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Demand-Side Management (DSM) in the Electricity Sector

Urgent Need for Regulatory Action and Utility-Driven Programs

Report by

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for

Climate Change & Energy Programme
World Wide Fund for Nature-India
New Delhi

February – 2005

Abbreviations

ADB	Asian Development Bank
ARR	Annual Revenue Requirement
CERC	Central Electricity Regulatory Commission
Crore	1,00,00,000
CSIs	Civil Society Institutions
DFID	Department for International Development (of UK, called ODA before)
DISTCOM/DISCOM	Distribution Company
DSM	Demand Side Management
EHV	Extra High Voltage
ERC	Electricity Regulatory Commission
GoI	Government of India
GRIDCO	Grid Corporation
HT	High Tension (or High Voltage)
IPS	Irrigation Pump Sets
IRP	Integrated Resource Plan
kg	Kilograms
kW	Kilo Watt
kWh	Kilo Watt Hour
LCP	Least Cost Planning
LT	Low Tension (or Low Voltage)
MDBs	Multilateral Development Banks (such as the WB and ADB)
MoP	Ministry of Power
MU	Million Units (million kWh)
MW	Mega Watts
NGOs	Non-Government Organisations
O&M	Operation & Maintenance
PLF	Plant Load Factor (also called Capacity Utilisation Factor)
RC	Regulatory Commission
Rs	Rupees (Indian currency)
SEBs	State Electricity Boards (vertical monopoly power utility owned by the state government)
SERC	State Electricity Regulatory Commission
T&D	Transmission and Distribution
TRANSCO	Transmission Corporation
WB	The World Bank Group

Acknowledgements

The work of Prayas (Energy Group) in the energy sector started with analysis of Integrated Resource Plan (IRP) and energy efficiency in the early 1990s. For the last few years we have been focussing on issues relating to reforms and regulation in the power sector. This work with WWF has given PEG an opportunity to revisit DSM and energy efficiency in India.

We wish to thank Mr Chandrashekhar Govindarajalu (World Bank) for extensive discussions and reviewing our draft report. We are also grateful to Ms Archana Walia (USAID) for reviewing the draft report and several others who shared their experiences with us including Mr Bhaskar Natarajan (of Indo-Canada Cooperation Office), Mr S Padmanabhan (USAID), Mr Mahesh Patankar (IIEC), Ms Ceronique Marier (Encomoler International), and Mr Sanjay Jadhav of Noida Power for sharing their experience and insights.

Mr Chaitanya Sthalekar has helped us improve our understanding of CFLs and lighting products in general for many years and we thank him for his inputs during the course of this work also. Mr Joe Pinto improved readability by editing the report.

The feedback during the discussion organised by WWF, for the launch of its campaign “People’s Power” in Delhi on 30 November 2004, was also useful.

Prayas (Energy Group)

15th February 2005

Executive Summary

The importance of energy conservation and demand side management (DSM) has been recognised by key institutions, including the Ministry of Power, Government of India, for many years. One unit of electricity saved results in reduced consumption of coal – a non-renewable resource – by about one kg. Studies by renowned experts and institutions have shown the tremendous potential of energy efficiency and DSM that can be achieved in a cost effective manner. The laws, government policies and even regulatory commissions have stressed the need to achieve this potential. Several agencies have also emphasised the need for implementation of DSM schemes by utilities.

DSM is defined as a utility initiated and supported program that aims at changing the timing or quantity of electricity usage by the consumers. This is in contrast to the usual supply side management (SSM) done by utilities – involving increased supply of electricity. But utilities in India have rarely implemented DSM schemes; whatever has been implemented has not gone beyond the pilot level.

Demand for power is increasing rapidly; partly due to the rapid growth of stock of inefficient equipment. Hence DSM schemes must be urgently implemented to limit the growth of demand for power by such inefficient equipment. This will not only be economical but also reduce power shortages, resulting in social benefits.

On this backdrop, this report takes an overview of the potential for DSM, the studies conducted in India, the legal position and the role of different actors. The report outlines why utilities should undertake DSM, summarises the representative studies carried out in the past, gives a summary of the implemented DSM schemes, the legal backdrop and the regulatory vision on the issue. Some international experience is also cited.

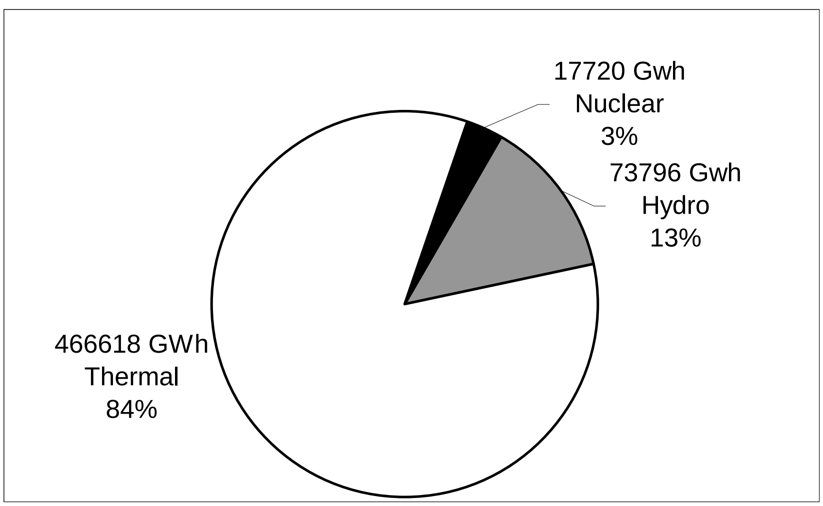
The report argues that regulatory commissions should direct the utilities to implement DSM schemes and to monitor their experience with DSM in order to improve the schemes. The report urges consumer groups to pursue DSM with the regulatory commissions and utilities and to create public awareness for the success of such scheme

Introduction

Electricity plays a crucial role in the development of modern society. Electricity consumption in India has increased by nearly 60 times, since independence. The Government of India is planning to double the capacity of power generation during the coming decade! Increasing the use of electricity not only brings more opportunities to earn livelihoods and provides more comforts but also has certain adverse impacts on people and on the environment.

About 75% of India's electricity (see Figure 1) comes from burning of coal and 9% comes from burning gas/oil in power plants. Burning fossil fuels like coal or oil/gas has significantly adverse impacts on the environment and on society. These impacts range from the local and community levels to affecting the climate of the entire earth. The mining and transport of coal, ash dumps, ground water contamination and air pollution affect the populations living around the mining sites and power plants. The carbon dioxide emission due to combustion of fossil fuel contributes substantially to global warming - that threatens the stability of the earth's climate. The power sector contributes nearly 40% of India's carbon dioxide emissions. India has signed the Kyoto Protocol – an acknowledgement that we share the concern of global warming, which also expresses our commitment to slow down climate change.

Figure 1: Share of electricity generation by energy source

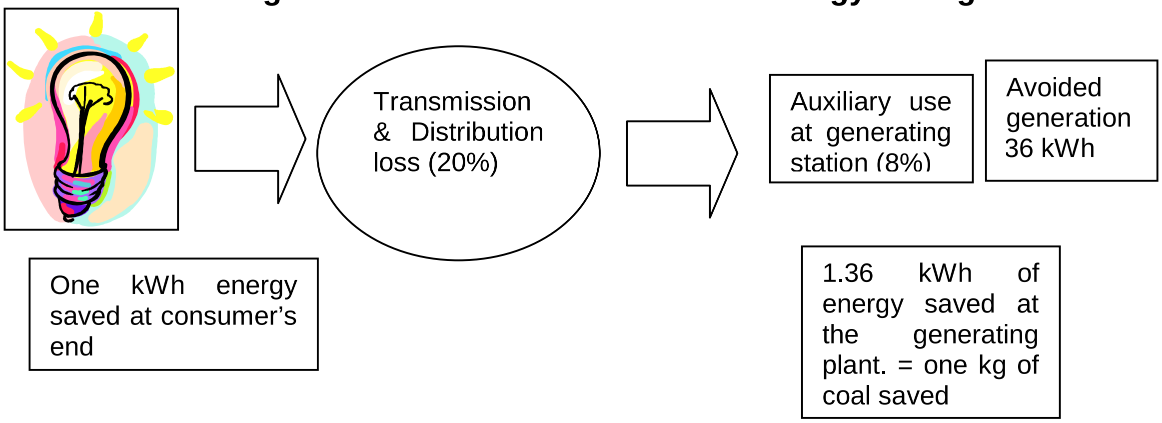


Source: Energy Profile of India, MoP, 31st March 2004

One of the ways to mitigate the adverse impacts of the power sector is to conserve electricity. Energy conservation can be achieved not only by avoiding the use of electricity but also by using it more efficiently, e.g., by getting the same amount of light from a lower quantity of electricity by using more efficient lamps. Every consumer is finally interested in "energy services" like heat, light and motive power and not in the quantity of electricity use per se. Hence, we need to differentiate between electricity consumption and the provision of energy services.

Any reduction in energy use at the point of end-use has a multiplier effect. For example, as shown in the Figure 2, one unit of electricity saved at the consumer end avoids 1.4 units of electricity generation, which implies a saving of about one kg of coal. In other words, a reduction of just 50W on the consumer side (that works out to say 6 hours a day), avoids coal usage of 110 kg per year!

Figure 2: Environmental benefit of energy saving



Large potential for cost effective improvements in efficiency

A number of studies have demonstrated that energy conservation or, more correctly, efficiency improvements have a large potential. Most of this potential should be achieved from a purely economic / financial point of view. In other words, it is far cheaper to save electricity in many situations, than to build new generation plants and strengthen the existing transmission and distribution networks.

This section takes an overview of studies done in India that quantify the potential for saving energy by such cost effective measures. These studies by Indian as well as foreign researchers, consultants or institutions were conducted during the last 15 years. They may be broadly classified into three types:

A. Potential and cost estimation studies – focus on the evaluation of one or more options for energy conservation or efficiency improvement. Typically, such studies estimate the potential for saving energy through improvement in end-use efficiency, either based on field experiments or on literature and cost analysis. A combination of more efficient equipment use and optimum system design is considered in such studies.

For example, a survey-based analyses undertaken by IGIDR indicated that peak demand by High Tension (HT) industries in Maharashtra could be reduced in a short period by about 9% by the adoption of a limited set of measures. (IGIDR – HT Industries Survey in Maharashtra – Jyoti Parikh, S. Modak, S.G. Deshmukh, C.B. Kagalkar, IGIDR 1991). Several studies have shown that potential of energy efficiency is to the extent of 30% in most sectors such as residential, commercial, or agricultural. The saving potential also increases if options of change in major equipment or industrial process are considered.

In the case of Delhi it is estimated by TERI that the savings potential in residential lighting is about 35 % or 294 MW and that too at a fraction of the cost of new power generation! (DSM from a Sustainable Development Perspective, see Part II.)

B. Integrated Resource Plans – Integrated Resource Plan (IRP) or Least Cost Plan (LCP) studies repeat the planning process in the power sector, by avoiding the mistakes done by the mainstream planning process i.e. avoiding the bias for the supply side and in favour of large projects. IRP studies project the demand for electricity and identify the least cost options to meet this demand. In this approach, a number of available options, including centralised or de-centralised generation, efficiency improvement, or change in load pattern, are evaluated for potential and costs. Out of such 'candidate' options, the combination of options, which best satisfy the projected demand at least cost are selected.

In India, the first such IRP was done by Prof. Amulya Kumar N. Reddy and others in the early 1990s. This plan, called DEFENDUS (Development Focused End Use Oriented), presented a new paradigm. DEFENDUS looked at planning in the electricity sector as an exercise to meet the demand for energy services essential for development.[1] The study considered efficiency improvement and electricity substitution measures and demonstrated that a combination of such measures could meet over 20% of the demand at a cost lower than the large centralised projects (Amulya Kumar N. Reddy et. al. 1991).

A similar study carried out by Prayas for Maharashtra in the early 1990s also indicated that energy efficiency improvement measures can meet about 40 % of incremental demand, while decentralised generation options can contribute about 15 % of incremental demand. On the average, such an integrated resource plan for Maharashtra would cost around 33 % less than the conventional planning based solely on centralised generation projects (Sant and Dixit, 2000). In the late 1990s, the ESMAP program also carried out such studies for Bihar and AP with similar results.

C. Program and implementation plans – These studies focus on some particular end-use or sector, and are aimed at developing programs / packages for implementation of options to improve efficiency. One pioneering effort was the Bombay Efficient Lighting Large Scale Experiment (BELLE). This plan was a detailed implementation program prepared by a consortium of Peico Electronics and Electricals Ltd., BEST (a municipal electricity distribution undertaking in Mumbai) and IGIDR (BELLE DPR 1990). Through a three-stage program, consisting of preparation, testing and full rollout, BELLE envisaged the leasing of 35,000 CFLs to residential consumers in a South Mumbai utility. BELLE envisaged leasing the efficient lamps to

[1] To this end, the plan included several 'development' considerations such as electrification of all homes in the state, energisation of all agricultural pump sets (to the extent of limit imposed by groundwater potential).

consumers and recovering the cost of lamps in the form of lease payment of Rs. 4 to 5 per month for a few years. This lease payment was to be collected through the consumers' monthly electricity bills. Apart from its pioneering nature, the uniqueness of BELLE was its focus on implementation with detailed planning, milestones, responsibility allocation to different actors, innovative financial and project management arrangements, and continued project evaluation. This DSM plan was economical even 14 years ago, when the nominal price of CFLs was nearly the same as today, but electricity tariffs were far lower. Unfortunately, the BELLE plan was not implemented (see Gadgil A. J. and Sastry, M.A. 1992).

In the mid to late 1990s again, the World Bank, though the Asia Alternative Energy Unit (ASTAE) and the World Bank under its sectoral reform projects developed plans for DSM implementation for several states (S. Padmanabhan, 1996). Some of them are listed below:

- Municipal water pumping in Bhubaneshwar, Orissa – This project envisaged saving of 2.25 MW (peak load) and 4.16 MU and an attractive benefit / cost ratio of 3.09.

- Motor Efficiency DSM project in Orissa – This project envisaged saving of 3.8 MW, with cost of avoided capacity of Rs. 5,833 / kW. The cost of voided capacity addition was nearly a fifth of the cost of new capacity creation.

- Integrated DSM strategy – BSES Mumbai – This study estimated that a saving of about 30 MW could be achieved in peak demand through a number of DSM measures in industrial, residential and commercial sections. The estimated average cost was Rs. 1.3 million / MW.

Box 1: Power of efficiency improvement

Load shedding is usually maximum in the evening, when the needs for lighting result in a sharp increase in power demand. In several states as much as a third to quarter of rural consumers are denied supply during this time. Addition of generation plants and strengthening supply lines to supply one lamp of 60W involves an upfront investment of Rs 4,000/-!

On the contrary, if one house uses an efficient lamp of 15W (that gives the same light as the standard 60W incandescent bulb) it can make sufficient power available to light three other houses, provided they are also using efficient lamps. The total upfront investment for the four efficient lamps is less than Rs 1,000/-. This is less than one tenth of the investment needed to increase supply for three 60W lamps! Hence, large-scale efficiency improvement at the house level is a fascinating way to reduce load shedding, especially where capital is scarce.

Efficiency improvement also creates more employment than increasing supply and hence is socially more beneficial. One efficient lamp in place of a standard bulb, avoids burning of half a ton of coal, and creation of 150 kg ash! Hence, such measures are a win-win situation for society, consumers and the utility.

Often, terms like efficiency improvement, energy efficiency, or DSM are used loosely. DSM must be distinguished from the other general terms. According to the definition adopted by the California Public Utilities Commission, DSM is "*Planning, implementation, and evaluation of utility-sponsored programs to influence the amount or timing of customers' energy use*." (Ref.: Glossary of words on the website of California Energy Commission). Indian regulatory commissions have use the term DSM in contrast to the supply side management, implying reduction or alteration of demand. The regulatory commissions in India have also used the tariff signal induced change in consumer behaviour, or reduced energy use due to mandatory standards as DSM. This issue is discussed in detail later.

Efficiency Improvement and DSM in Electricity Planning and Law

A number of government agencies in India have recognised the importance of energy conservation and efficiency improvements. This is reflected in the number of government publications, plans, policies, and legislations as well as in the institutional set-ups. At the state level, Nodal Energy Development Agencies have been created with specific mandate to undertake energy conservation along with promotion of renewable energy resources. Governments, both central and state level, have undertaken several programs to increase public awareness about energy conservation.

An Energy Management Centre was created under the Ministry of Power (MoP) of Government of India (GoI) to promote energy conservation and energy efficiency. This centre has now been merged in the Bureau of Energy Efficiency (BEE). GoI has also offered significant fiscal incentives to promote energy conservation. For example, energy conservation and energy efficient equipment has been eligible for 100% depreciation, which offers significant tax benefits for customers.

The extent of importance attached by the central government to energy conservation is reflected in promulgation of a separate Act 'Energy Conservation Act 2001', which was specifically enacted to promote energy conservation.

Energy Conservation Act 2001:

The Energy Conservation Act 2001 is primarily aimed at the intensive consumers of energy called Designated Consumers. The Energy Conservation Act has created the Bureau of Energy Efficiency (BEE) under the Ministry of Power. The BEE has powers to direct the designated consumers to abide by energy consumption norms and to get their energy consumption audited. The BEE is also empowered to mandate that all appliances carry labels indicating their efficiency; that appliance manufacturers abide by efficiency standards set by BEE; and that energy consumption standards set by BEE are met by specified industry or building complexes. The power supply utilities are included in the list of Designated Consumers. At present, the BEE is following a consensual approach and has not started to use its legal / penal powers. The BEE has also declared that it may start using its penal powers and powers to mandate actions in future.

The BEE website suggests that the power distribution utilities should have DSM cells (to implement the DSM programs). The BEE also offers training support for the DSM cells set up by the utilities. The BEE seems to imply utility-sponsored efficiency programs as a meaning of DSM.

The BEE has estimated a potential of 23% savings through energy conservation. BEE has set up an action plan for achieving 10% saving (nearly 10,000 MW) in the next five years. (Ref: Statement made to the press by Union power minister P. M. Sayeed on 25 May 2004, "*Priorities of Power Ministry*", http://powermin.nic.in/statement to press.htm as on 15 November 2004)

Electricity Act 2003 (E Act)

The Electricity Act 2003 is an overarching legislation, enabling major restructuring of the power industry in the country. Despite a much broader focus, the E Act 03 has significant emphasis on energy conservation and environmental protection as discussed below:

The preamble says the E Act is intended to '*promote* ***efficient and environmentally benign policies'*** among other things.

Section 61 of the E Act gives electricity regulatory commissions the mandate to regulate electricity tariff and lays down the guiding factors to be considered while determining tariff. Section 61 C requires regulatory commissions to set tariff by considering "*the factors which would encourage competition,* ***efficiency, economical use of resources****, good performance and optimum investments*"

As per section 185.3 of the E Act, the provisions of E Act 2003 would prevail in case of any conflict with the provisions of the state reform acts passed earlier. This implies that the above-mentioned provisions are in force throughout the country.

As per section 86.4, in its discharge of functioning the ERC shall be guided by the National Electricity Policy and National Electricity Plan to be published by the central government and the Central Electricity Authority (CEA) respectively. Though the above-mentioned policy or plan are yet to be finalised, the draft policies published by the government also emphasise energy conservation and DSM.

The draft national electricity policy devotes a whole sub-section to energy conservation and DSM. The national electricity plan to be prepared by CEA is expected to reflect the national target for efficiency improvement. (Ref: Draft National Electricity Policy – MoP, August 2004)

Apart from such a strong legal approach, energy conservation has found priority in many other related initiatives of the MoP. For example, the MoP has insisted on DSM and energy conservation measures in the MoUs signed with several state governments / utilities under its financial assistance program (called APDRP). Typical MoUs by MoP required the state governments / utilities to undertake DSM activities. The typical provision reads as follows:

"An effective program in the field of demand side management through - energy-efficient bulbs, tube lights and agricultural pumpsets. Time of the day metering and differential tariff for peak and off peak hours needs to be implemented with suitable mass awareness and extension efforts."

In summary, the GoI has accorded priority to energy conservation including DSM and initiated several actions to facilitate and ensure its implementation.

Efficiency improvement and DSM – Role of different actors

There is a large and cost-effective potential for energy efficiency. The government has also set an impressive target for saving energy through efficiency improvements and provided strong legal support for this purpose. But, unfortunately, little progress is seen in terms of actualisation of this potential. This section analyses the barriers to achieving this potential and suggests actions that may be taken by power utilities and consumers.

Barriers to Energy Efficiency

Several researchers have tried to analyse the reasons for the large gaps between the potential and actual achievements of energy conservation. Many studies listed in Part II of this report also discuss the various barriers to energy efficiency and measures to overcome them.

A report by Amulya K.N. Reddy, titled "Barriers to Improvements in Energy Efficiency" is one of the comprehensive and succinct analyses of this topic (REF Amulya Kumar N. Reddy, 1991). The report has identified several actors, who are critical for enhancing energy efficiency. These include:

1) Energy consumers
2) Manufacturers and providers of end-use equipment
3) Producers and distributors of energy carriers
4) Actual and potential co-generators
5) Local / national financial institutions
6) Government / country and (vii) International organisations and & funding agencies.

The report identifies about 30 barriers faced by these actors in achieving the potential of energy efficiency. The report analyses the origins of these barriers and identifies the measures that can be taken to overcome these barriers. An important conclusion of this report is that a "combination of measures" is required to overcome barriers and any measure in isolation may not be as effective.

In the last decade, agencies like Global Environment Facility (GEF) have attempted to find solutions to the identified barriers to the energy efficiency. The GEF has funded several efficiency improvement / DSM projects in developing countries that are targeted to overcome such barriers. More information about the projects (project database) can be accessed at http://www.gefonline.org/home.cfm

The remaining section discusses important aspects regarding barriers arising out of role of three key actors namely consumers, government, and the utilities.

Role of Energy Consumers, Government, and Utilities

A review of the literature suggests that, for effective realisation of energy efficiency, the potential role of three actors is particularly important: energy consumers, government, and the utility.

Energy Consumers

The key role of energy consumers is obvious because it is the point of actual energy usage. The consumer can switch off appliances when not required. As shown in Box 2, this has large potential but needs consumer awareness about energy conservation; moreover, sustaining this habit is difficult. Consumers should also use appliances in a manner that they operate at the best efficiency – this requires that consumers understand the proper manner to use the appliance. Consumers can opt for efficient devices and avoid purchasing inefficient appliances. But even educated users are seldom aware of the true potential saving possible by opting for efficient appliances.

The appliances have a purchase price tag but do not carry a price tag for energy consumption – the price paid after purchasing the appliance and using it. The consumers do not know where to find the vendor to purchase the efficient appliance. At times, consumers are helpless, since efficient appliances are simply not manufactured or the architects who design a building give priority to appearances and ignore the energy efficiency of buildings. Some consumers may not care about energy bills, either because the energy bills are small (compared to their income) or they can pass on the energy cost to someone else. The apathy of such consumers results in waste of energy.

Box 2: Switch-off when not in use

Several advertisements talk about the need for switching off lights and appliances when not in use. An effective campaign in Thailand could demonstrate its impact. In the first part a well-designed advertisement campaign was launched on TV and other media that talked about the need to conserve energy and how all consumers can avoid unnecessary use of energy. In the next stage, a one-hour program on energy conservation was simultaneously broadcast on all TV channels to coincide with the system peak time. Political, religious, and social leaders were interviewed on the importance of energy conservation. Then the projected system demand (load) was shown and was compared with actual load. The TV compere requested viewers to switch off one appliance not in use at that time. And it could be seen visibly on the TV screen that the system load was lower than expected load by hundreds of MW!

If all consumers in, for example, the state of Maharashtra switched off one 60 W lamp (or a fan or a tube light), then two power plants of 500 MW can be switched off! This is a significant saving compared to the total peak shortage. In Delhi city, the amount of saving would be nearly 240 MW! But sustaining this habit is a task, because of several reasons.

In addition to the usual “information barrier” faced by energy consumers, they may be unsure about the quality of new appliances, and cannot devote a lot of time to locate the vendor or technician to modify their equipment to improve its efficiency. This can be called a “transaction barrier”. To add to the difficulties, efficient appliances usually have higher first cost (”first cost barrier”). And consumers may not have sufficient upfront cash, and hence may end up paying more over the life of the appliance, despite knowing fully well that the higher cost appliance is more cost-effective in terms of energy consumption. Researchers have repeatedly shown this (as in the case of kerosene-stove v/s LPG stove. The LPG stove was much cheaper to run in the era of subsidised LPG prices).

Moreover, poor consumers tend to value present expenditure much more than expenditure in future (have a high discount rate). If they can pay in instalments, instead of upfront cash, they tend to go for an economical option by choosing an efficient appliance. Hence, the actions by consumers are sizable but not substantial enough to achieve the true potential of energy efficiency. The other barriers faced by consumers can be overcome by actions of the government and the utility – to help achieve fuller potential of saving.

Government

The government can substantially influence the actions of other actors, including the consumers. For example, lack of information about reliable and efficient products is an important barrier for consumers. The government can institute an energy efficiency-labelling program to make sure the buyer of electrical equipment knows the running / energy cost of the appliance. Similarly, the government can mandate efficiency standards to ensure that equipment manufacturers produce efficient equipment. Government can encourage sale of efficient appliances through tax structures or giving other fiscal incentives. GoI’s initiatives through Energy Conservation Act, BEE and fiscal incentives are directed towards such a role and are a welcome step.

In the near future, the BEE is expected to mandate the efficiency labelling, minimum appliance efficiency standards, and building codes among other things. The government has already mandated that large consumers of electricity should carry out energy audits and take corrective actions to ensure efficient operation of their plants / appliance. It can be seen that the Government of India is taking required steps, albeit slower than desired, to carry out its due actions.

Energy Utilities

Active participation of the electricity distribution utilities, the producers and distributors of energy carrier, is equally important for promoting energy efficiency. Electricity utilities regularly reach all consumers; to read meters, send bills, collect revenue and repair faults, etc. They collect bills from consumers and keep the records for several years.

The participation of utilities can greatly assist consumers in a number of ways. The utilities can:

1. Take the message of energy saving to consumers (at little extra cost)
2. Act as providers of know-how about energy efficient products and their suppliers
3. Act as an agent to assist in the delivery of such equipment
4. Function as an aggregator of consumer's demand for efficient equipment. The utilities can bargain for a good price from equipment manufacturers and pass on the benefit of reduced prices to consumers. The discounts can be as high as 40% of retail price!
5. Carry out research to identify the best produce and promote that product
6. Provide low interest loan or rebates to consumers and recover the loan through the monthly bills. The small consumers get loans at a very high interest rate whereas the utilities can procure loans at much lower interest.
7. Subsidise such programs, as the utilities also stand to gain by reduction in electricity demand, especially at the time of peak hours or situation of shortages.

Utilities can educate consumers by inserting information broachers or fact sheets with the monthly bills, operate consumer information centres, and organise seminars for example designers of buildings or mechanics (motor re-winders or plumbers). Rebates can be provided to consumers purchasing specific efficient devices. Utilities can provide incentives for manufacturers and retailers to increase availability of efficient devices and reduce their prices.

Through a host of such measures, the utilities are capable of substantially reducing the barriers faced by consumers and help society in achieving the efficiency potential. In the utility-driven DSM programs that have been implemented, utilities have taken up several of these routes to overcome consumer barriers. The later part of the report documents some of these programs.

Why should utilities support efficiency improvement?

Efficiency improvements result in large social and environmental benefits, which are achieved in a cost effective manner. Utilities and governments have a significant role to play in achieving the full potential of efficiency improvement. The government is moving in the desired direction. But little action is seen from the utilities. Why should utilities take efforts or spend money on efficiency improvements? How does a utility benefit by encouraging reduction in sales? Does it not suffer if electricity sales decline?

In most cases, utilities do not lose even if they promote energy efficiency. In cost plus regulation or limited incentive based regulation (prevalent in India), the utilities are compensated for the costs "properly" spent and also reduced sales, if any. During routine tariff adjustments, the ERCs correct tariff for such effects so as to protect the utility profits.

In fact, supporting energy efficiency can benefit utilities in a number of ways. In the case of supply shortage, energy saved due to efficiency improvements can be sold to other consumers and it can reduce load shedding (and thereby improve consumer service). It also reduces the pressure on utilities for more investment / building new power plants or grid strengthening. Even in the case of adequate supply, efficiency improvement helps to reduce the peak load and hence postpone investments in distribution networks or new generation plants. This helps the utility in reducing the cost of supply.

If DSM helps in reducing peak loads (called peak clipping) efficiency improvement reduces the need for high-cost peaking plants. The reduced network loading, especially at the peak time, greatly reduces the technical T&D losses. The technical losses are proportional to nearly the square of the current; hence a 10% reduction in the current results in a 19% reduction in technical loss. Thus, especially in the Indian context, efficiency improvement at the consumer end helps the utility to reduce the cost of power, improve consumer service, and reduce T&D losses.

Box 3 illustrates a case of large benefits of CFL program in Delhi, without any cost to the utility.

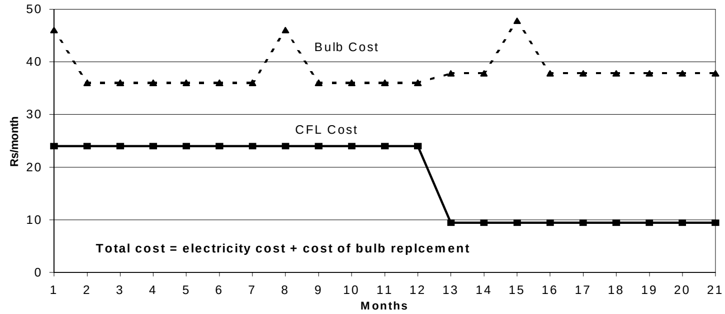
Box 3: Economics of a CFL leasing program

The incandescent bulb, used in most homes, is 10 to 20 times cheaper than the CFL (Compact Fluorescent Lamps). Hence, most domestic consumers do not buy CFLs. Let us see how a simple leasing program by the utility can benefit consumers and save tremendous electricity.

Let us take the case of a 60W incandescent bulb, being used by residential consumer. The bulb costs Rs.10 and lasts for about 1,000 hours, i.e. 7 months, for usage of 5 hours/day. The energy consumption of the bulb then comes out to 9 units / month (60W $\times$ 5hrs $\times$ 30days = 9 kWh). The typical tariff for Delhi residential consumers is about Rs.4/Unit. Hence, the cost of electricity consumed by one 60W bulb is Rs.36/month. Every 7 months there is an additional cost of Rs.10 for buying a new bulb. Hence, the consumer pays Rs.46, every eighth month. This cost is shown in the graph (line Bulb Cost). A 5% rise in the electricity tariff is assumed every year.

If the utility implements a program to lease CFLs to its consumers, the first cost barrier faced by consumers can be overcome. A CFL equivalent to 60 W bulb would consume only 15W. The CFL would have a life of about 8,000 hours (53 months) and would cost Rs.180, assuming a 10% discount to the utility. The utility can recover this cost through monthly bills at the rate of Rs.15 per month for the next 12 months. It is assumed that the 10% discount obtained by utility is inclusive of the financing charges. Hence, this is a "no-cost" operation for the utility (other than some modifications in the billing and accounting procedure).

For the consumer, the monthly electricity consumption of one CFL is 2.25 Units (15W $\times$ 5hrs $\times$ 30days = 2.25 kWh). i.e. monthly electricity bill of only Rs.9 ! Therefore for the first 12 months consumer pays Rs.24 per month (Rs.15 repayment + Rs.9 electricity bill). Thereafter, he pays only the electricity bill or Rs.9 ! (Refer the line CFL cost in the graph.)



The consumer bill comes down drastically, without any subsidy. Over a span of 53 months, the consumer saves Rs. 1,000 (@ 12% discount rate) if he replaces one 60W incandescent with a CFL! If only one lamp per residential and commercial consumers in Delhi is fit for such replacement – 24 lakh lamps can reduce Delhi's peak demand by about **100 MW** during the evening peak period (assuming a peak coincidence of 75%). **This would save Rs 237 crores for Delhi consumers without any cost to the utilities!** In addition, the utility can ensure that only good quality CFLs are promoted. Therefore, it is a win-win solution for consumers, the utility, as well as the society in general!

The World Bank conducted a workshop in year 2000 for electricity regulators and utility managers to discuss the drivers of DSM programs and best practices in DSM. The report of the workshop indicates that many progressive utilities find it sufficient to support DSM, as it benefits the consumers. As per these utilities their ultimate interest is in the interest of their consumers.

More fundamentally, it is a duty of the utility to support such initiatives. The utilities are given a license to supply electricity in the public interest and as per the provisions of the Act, narrated in earlier sections, it is their statutory duty to support and even finance initiatives such as end-use efficiency programs, which enhance public benefits. Only if such actions directly (and in a manner that can be demonstrated) reduce their profits, the utilities may have some point to argue and may seek some relief from ERCs. It is in this context that we will discuss utility-driven Demand Side Management (DSM) programs.

The International Experience of DSM

Since the mid-1980s, US researchers have shown the importance of utility-driven DSM schemes. The Public Utilities Commission in several states of the USA started mandating the utilities to implement DSM schemes. By now, several utilities in USA, Canada and other countries have accumulated experience of implementing DSM schemes.

This sub-section first gives a short introduction to DSM programs in some countries, followed by the larger lessons that may be drawn from the international experience.

Country Experiences

Taking an overview of DSM experiences in many countries is the topic of an independent report. This section draws attention only to selected schemes is some countries in order to highlight certain points.

USA

For over a decade, the regulatory commissions in the USA (called Public Utilities Commissions) have been directing the utilities to carry out DSM schemes. The commissions also monitor the savings achieved and have directed refinement of DSM plans.

The state of California, USA, has achieved a peak reduction of 4,500 MW to 5,500 MW, which turns out to be 11-14 percent of its peak demand, through utility-sponsored DSM measures. This fairly large saving has been achieved through utility actions in response to the directives of the commissions. During a power crisis around 2001, the voluntary DSM supported by tariff concessions (for reduced consumption) substantially increased the savings to about 6,500 MW. In the absence of such major savings, the energy crisis in California could have been much worse.

Since 1992, US regulatory commissions have been monitoring the peak load reduction and energy saved due to DSM programs initiated by the large power utilities. The US Department of Energy data shows that the USA achieved a reduction of 23,000 MW to 30,000 MW and energy saving of 54,000 million kWh to 60,000 million kWh due to energy efficiency programs initiated by utilities.

This saving does not include the reduction in demand due to the appliance efficiency standards, actions initiated by individual consumer / industry (such as energy audits), the savings due to tighter norms for construction of buildings or the load management programs. Moreover, nearly two-thirds of the peak as well as energy saving came from residential and commercial (non-industry) consumers! (Ref: Energy Information Administration, Form EIA-861, "Annual Electric Power Industry Report" December 2003).

Thailand

A DSM project implemented during 1993 to 2000 had a budget of $189 million and had a target of saving 240 MW (1,430 MU). Through 19 DSM programs the power utility EGAT achieved a saving of 570 MW (and 3150 MU) at a cost lower than the budget! The cost of saved peak MW was much lower than the cost of supplying additional power! (Ref: “DSM in Thailand: A Case Study” by UNDP, World Bank, Energy Sector Management Assistance Program, Oct 2000). The DSM project included many advanced programs, including market transformation of domestic manufacturers and pilot projects with Energy Service Company (ESCO).

The fluorescent lights program in Thailand was the primary reason for the manufacturers to shift production. (Similar was the case in the “Golden Carrot” refrigerator program in the USA; which achieved similar market transformation.)

Thailand probably has the most extensive experience in program evaluation, having completed a detailed evaluation costing about US$4 million and engaging multiple consultants to assist in the DSM effort. Thailand’s experience has underlined the importance of a concurrent evaluation process being an integral part of DSM.

Canada

The province of Quebec in Canada has provided significant emphasis on energy efficiency and DSM since 1970s. There have been 25 energy efficiency / DSM programs covering the residential, industrial and commercial sectors. Government as well as utilities undertook these multi-year programs.

Initial programs for residential sector focused on heating systems and range from simple information and awareness programs to mandatory standards and regulations to providing technical and financial assistance. Programs for industrial sector focused on providing support for energy audit and efficiency improvement studies as well as investment support. Many programs led to significant benefits. For example, a street-light efficiency program conducted during 1992 to 1995, which replaced mercury lamps with more efficient sodium lamps converting almost 250,000 luminaries, resulted in energy saving of 152 GWh.

Brazil

Recent legislation in Brazil mandates utilities to invest one percent of their revenue in energy efficiency projects (demand side and supply side) and R&D. This is a large sum of money and a major commitment to efficiency improvement. Utilities are required to develop and implement DSM programs – but issues relating to finding the most efficient manner of using money would arise and would need to be sorted out. Training of staff, assembling a specialized workforce to implement DSM, project assessment capability and expertise in measurement and verification of savings are being seen as constraints.

Sri Lanka

Sri Lanka had achieved a saving of 98 GWH during 1999 through DSM programs. This included information dissemination, energy audits, efficiency lighting, PF correction, appliance labelling, "best practices" group in the industry and building codes. Govt funds to support these initiatives and a DSM group have been working for some time. In fact, the CFL program implemented in Sri Lanka is similar to the one described in Box 3.

Uruguay

A noteworthy part of DSM in Uruguay is the leasing program. UTE – a utility in Uruguay implemented a DSM scheme – whereby it tied up with a financing agency for an appliance-leasing program. UTE offered to recover the money from consumer bills. If the consumers did not pay the bill, then it had the authority to disconnect supply. The interest rates which the utility could get for the loans were half the rates commercially available to consumers. This reduced the lease payments of consumers and the utility could promote selected high efficiency appliances through 400 enlisted retailers. This approach is innovative on the backdrop of legal limitations on the utility, that it could not directly sell or lease the appliances.

China

China has also implemented a couple of large DSM programs with the help of GEF funds. In 2001, it commenced a project for removing barriers to efficient lighting products; objectives include energy saving, improving technology. China aims at reducing lighting energy use by 10% relative to a constant efficiency scenario for 2010.

In 1999, China also started a project to remove barriers to commercialisation of efficient CFC-free refrigerators. It targeted a market transformation through technical assistance and training for manufacturers, incentives for efficient product design, conversion of factory production lines, national efficiency standards, labelling program, consumer education, dealer incentive programs, and a consumer buyback/ recycling program.

Costa Rica

CNFL (The National Company for Power and Light, Costa Rica) started with energy efficiency programmes in 1992 to address the peak load problem. The major contributor to peak load was due to electric cooking and lighting. The utility's morning peak contribution from cooking was 308 W/consumer. CNFL promoted mass replacement of bulbs by CFLs and replacement of electric by LPG stoves. The Federal Government granted tax exemption to CFLs in all its marketing stages.

Mexico

In 1995, Mexico started its first ever DSM project called "ILUMEX". Funds of about US $ 23 Mn were raised with The World Bank and GEF as major contributors. In this program, CFLs were purchased in bulk and distributed to the consumers by the utility. It was a grand success. About 2.4 Million CFLs were distributed against the target of 1.75 Million despite a severe recession in the country and peso devaluation.

After successful completion of ILUMEX, another program called FILUMEX was promoted in 1998. It did not offer any direct subsidies to end-consumers. CFE (Commission Federal de Electricidad - Mexican utility) held a campaign to promote use of CFLs. Rest all was handled by the CFL manufacturers. This program also was a great success selling nearly 8.6 Million CFLs by 2004.

Poland

The DSM program in Poland, called PELP (Poland Efficient Lighting Project), started in 1996. This provided subsidies directly to CFL manufacturers via a competitive bidding process. Successful bidders had to agree to pass on at least the full value of the subsidies to the product distribution chain in the form of lower wholesale prices. This approach required only a few transactions, those too at the manufacturer level. So the administrative expenses were substantially below other DSM programs that deliver subsidy directly to consumers via rebate coupons or other methods. It aimed at implementing about 1.2 Mn CFLs in 18 months.

Others

Several countries have also implemented large-scale DSM programs (especially DSM of lighting but insufficient information is available. The programs funded by the multilateral agencies like the World Bank, GEF and bilateral agencies are the ones about which sizable information is available. A table in Annex I shows an example of seven lighting and five refrigerator related projects funded by GEF.

There are many impressive schemes that strictly do not fall under the ambit of DSM, but in the end affect the transformation of markets and have the same net effect as of DSM – i.e. impact the reduction / change in consumption pattern of consumers. The case of efficiency improvement of refrigerators in the USA is widely discussed.

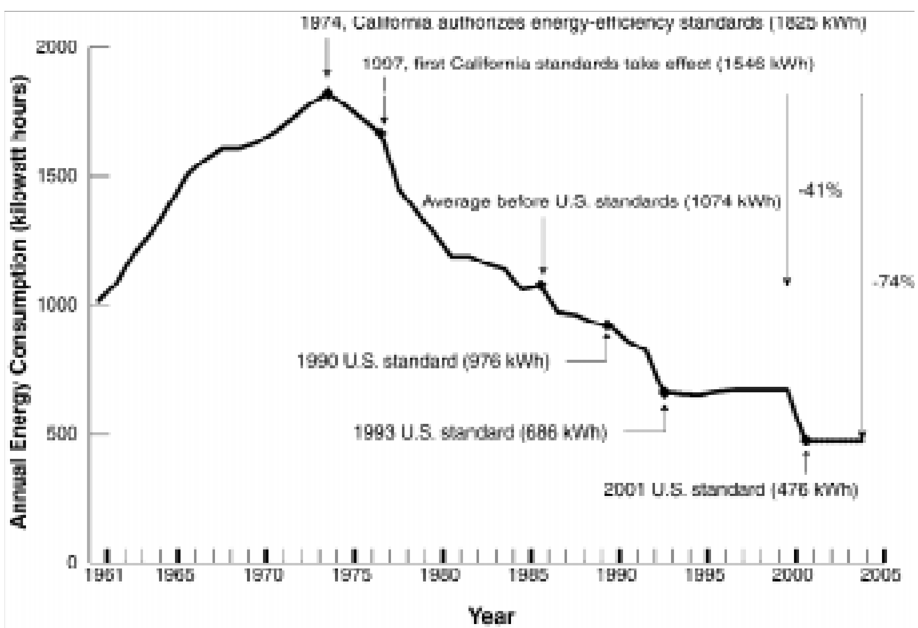
Box 4 discusses a little more on this aspect.

Box 4: Sustained efficiency improvement of refrigerators in the USA

The sustained efficiency gains in refrigerators has been a widely discussed success story. In the absence of Federal standards for efficiency in the USA, in 1975 California announced minimum efficiency standards for refrigerator sold in the state. The enforcement of standards was pre-announced and the government also published a detailed report on measures / design changes that could allow the manufacturers to raise refrigerator efficiency to meet the standards. California and the Federal standards played a key role in increasing efficiency of the appliances.

Around the 1990s an innovative approach was conceived by a utility and an NGO, Pacific Gas & Electric (PG&E) and Natural Resources Defence Council (NRDC) respectively, to use the market to improve efficiency again. A group of 24 utilities with small support from a government agency (EPA) announced a competition called “Golden Carrot”, whereby the refrigerator manufacturer that builds the most efficient CFC-free refrigerator would win a prize. The utilities had pooled a sum of $30 million as prize money. The rebates of utility DSM programs were to help the winner sell the super-efficient refrigerator at no extra cost for higher efficiency. The prize money and publicity helped the winner and also made sure that other manufacturers reduce cost and improve efficiency to compete with the winner.

The figure shows the sustained and rapid reduction of electricity consumption by the average refrigerator in the USA over the last three decades. The reduction is primarily driven by appliance standards and has been significant (74%), despite the fact that the average size of the refrigerator has increased during this period. Similar, even if somewhat lower, efficiency gains are possible in applications such as air-conditioning and combined heat-power application (through fuel shift).



There are also examples of utilities in USA and Canada that have committed themselves to meet the growth in demand through energy conservation and renewable energy sources (without building more large power plants). Although the growth of demand in these areas is not as large as in India, their commitment speaks well about the large achievable potential due to DSM and renewable energy.

Lessons from past experience[2]

The international experience of implementing DSM schemes suggests the following broad lessons for India. Such lessons need appropriate adjustments to local conditions, but seem useful to stimulate thinking.

- Concerted efforts by power companies with the regulatory commissions are crucial to achieve substantial energy savings and efficiency improvement potential.
- The primary objective of DSM has usually been to lower the total societal cost of provision of electricity services. Some times it is also to mitigate load shedding.
- Usually the residential and commercial sector has been the primary target of DSM programs. But as seen in South Africa, where the interruptible tariff to industry offers 1,800 MW can also be significant contributor.
- Cost reflective tariffs are useful but not essential for implementing DSM. In case of subsidised supply, the utility has a lot of incentive in selling the saved energy to the high tariff class.
- The utility has to take the lead in DSM. Once the market gets established, the private sector can be encouraged (through ESCO). But ESCOs are more appropriate for industrial and large commercial consumers. There are advantages in the utility continuing DSM programs for residential consumers due to high transaction costs for other players.
- DSM programs being funded through the tariff (i.e. through regulatory process) have an advantage over funding directly coming from the government – through imposition of taxes on other commodities. This avoids transfer of money between agencies and it encourages more efficient programs.
- Consumers should commit some resources before they get subsidies. The experience of Thailand and North America indicates this as a better design than ‘all free’ schemes as in some other countries.
- It should be a priority to initiate DSM capabilities and produce momentum, rather than keep debating on how best to achieve results.
- Evaluation should be an integral part of DSM plans and must be made concurrently. The evaluation should also be dynamic so as to give regular feedback on program effectiveness and allow for on-going adjustment.

[2] This section draws lessons from our general reading and an ESMAP report of workshop “Operating Utility DSM Programs in a Restructuring Electricity Sector” at Uruguay, October 2000.

Examples of Utility-initiated DSM action in India

On the backdrop of the large international experience, the next section reviews actions by utilities in India.[3]

The concept of DSM – implying modifying the consumer electricity consumption through utility initiated actions – is not new to Indian utilities. In the early days, the power utilities leased power-consuming devices such as electric toasters to consumers. The cost of the equipment used to be recovered from the consumer through the electricity bills. This was a form of DSM, but aimed at boosting the energy sales of the utilities.

But in recent times, the utilities have rarely implemented DSM schemes aimed at energy conservation. There are a few sporadic attempts, but these are more of an exception than the rule. Some recent DSM programs initiated by utilities are discussed below.

MSEB

The Maharashtra utility, MSEB, helped capacitors leasing to the powerloom consumers in the troubled area of Bhiwandi, notorious for high thefts and low payment by powerloom consumers. A capacitor manufacturer leased the capacitors to powerloom consumers and the payment was recovered through MSEB bills. It was a no-cost affair for MSEB, but reduced the transformer burn-out rate and improved service quality in that area. But MSEB has not repeated such a scheme or other DSM schemes, despite regulatory directives.

DVB:

The public sector power distribution company, Delhi Vidyut Board, had a program to lease capacitors to consumers. The capacitors were leased from the 11 kV substations. The present status of the scheme is not known.

Ahmedabad Electric Company

They are at present leasing high efficiency devices in collaboration with an ESCO. High efficiency fixtures with fluorescent tubes, electronic ballasts and capacitors are being leased under this program. Utility involvement helps to build consumer confidence in the quality of the devices and consumers can pay for the capital cost over a long period – through the savings achieved. The initial investment is done by ESCO – hence this too is a no-cost affair for the utility. This program has been functional for over two years. AEC has distributed over 50,000 efficient fluorescent fixtures in the city of Ahmedabad under this program.

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[3] Programs by agencies like USAID and Indo-Canada co-operation office to identify and help customers execute efficiency improvement in municipal water pumping or industrial processes are not included in this section. This section focuses on the DSM program where the utility has a key role.

Earlier, the AEC also carried out energy audit of water pumping systems in the high rise residential colonies. AEC contractor also carried out rectification of the water pumping systems. Studies and sample tests found that the saving in water pumping was very large – usually 30-45%. With payback period of less than a year (DSM from the sustainable development perspective: see part II of this report for detailed reference) But this program has been discontinued.

<u>MPEB</u>:

The erstwhile MP Electricity Board implemented a program to replace inefficient streetlights with more efficient lamps and a small program of replacing existing agricultural pumps with efficient pumps. The project aims at mitigating greenhouse gas emissions from Indian power utilities through the implementation of DSM measures. It has been largely funded by Canadian International Development Agency (CIDA)

The financial scheme for the agriculture module is as follows: MPEB would collect 35% of the project value from the agricultural customers and remaining project cost is fully financed by CIDA. Indian Renewable Energy Development Agency (IREDA) is also actively involved.

The demonstration program of the street light replacement is expected to achieve its target of replacing all inefficient lamps in the near future. But the agricultural pump replacement program has not gone beyond the experimental stage. Till now only a handful of pumps have been replaced and these too have not shown significant achievements in energy conservation.

<u>Noida Power (UP)</u>:

The agricultural power sale is a loss-making proposition for most utilities. In the case of Noida Power, the agricultural energy tariff is Rs. 0.75 / unit (and a fixed charge of Rs 180/Hp/yr), whereas the utility incurs much higher cost to purchase power (~ Rs 2.75/unit). Hence, each unit of reduced agricultural consumption reduces the cross-subsidy by Rs 2. Realising that efficiency improvement is a win-win situation, the DSM program of the utility focuses on agricultural consumers.

The utility replaces the old pumping system with an efficient system of lower Hp (without adversely affecting the water flow rate). The farmers pay about half the cost of replacing the pump and the utility pays the remaining. The NPCL then meters the pump, extends HT line up to the pump and installs a small Distribution Transformer (11 kV / 410 V, 10 kVA) dedicated to the pump user – leading to HT less distribution. The utility promises increased hours of supply to these pumps and expects reduced theft due to HV distribution and metered supply. About 55% reduction in energy use and reduced Hp is said to benefit farmers as well as the utility. The overall scheme has an investment of Rs 80,000/pump and its cost effectiveness was not readily available, but utility estimates payback period at four years. (Ref.: personal discussions and the ARR fillings to UPERC for FY 04-05). The NPCL has retrofitted 50 pumps and is targeting 35 pumps in FY 04-05.

Subsidy for the scheme, if at all, may be coming from overall revenue of the utility – i.e. from other consumers.

Karnataka DISCOM:

One of Karantaka's distribution companies, supplying power to Bangalore and surrounding areas, BESCOM (Bangalore Electricity Supply Company) is planning to implement three DSM program

(a) to promote CFL and 36W fluorescent tubes
(b) efficient water pumping initiative and
(c) Solar water heating initiative;

with assistance from IIEC (International Institute for Energy Conservation) under a USAID program. The BESCOM's efficient lighting program is in an advanced stage, and BESCOM has issued Invitation for Bids to procure CFLs.

The consumers would be able to purchase CFLs from the market against the utility coupon and repay the CFL cost through the utility bills. The consumer benefits on two accounts, firstly, the CFL cost is lower due to bulk purchase by the utility and, secondly, the consumer can repay the cost through the savings achieved by use of the CFL. This program would target 1.7 million residential consumers in the first phase. When implemented, "BESCOM would be the first utility to implement a large-scale DSM program in collaboration with the private sector". But the news report does not mention the program's target in terms of lamps to be sold (over and above the normal sales). (Ref.: ECO-II August 2004, IIEC).

As can be seen from the above listing of six examples, with thee exception of the program by Noida Power, most other DSM programs by utilities have virtually no-cost to the utilities. Several utilities including AEC, Karnataka, Orissa, AP and MP utilities have a DSM cell. But DSM programs of most utilities can only be described as nominal and sporadic; rarely sustained; not even properly evaluated.

There is an urgent need for all utilities to start no-cost programs such as "leasing of efficient appliances" with help of ESCO and then go beyond such 'no-cost' programs. The utilities need to show more commitment to DSM and also integrate DSM into their long term and medium term planning process.

Electricity Regulatory Commissions and DSM

The state regulatory commissions govern the power utilities. For example, in Delhi, the Delhi Electricity Regulatory Commission (DERC) sets the tariff for all electricity utilities in Delhi, approves the repairs and maintenance costs, budget for new investments; it also oversees the billing and other activities of these companies. The mandate and authority of ERCs is defined through the state level Electricity Reform Acts or through central Electricity Act 2003. These Acts envisage a significant role for ERCs in efficiency improvement and DSM as seen in the earlier part of the report.

<u>DSM in the ERC orders</u>

This section provides a brief review of the approach by some regulatory commissions to energy conservation and DSM. The ERCs are quasi-judicial bodies and have the authority to direct utilities to plan and implement DSM schemes. Table 1.1 gives a list of orders issued by state electricity regulatory commissions that have discussed the issue of DSM.

Table 1.1: DSM in Orders by State Regulatory Commissions

State	Context of the order
Maharashtra	MSEB tariff FY 2000-01
	MSEB tariff FY 2001-02
	MSEB tariff FY 2003-04
Andhra Pradesh	AP utilities tariff FY 2001-02
Karnataka	KPTCL tariff FY 2001-02
Delhi	DVB tariff FY 2001-02
Madhya Pradesh	MPEB tariff FY 2001-02
Uttar Pradesh	UPPCL tariff FY 2001-02

In some other cases, the ERCs have actually discussed or directed implementation of measures for enhancing energy efficiency that can actually fall under the heading of DSM, but are not defined as DSM by ERCs. These are not listed in the above table.

The major conclusions from this discussion are:

- Many ERCs have recognised the importance of energy saving as well as of DSM schemes (the utility implementing these schemes).

- By and large, ERCs have adopted a “tariff” based approach to promote energy conservation and DSM. For examples

    - KERC has provided a tariff rebate of Rs. 0.15 / kWh to households that have installed and are using solar water heaters. The rebate applies to all electricity consumed by the house. The use of solar water heaters, by reducing the morning peak load, is beneficial to the utility.

- In Andhra Pradesh, APERC offered a 50% concession in energy charges for agricultural consumers which have installed (i) Friction-less foot valve, (ii) HDPE piping for suction and delivery (iii) ISI marked pumpset and (iv) capacitor of adequate rating for the pumpset. Further the ERC also assured that this concession would be valid for three years.

- Time-of-day (ToD) tariff is another measure adopted by several ERCs, including Maharashtra, UP and AP. For example, Maharashtra ERC has significantly enhanced the differential in peak and off peak energy charges (being Rs. 1.45 / kWh in March 10, 2004 order). Through its tariff order for 2001-02, UPERC has introduced KVAh based tariff for high-tension consumers. Apart from this, tariff orders of several other commissions, such as KERC and DERC, have paved the way for introduction of ToD tariff in the near future.

- In their May 2000 and January 2002 orders on MSEB tariff, the Maharashtra ERC introduced stiff Power Factor (PF) incentives and penalties for the HT industries, to try and bring PF close to unity. In the subsequent order, Maharashtra ERC analysed the impact and found significant positive impact of its decision, the PF of large industries increased from 0.94 to 0.97 in one year, substantially reducing the reactive power requirement of the grid and thereby increasing the efficiency of generation plants.

♦ Only in exceptional cases, the ERCs have directed the utility to implement the scheme. In these cases too, the utility has not followed the directives and the schemes have not been finally implemented. The two cases where the ERCs have done this are discussed below.

MPERC:

The MPERC order states that "Although the MP Electricity Board has taken up the Demand Side Management and energy audit of agriculture and street light categories, the Board is directed to take up the work of energy audit and Demand Side Management in any industrial pocket on experimental basis and also on Board's own power stations and Administrative offices." The MPERC also directed the Board to constitute a DSM Cell immediately. Quarterly reports were to be submitted to the Commission for the above work. (MPERC order 2001-02). The progress of the street lighting DSM program (to replace street lights by efficient lamps) has been implemented, but the agricultural DSM program has been implemented only on a very small scale.

MERC:

The MERC order mentions, "*Commission is of the opinion that there is an urgent need for implementing Demand Side Management measures* apart from the ToD tariff". MERC directed MSEB to implement DSM schemes on pilot basis for the commercial buildings and the agricultural consumers. MSEB invited suggestions from the researchers and experts on how it should design the DSM scheme. But MSEB lacked the follow-up and did not implement any DSM scheme. MSEB did not take up even the sample ESCO demonstration project. MERC also directed MSEB to create a fund for promoting agricultural energy efficiency improvement, by charging a cess of 2% on all agricultural consumers. MSEB has not created this fund, nor has initiated the envisaged schemes.

Limitations of the Tariff-based approach to DSM

As seen in the section on international experience, cost-reflective tariffs are helpful in implementing DSM; they are not essential. Subsidised tariff is only one of the barriers for energy efficiency, and several other barriers prevent full exploitation of the potential. On the other hand, as seen in case of lighting efficiency improvement, having an economic incentive is not sufficient to ensure that people actually start using good quality high efficiency appliances. Hence, the regulatory commissions need to go beyond the tariff based approach to the DSM implementation. The ERCs ought to make it mandatory for the utilities to implement the DSM schemes, and help consumers overcome several of the barriers discussed earlier.

On this backdrop, getting utilities to carry out large-scale DSM schemes is critical at the present hour. This is also essential to make the utility overcome its own inhibitions and perception that DSM is not its core work or it is counter productive to try and reduce power consumption.

The Way Forward

As discussed in the report, energy efficiency has a large potential to the tune of avoiding 20 to 30 % of demand growth. This enormous potential should be harnessed if we wish to achieve the goal of economy and efficiency. Several studies have been carried out in India to demonstrate this beyond doubt. A lot of money and time has been spent on these studies. But little action has happened on the ground to actualise the benefits of DSM.

Government

The Government of India is taking some steps to achieve the potential. The actions by the GoI are slow but it is likely (as well as essential) that in the coming years the BEE will accelerate this pace. This should be a major area for consumers and others to watch for. The state governments have set-up the nodal agencies for implementation of Energy Conservation Act, but these rarely have a coherent program, capable manpower, or funds. The state governments need to make sure that this situation changes soon.

Utilities

Action by utilities, in implementing DSM schemes to reduce the barriers faced by consumers in achieving energy efficiency; is yet to take off. As discussed in the report, many utilities have a DSM cell as suggested by BEE or agreed by utilities in the MoU with the Power Ministry. But the implementation of DSM schemes on the ground is never more than at the pilot or experimental scale. It is urgent that the utilities study the viable DSM options and incorporate these schemes in their business plan.

The utilities should work on all types of schemes

(a) schemes that do not have any cost implications to them
(b) schemes that have cost implications to the utilities but where the utility savings offset the costs, and at the last level
(c) schemes that have cost implications, beyond the utility savings but are socially beneficial to the extent that loading of this extra cost on all consumers is justified.

The extra cost can then be included in the Annual Revenue Requirement (ARR) of the utility and passed to all consumers after examination by the ERC.

Electricity Regulatory Commissions

It can be seen that the ERCs have extensively discussed the need for efficiency improvement, for load flattening, reducing the consumption of highly subsidised agricultural consumers. But the commissions have not really taken up the path of DSM to achieve this goal. In the two cases, where the ERCs have directed implementation of DSM schemes, the utilities have not complied with the directive.

The commissions should take act against such non-compliance. The ERCs have the legal space to do so. Rather, ERCs have a legal responsibility to do so. Hence, the ERCs ought to reconsider their approach to DSM. Moreover, if we have to achieve the goal, set by BEE, of 10% energy saving through efficiency; it is essential that the utilities and ERCs are fully committed to DSM. The utilities are best placed to remove several barriers faced by consumers in achieving energy efficiency. Moreover, the extensive international experience of DSM indicates that DSM implemented by utilities (due to regulatory directives) can achieve large saving potential.

Hence, the ERCs should direct utilities to study different DSM options and submit DSM schemes for approval; then they should monitor the implementation of the approved DSM schemes.

Consumers

The consumers should ensure that the ERCs ask the utilities to implement DSM schemes and that the utilities implement ERC directives. Consumer groups can also help the utility in designing DSM schemes and getting popular support for such schemes among consumers. The Indian experience indicates that rapid and effective implementation of DSM schemes would not be possible without an effective public campaign focussed on regulatory institutions.

Hence consumer groups should make submissions to the regulatory commissions; either in response to the tariff application of the utility or as an independent application to demand

(1) implementation of different pilot DSM schemes,
(2) monitoring of DSM schemes by the ERC and
(3) preparation of an integrated resource plan by the utility (that considers the efficiency improvement / DSM on par with procuring new power generation).

It is important that the DSM savings are compared with the cost of new power purchase and T&D strengthening costs before ERCs give approval for new power purchase or large investments for T&D strengthening.

Lighting and Refrigerator efficiency projects by the GEF

Lighting projects

Country	Project Name	Project Type	Brief Description
Argentina	Efficient Street Lighting Program	Medium Size	The project focuses on demonstrating innovative mechanisms to overcome identified market barriers for efficiency improvement of street lights. Projected annual energy savings after barrier removal exceed 1450 Mn kWh.
China	Barrier Removal for Efficient Lighting Products & Systems	Full Size	Started in 2001, the overall objective is to save energy and protect the environment by reducing lighting energy use in China by 2010 by 10% relative to a constant efficiency scenario.
Mexico	High Efficiency Lighting Pilot	Full Size	The project is aimed at replacement of incandescent bulbs with CFLs. It was approved in 1991 and since then the results are highly satisfactory. Total sale of CFLs is nearly 2.5 million.
Philippines	Efficient Lighting Market Transformation Project	Full Size	It will specifically focus on the promotion of energy efficient version of linear fluorescent lamps, CFLs, high intensity discharge lamps, ballasts (low loss electromagnetic and electronic), and luminaries.
Poland	Efficient Lighting Project (PELP)	Full Size	The project, commenced in 1994, required manufacturers and wholesalers of CFLs to pass on full savings to retailers, who would apply a standard percentage-based mark-up, passing savings on to consumers. This has sparked the demand for CFLs in Poland largely achieving huge energy saving.
Vietnam	Energy Efficiency Public Lighting (VEEPL) Project	Full Size	By increasing the energy efficiency of public lighting installed over the next 10 years, the project will significantly reduce electricity consumption by the public lighting sector in Vietnam.
Global	Efficient Lighting Initiative (Phase I and II)	Full Size	The project is intended to take lessons learned in the efficient lighting projects and applies them to a selected set of other developing countries in order to significantly accelerate the penetration of energy efficient lighting technologies. It was started in 2000.

Refrigeration projects

Country	Project Name	Project Type	Brief Description
China	Barrier Removal for the Widespread Commercialisation of Energy-Efficient CFC-Free Refrigerators in China	Full Size Project	Activities undertaken include technical assistance and training for compressor and refrigerator manufacturers, incentives for energy efficient product design or modification and conversion of factory production lines, national efficiency standards, a national labelling program, consumer education and outreach, dealer and manufacturer incentive programs, and a consumer buyback / recycling program.
Cuba	Producing Energy Efficient Home Refrigerators Without Making Use of Ozone Depleting Substances	Medium Size Project	To phase out 100% of the use of CFC 11 as a blowing agent and CFC 12 as a cooling agent for domestic refrigerators production in Cuba. It was started in 2000.
Lithuania	Elimination of Green House Gases in the Manufacturing of Domestic Refrigerators and Freezers at Snaige	Medium Size Project	Elimination of hydro-fluorocarbons (HFCs) in the manufacture of domestic refrigerators; and production of energy efficient home refrigerators without making use of ozone-depleting substances. It was started in 2001.
Slovak Republic	Elimination of Ozone Depleting Substances in the Production of Household Refrigerators and Freezers	Full Size Project	Started in 1995, this project will eliminate annual consumption of 280 metric tons of weighted, ozone-depleting substance potential through phasing out the use of chloro-fluorocarbons.
Tunisia	Barrier Removal to Encourage and Secure Market Transformation and Labelling of Refrigerators	Medium Size Project	Commenced in 1999, the project would ensure that energy efficiency and consumption labels are developed and adopted by all local refrigerator manufacturers. The energy efficiency standards are expected to be issued by 2005.

PART II

"Opportunities for improving end use electricity efficiency in India"

by
Steven Nadel, S. Gopinath, Virendra Kothari
USAID, November 1991
Pages – 225

This is a comprehensive study carried out in the early 1990s covering the all-India potential and costs of different efficiency improvement measures. The study uses 1989-90 data for all-India electricity consumption in different sectors such as domestic, agriculture, industry, and commercial. Based on past trends, the 13th electric power survey of CEA and estimation of consumption trends in the future, sectoral electricity consumption in the year 2004-05 was forecasted using regression analysis. Further, for both base year as well as forecast year, end-use pattern (i.e. contribution of different equipments to total consumption) was estimated. Estimation of end-use pattern was based on existing studies, literature references and results of other surveys. The basic approach adopted for estimating end-use patterns was to estimate equipment population, typical daily or annual operating pattern and consumption, etc.

Based on the contribution of different end-uses to total consumption and likely efficiency gains, the study considered 27 different energy efficiency improvement and load management measures. Based on the savings potential of each measure and likely cost, the study worked out cost of saving one peak load (Rs. / kW) as well as saving one unit (Rs. / kWh) of electricity using the particular measure. To determine the cost effectiveness of the measure, the study considered cost of a new power plant (Rs.23,500 /kW for base load plant and Rs.12,900/kW for peak load plant) and marginal generation costs (short term Rs.1.1/kWh and long-term Rs.1.9/kWh) as reference points. Any measure, which cost less than these costs, was considered to be cost effective. As seen in several studies, even this study found that the energy efficiency improvement measures are highly economical. All 27 measures considered in the study were found to be cost effective.

The major findings of the study are summarised below:

- Number of efficiency improvement and load management measures considered – 27
- Cost of these measures : Rs.2,200/kW to Rs.20,000/kW and Rs.0.09/kWh to Rs.0.79/kWh
- Average capital cost : Rs.8,800 / kW
- Cost of generation options : Rs.12,900/kW to Rs.23,500/kW and Rs.1.1/kWh to Rs.0.79/kWh
- Total cost effective saving potential 20 % of demand

The table above shows details of various measures considered, their cost and potential.

- - -

Special Study on Demand Side Management

for Environmental Resources Management, London
by
Energy, Economy and Environmental Consultants,
Bangalore, India, 1997
Pages – 90

This study was part of a larger project titled "Environmental Issues in the (India) Power Sector." funded by UK's Overseas Development Administration (ODA, now DFID) and executed through the World Bank by Environmental Resources Management. As part of this project, least cost integrated resource plans were developed as case studies for two Indian states of Andhra Pradesh and Bihar. This special study on DSM was intended to provide inputs for these case studies. The report provides a useful review of past studies and experiences relating to DSM and energy efficiency in India as well as a very brief overview of international experience.

The study analyses several DSM/EE options in the industrial, domestic, commercial and agricultural sector. Table 2.1 highlights the potential and economic savings from some of the DSM/EE options.

Table 2.1: Various measures of DSM and corresponding savings

Measure	Rs./kWh at peak hours	Monetary Savings (Mn. Rs.)
Fluorescent lights	1.24	346
Compact fluorescent lights	1.24	492
Solar water heater	0.31	80
Electronic chokes	1.00	44
Shifting discontinuous loads	0.21	1,709
Industrial motor systems	0.21	118

The study also identified technical savings potential from such options, which is estimated to be over 7000 MW.

A pertinent part of the report is discussion about potential DSM programs for measures such as industrial peak load reduction programs, electronic chokes, compact fluorescent lamps and solar water heaters. The report provides detailed spreadsheet calculations of potential benefit and costs of different DSM programs. Several key assumptions such as life of equipment, usage pattern, energy and peak load savings, cost of equipment, program costs, sharing of costs between utilities and consumers are also transparently provided in the report. Some recommendations of the report include subsidizing energy efficient equipment by utilities and adopting Energy Service Company (ESCO) route to undertake efficiency improvements in industrial, domestic, commercial sectors with the help of the utility.

Study of DSM Options, Role of MSEB, Analysis of DSM Options

Prepared for MSEB, Mumbai
by
SRC International, Tata Energy Research Institute and
Ontario Hydro International, 1995,
Pages - 250

The focus of this report is on developing and recommending actual, utility-supported DSM programs for implementation and not mere estimation of the cost-effective potential of different measures. Based on literature review, the report lists 45 potential DSM options covering the domestic, commercial, industrial and agricultural sectors. These 45 options were screened using different criteria, which are listed below:

- Meets load shape objective
- Product or technology availability
- Customer acceptance (financial)
- Customer acceptance (non-financial)
- Magnitude of saving potential
- Reliability of technology / savings
- MSEB revenue considerations
- Ease of program design and implementation
- Relatively lower costs with higher returns
- Availability of performance and cost data
- Impact on load shape can be evaluated
- Relative ease of program monitoring and evaluation

The report has a good discussion on the role of utilities in DSM programs, customer barriers to energy efficiency options and how to overcome the barriers, the role of government and other stakeholders (e.g. equipment manufacturers)

Based on the above-listed screening criteria, the report develops and evaluates DSM options and programmes using computer model COMPASS. This model is used to integrate factors such as load shapes, tariff, and technology characteristics. Through the COMPASS model, it is possible to test the benefits of DSM programs from different perspectives such as utility, participant (consumer) and societal benefits.

The following 10 DSM options were evaluated in detail using this methodology:

- Commercial and Domestic sectors:
    -Electronic ballast program
    -Compact fluorescent lamp program
- Industrial sector:
    -High efficiency motors
- Agricultural sector:
    -Agricultural pumping efficiency package
    -Solar pump-sets
    -Wind pump-sets
- Time-of-use rates:

HT industrial sector
LT industrial sector
Commercial sector

The detailed DSM program analysis for above options indicated significant potential and economic benefits for all stakeholders as shown below:

- Savings potential (in year 2005)
  Winter evening peak load – 1,109 MW
  Summer evening peak load – 724 MW
  Annual energy saving – 6,291 GWh
- Economic benefits
  Total plan costs in 2005 – Rs. 102 Cr.
  Benefits to costs ratio – From MSEB perspective – 9.0
  From Total Resource Perspective – 8.4
  From consumers perspective – 2.2
  DSM plan levelised life cycle cost is about a quarter of MSEB's long run-marginal cost.

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“Demand Side Management from a Sustainable Development Perspective:

Experiences from Quebec (Canada) and India”

by

TERI, IREDA, ECONOLER and

Agence de l’efficacite energrtiquedu Quebec , 2003

Pages - 246

This is a book about DSM, published in 2003. The publisher says, ‘This book brings out the concepts underpinning the design and implementation of energy efficiency and DSM projects and presents case studies from Canada’s Quebec province as well as from India, a developing country. It also elaborates the subtleties of DSM for worldwide applications.” The book is divided in four parts. Part I presents overview of DSM as well as details relating to DSM programs. One chapter each in Part I is devoted to four crucial steps in DSM programs i.e. Planning, Design, Implementation and Evaluation. The second and third parts present experience and case studies from Quebec in Canada and India. The last part is conclusions and development perspective of DSM.

Part I of the book, which focuses on DSM programs, is particularly useful. Four key chapters in this part introduce the reader to the various steps involved in successful DSM implementation. For example, how to select appropriate DSM options by integrating different considerations and constraints such as nature of demand, utility economics, consumer response, end-use pattern and technological aspects, how to evaluate economic benefits of DSM programs for the utility as well as consumers and how to design appropriate benefit sharing arrangements. Issues regarding administration of DSM programs, like institutional set-up, marketing arrangements, and nature of utility support are also discussed. The last chapter in Part I, which focuses on evaluation of DSM programs, correctly highlights the importance of adopting systematic measurement and evaluation of program benefits. Different analytical techniques as well as critical steps in program evaluation are discussed.

Another interesting feature of the book is the chapter on case studies of DSM in India. It presents details of two case studies of which a case study of DSM program of Ahmedabad Electric Company (AEC) is particularly important. It explains how the DSM program of AEC evolved through the four stages of Feasibility Research and Targeting, Initial Testing and Program Design, Pilot Programs and Full program roll-out. It shares the major considerations in design and implementation of DSM programs and major lessons to be noted while undertaking other DSM programs.

Overall, this book is useful to understand the benefits of DSM programs for various stakeholders and is a valuable resource for designing and implementing effective DSM programs.

Bibliography

List of major reports on Energy Efficiency and DSM

This indicative list demonstrates the spread and depth of work already done on this topic. The reports which have been summarised above are indicated with " ## ".

1. Electricity Pricing, Policies and DSM in India - Rangan Banerjee, Energy Systems Engineering, IIT, Mumbai, India, Pages ~ 30.
2. A Blueprint for DSM Plan: An Exercise for HT industries in Maharashtra 8th five year plan - Rangan Banerjee and Jyoti K. Parikh, Indira Gandhi Institute of Development. Research, Mumbai, India, Pages 23.
3. Utility DSM Program Experience - Michael Totten, International Institute for Energy Conservation, USA, 1992, Pages ~ 40.
4. Demand Side Management, A useful tool for energy conservation in industry - Evald Brond, 1990, Pages 13.
5. On the assessment of utility Demand Side Management Programs-Mark D. Levine and Richard Sonnenblick, Lawrence Berkeley Laboratory, California, USA, Pages ~ 25.
6. Designing and implementing a demand side management program in Thailand - Piyasvasti Amranand, National Energy Policy Office, Thailand, Pages 40.
7. DSM Strategy Programs in India: The World Bank's Experience - S. Padmanabhan, ASTAE, The World Bank, 1996, Pages ~ 110.
8. Demand Side Management in the Agricultural sector of Uttar Pradesh - Investment Strategies and Pilot Design - TERI, New Delhi, India, Pages ~ 200.
9. Feasibility Study: Electric Motors Demand Side Management Project (Orissa: Electric Motors DSM Investment Programme) - Innotem Services Pvt. Ltd., 1996, Pages 122.
10. Environmental Issues in the Power Sector: Demand Side Management - Special Study - Environmental Resources Management, London, 1997, Pages 154.
11. Opportunities for improving end-use electricity efficiency in India - Steven Nadel, S. Gopinath and Virendra Kothari, 1991, Pages 227. ##
12. An industrial DSM program for the Uttar Pradesh State Electricity Board - Hagler Baily Consulting, Inc., USA and National Productivity Council, New Delhi, India, 1996, Pages ~ 120.
13. Study of DSM options role of MSEB Analysis of DSM options - SRC International, USA, TERI, New Delhi, and Ontario Hydro International, Canada, 1995, Pages ~ 200. ##

14. Demand Side Management Load Research Component (Orissa State Power Sector Restructuring Project): Vol I and II - Metering Engineering, Inc., 1995, Pages ~ 240
15. Advanced Technologies for Electric Demand Side Management - Conference Proceedings, Italy, 1991, Pages 441
16. Bombay Efficient Lighting, Large Scale Experiment - PEICO Electronics and Electricals Ltd., BEST Undertaking and Indira Gandhi Institute of Development Research, 1990, Pages ~ 80. ##
17. Northwest Conservation and Electric Power Plan, 1991, Pages 51.
18. Demand Management Development Project: Information Paper No.1 to 6 - Department of Industry, Technology and Resources, State Electricity Commission of Victoria, 1989, Pages 414.
19. Amulya Kumar N. Reddy, Gladys D. Sumithra, P. Balachandra, Antoinette D'Sa, 'A Development-Focused End-Use-Oriented Electricity Scenario for Karnataka', Economic and Political Weekly, April 1991. ##
20. Girish Sant and Shantanu Dixit, "Least Cost Power Planning: Case Study of Maharashtra State" - Energy for Sustainable Development, Vol. IV, No. 1 June 2000.
21. A.J. Gadgil and M.A. Sastry, 'Stalled on the Road to the Market: Analysis of Field Experience with a Project to Promote Lighting Efficiency in India' Lawrence Berkeley Laboratory, 1992. A paper presented at the ACEEE 1992 Summer Study on Energy Efficiency.
22. S. Padmanabhan, 'DSM Strategy and Programs in India: The World Bank's Experience' - Workshop on Demand Side Management and Strategies for the Indian Power Sector, Goa, 1996.
23. Amulya Kumar N. Reddy, 'Barriers to Improvements in Energy Efficiency' - Lawrence Berkeley Laboratory, 1991 (LBL rpt. No. 31439).
24. Joel N. Swisher, Gilberto de Martino Jannuzzi, Robert Y. Redinger, " Tools and Methods for Integrated Resource planning – Improving Energy Efficiency and protecting the Environment" - UNEP Collaborating Centre on Energy & Environment, Riso National Laboratory, November 1997, Pages- 270. (Working Paper No. 7, ISBN 87-550-2332-0, ISSN 1025-2258).
25. Energy Efficiency Program Planning Workbook, Donald D. Gilligan, National Association of Energy Service Companies, Washington, DC, December 2002, Pages –37.
26. Operating Utility DSM Programs in a Restructuring Electricity Sector - Workshop Summary – Uruguay, October 23-25, 2000 ESMAP report.
27. Demand Side Management from a sustainable development perspective – Experiences from Quebec (Canada) and India, by TERI, IREDA, ECONOLER and Agence de l'efficacite energrtiquedu Quebec, 2003, Pages - 246. ##