanced residential meters, gaining real-time visibility into voltage levels beyond the substation was simply not practical. As a result of this lack of visibility, utilities have typically maintained customer voltage at a higher level to prevent end of-line locations from falling below 114 volts. As cumulative load or distance along a circuit increases, voltage begins to diminish on distribution feeder lines. To make up for this loss, utilities typically raise the level of voltage to customers at the beginning of the circuit.

The information shown in this module of the portal is gathered through extensive secondary research from the reports, publications and websites of DSM experts and various international organizations promoting energy efficiency across the globe.

Dynamic voltage management, or adaptive voltage control, is a DSM solution that offers substantial opportunities for utilities to lower net energy consumption by customers and reduce distribution losses between the distribution feeder and the customer site.

Monitoring and controlling voltage at the customer level requires an advanced metering system that can collect voltage information at customer sites and provide mechanisms for alerts and feedback. Smart grid technologies are now available that provide robust sensing, analytics, communications and business logic. With these new technologies, utilities can now have near-real-time data about the energy being consumed at any point on the distribution network, as well as information about power quality —including voltage — and much more.[1,4,6,7]

V. CONCLUSION

A serious energy shortage and growing pressure on imports have been seen in the Indian energy sector. In the middle of 2012, India’s power shortage led to massive rolling power cuts across the nation. The formulation of the comprehensive and coherent, demand side management scheme will target the energy saving rather than generating which would save the future reserve for sustainable growth. By integrating next generation smart grid technologies into current voltage management, and energy efficiency programs, utilities can realize significant savings by reliably flattening peak demand, thereby reducing the need for more generation capacity and lower peak power costs. Of course, the added information provides operational benefits that extend to proper equipment sizing, preventive maintenance, and a better understanding of system load beyond the substation. Consumers, too, benefit from these programs in associated cost savings from reduced energy consumption and power quality improvements.
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