Krishan Dhawan, Deepak Gupta, Vrinda Sarda

Demand Side Management

The Unseen Resource in India's Power Sector

India is witnessing rapid economic growth and steady population growth. By 2030, it is expected to be the most populous country in the world and one of the largest consumers of energy. India's electricity demand is presently increasing at the rate of about 5% every year. Despite an installed capacity of more than 279 Gigawatt[1] (GW), a modest power consumption rate of 914 kilowatt-Hour[2] (kWh) per capita annually, and only 78% of the population connected to the grid – we are still a power deficit country with an overall peak shortage of 5%[3], and an overall energy shortage of more than 4%[4]. Providing the much needed energy access to the currently unserved 400 million people and higher levels of energy use as a result of economic growth and urbanization, may well lead to a demand-supply mismatch. Meeting the energy challenge is, therefore, of fundamental importance to India's economic growth and its efforts to raise its level of human development.

The National Institution for Transforming India (NITI) Aayog estimates that in 2031-2032, India will need 2,628 Billion Units (BUs) of electricity, which is more than double the current demand of 1,049 BUs. Historically, India has set up more power plants to build supply, promoting all kinds of supply sources – fossil fuels, renewable sources and other non-conventional sources. In times of depleting conventional resources and growing climate change

[1]http://powermin.nic.in/power-sector-glance-all-india

[2]http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS The world average per capita power consumption rate is at 2,429 kWh

[3]http://cea.nic.in/reports/annual/lgbr/lgbr-2014.pdf

[4]http://cea.nic.in/reports/annual/lgbr/lgbr-2014.pdf

concerns, significant reliance on conventional supply alone may not be an ideal energy blueprint. Further, such efforts have been constrained by various challenges around coal and gas allocation, environment clearances, land acquisition and financing. As a result, only a few new projects have been set up.

While it is important to strengthen the supply side infrastructure, such measures are largely time intensive and have long gestation periods. There is a need to complement such efforts with measures that can yield quicker and sustainable results. Energy efficiency and Demand Side Management (DSM)[5] , offers one of the fastest, cleanest and most cost effective ways to meet our growing energy needs. Such efforts will help us significantly bridge the demand supply gaps in a relatively shorter time frame, bring down our future demand trajectories, and will be far cheaper than building new power plants and laying new transmission and distribution infrastructure.

India's Intended Nationally Determined Contributions (INDCs) pledge to reduce greenhouse gas emissions intensity by 33-35% of its 2005 levels by 2030[6] further strengthen the case for aggressive DSM interventions.

WHAT IS DEMAND SIDE MANAGEMENT?

The Ministry of Power defines DSM as actions taken by the electric utility to alter the end-use of electricity consumption beyond the customer meter. These actions may be taken to increase demand, or decrease it, or shift it between high and low peak periods, or manage it when there are intermittent load demands. This can be carried out in two different ways – either by load reduction techniques or by load management techniques.

Load reduction techniques reduce the kilowatt hours (kWh) consumed without altering the overall level of services being availed by the customers. They encompass both energy efficiency and energy

[5]Demand Side Management (DSM) refers to actions taken by the electric utility (discoms) to alter the end-use of electricity consumption beyond the customer meter

[6]Press Information Bureau, Government of India, Ministry of Environment and Forests, 02-October-2015; http://pib.nic.in/newsite/PrintRelease.aspx?relid=128403

conservation measures. The former lead to the adoption of energy efficient technologies and end use appliances, while the latter lead to lifestyle or behavioural changes resulting in the efficient use of various end-use applications.

Load management techniques are employed by utilities when there is a need to modify customer load profiles and thereby reduce, or shift demand from one period to another – typically peak to off-peak – with the overall aim to flatten the load curve. A few examples of widely adopted load management techniques include Demand Response, a voluntary load curtailment scheme, and time of use tariffs structure, in which different rates are applicable for use of electricity at a given time.

The DSM intervention adopted by the distribution utility (henceforth Discom) usually depends on the objective of the utility in question – whether it is peak clipping, load shifting, strategic load conservation or load growth. While the terms DSM and Energy Efficiency are often used interchangeably, they are in fact not the same. It is important to note that DSM explicitly refers to actions that involve deliberate interventions by the Discom to alter the consumer's load profile.

WHO NEEDS DEMAND SIDE MANAGEMENT?

For decades, the Indian power sector has remained chronically inefficient due to its complex nature and legacy issues. While the reforms proposed by the Electricity Act, 2003 have made headway in both the generation and the transmission segments, not much has changed on the distribution side.

The distribution segment shoulders the most critical role in the overall power supply value chain. It delivers the generated and transmitted electricity to electricity consumers and collects revenues, which is necessary to keep the sector going. Over many years, the distribution sector has become financially unstable due to three main reasons: high aggregate technical and commercial (AT&C) losses (approximately 27% against a target of 10%); heavy subsidy to select consumer categories; and poor metering and billing. As a result, Discoms are in a financially stressed condition, where they are

unable to make investments in their network and systems. They are caught in a vicious cycle where serving customers will require them to procure more power, which is increasingly expensive, but revenue collection is insufficient to meet the increasing costs of supply.

This is where DSM can play a critical role. DSM has the ability to mitigate peak load as well as base load (energy demand) at much lower costs (since efficiency is cheap). Therefore, it can reduce the demand for expensive power purchases by Discoms, during peak as well as off peak times, while reducing shortages immediately.

BENEFITS OF DEMAND SIDE MANAGEMENT

Scaling up DSM will result in improved end-use efficiency, which in turn will reduce the expected increase for overall power demand in future. DSM also offers improved service quality and reliability by filling the demand-supply gap. With reduced power procurement costs, the financial condition of Discoms will improve, enabling them to provide reliable and cost-effective electric supply to their consumers. This in turn will help consumers make timely payments of their reduced electricity bills – thus breaking the Discoms' operational and financial deadlock.

Further, DSM programs targeted at low paying and subsidised consumers can help bring down the overall cost of electricity delivery for Discoms and for the state. Thus, DSM can support the enforcement of the Electricity Act 2003, and has the potential to address the challenges faced by the distribution sector including high subsidy allocation and pilferage in some consumer segments. Considering these benefits, most Discoms will recognize that demand management is a key solution for reforming the sector. And, it is better to save electricity at lower per unit (kilowatt hours - kWh) costs than to invest in expensive generation and transmission networks. On the other hand, most consumers will find it an attractive proposition to support DSM, since they can avail of incentives from the Discoms, without changing their overall service needs. The efficiency supported by Discoms is a far more attractive option than leaving it purely to consumer adoption in the markets.

Other key stakeholders of the power sector i.e. the Regulator

and the Government, with their responsibility towards consumers, also believe DSM to be an attractive option, since it helps them reflect the benefits of efficiency in the electricity tariff structures for Discoms.

THE CONVERSATION AROUND DEMAND SIDE MANAGEMENT

A large number of state officials, regulators and Discoms are now expressing interest in implementing DSM measures. Significant progress has been made in the DSM policy and practice space. Sixteen state regulators have already notified DSM regulations, and the Discoms in these states have now started to look for innovative measures to gain savings and optimise their existing energy mix. This is a marked shift from early 2009 where much of the Indian DSM policy and regulatory conversation was limited to setting standards and labels as well as debate over the efficacy of CFL lighting. In contrast, the value linkage between efficient electricity demand and consumption and an efficient and cost-effective power system has become more conventional wisdom, both in the Central Government and amongst State Electricity Regulators.

In another positive development, DSM conversations in policy circles focus on fuelling market-transformation across a broad cross-section of energy-using equipment. There is a significantly enhanced understanding of the linkages between scaled-up DSM activities and reduction in electricity shortages.

HOW TO DESIGN A DSM PROGRAM

To design effective DSM programmes across consumer categories, it is important to assess how and when electricity is used. It is also important to understand the consumer's choice of appliances and usage patterns. Load Research, which is the process through which Discoms study how consumers use electricity either in total or by end use, is the first step towards the development of an effective DSM plan. Load Research provides data on consumer load profiles and load patterns by using local sub-metering data, consumer bill analysis, walk through audits, consumer surveys and market research.

Subsequently, these outputs are converted into a DSM action plan and detailed program designs.

Program design is an integral component of the DSM plan. It aims to reach out to consumers and motivate them with incentive payments and awareness campaigns. A few widely accepted program designs adopted by various Discoms are discussed below:

Rebate Programs - These programs typically involve a rebate/ discount on the capital cost of the energy efficient equipment to offset the high differential cost involved in the purchase of the energy efficient appliance. The rebate is usually paid directly to the buyer, but on the submission of proof of purchase in the case of an end user or proof of sale in the case of a retail or a distributor. A perfect example of this is the Bachat Lamp Yojana (BLY), which was implemented by the Bureau of Energy Efficiency in 2009. Under this, any domestic consumer could get up to four energy efficient Compact Fluorescent Lights (CFLs) in exchange for working Incandescent Bulbs (ICLs), each at a discounted (rebate) price of 15. Rebate programs are of much benefit to consumers since they mitigate the high upfront cost of the energy efficient appliance and offer the appliance at a lower cost.

Standard Offer Programs (SOP) - The SOP is an innovative approach to augment energy efficiency deployment. It treats energy efficiency as a commodity comparable to generated electricity. Under this arrangement, an energy efficiency resource acquirer (typically a Discom) purchases future energy savings or demand reductions from an energy user (say, a utility customer) or third party energy efficiency implementation agencies (such as an Energy Service Companies) at a pre-determined price. The SOP is comparable to Feed-in-Tariffs used to promote renewable energy. A perfect example of this is the Domestic Efficient Lighting Program (DELP) implemented by Energy Efficiency Services Limited (EESL)[7] in Puducherry and Andhra Pradesh. Under this program, EESL along with respective State Governments offered self-ballasted Light Emitting Diode

[7]A prominent public sector Energy Service Company (ESCo)

(LED) lamps to domestic households at discounted prices. Further, both the Puducherry and Andhra Pradesh utility committed to compensate EESL's investments at a price in the range of 1 to 2 per unit of verified energy savings. These projects have been structured as standard offer contracts with EESL and respective Discoms as counterparties. It is possible to structure Demand Response programs under similar structures, where consumer can be paid by the Discom at a fixed or competitive rate via a third party (say a demand aggregator), for the demand curtailed by the consumer upon the Discoms' request.

On-Bill Financing Programs - This is a mechanism through which a utility provides the capital cost of the energy efficient equipment to consumers for meeting the upfront cost of an energy efficient equipment. This cost is subsequently recovered from the consumer by including its repayment in the consumer's electricity bill. At times, the capital cost itself and its interest is also subsidised. It can be likened to a loan provided by the Discom to the consumer for bridging the high cost of an energy efficient appliance, with or without an additional subsidy. A perfect example of this is the DELP program implemented by EESL in Delhi and Rajasthan. Under this program, Discoms along with EESL are providing up to four 7W LED's to all domestic households at a wholesale price of 93/LED in Delhi and 150/LED in Rajasthan. The consumer may either buy it upfront at these prices or make a down-payment of 10 and pay the balance through their electricity bills over a period of 9 months and 12 months in Delhi and Rajasthan respectively. Such a program is highly cost effective for the utility as there is a complete recovery or costs through bills.

APPLICATIONS FOR DEMAND SIDE MANAGEMENT INTERVENTIONS

Discoms can use any of the above program designs or a combination thereof to develop DSM programs across various consumer categories including residential, agriculture, commercial, municipal and industrial. DSM has immense potential for achieving efficiency across dominant end uses applications like lighting, cooling,

heating, refrigeration, motors, pumping etc. Key applications suitable for DSM interventions are discussed below:

Lighting[8] - Lighting accounts for around 18% of India's total power consumption, which is much higher than the average of 12-15% in developed countries, thus suggesting the need for energy efficiency. The lighting industry has made enormous leaps, growing from 8500 crores in 2010 to 13,500 crores in 2013 – a 53% growth in three years. The growth of the lamp segment was driven by CFLs while ICLs and Fluorescent Tube Lights (FTL's) saw minimal growth in their volume. The Bachat Lamp Yojana (which replaced ICLs with CFLs) improved CFL adoption considerably. The LEDs segment with high procurement cost (about 500 and above per LED) as compared to its counterparts (CFLs at less than 200 and ICLs at less than 20), moved at a slow space till 2013, but expanded significantly after.

LEDs offer a significant efficiency opportunity providing a higher level of service as a CFL lamp at less than half the power consumption. In replacing all CFLs with LEDs, and assuming we do not use any ICLs, the share of lighting demand in India would be halved. With ICLs still widely used in rural areas and even in urban areas, the efficiency opportunity is enormous.

India is already undertaking national level initiatives for promoting LEDs and enabling the transformation of the LED market. These initiatives have the potential to lower the base load requirement – across the day and year, and will help discoms decrease subsidy requirements. A few recent initiatives include replacing street lighting with LEDs, providing free LED lights to below poverty line houses, and distributing LEDs to domestic consumers under the Domestic Efficient Lighting Program in various states. This combined with changing consumer preferences and steadily dropping prices, the LED market is expected to grow to 60% of the total lighting industry by 2020.

[8]All numbers under 'Lighting' can be found here: http://www.elcomaindia.com/wp-content/uploads/ELCOMA-Vision-2020.pdf

Cooling / Air Circulation (Ceiling Fans)[9] - After lights, ceiling fans are the most common electric appliance with a 20% share in current domestic electricity consumption and an expected growth of 10% each year in sales. It is also expected that 70% of the ceiling fans in 2020 would have been added only since 2009. With a useful life of around 15-20 years, ceiling fans have a long replacement cycle, thus locking in the inefficiency for an extended period of time. Cooling fan technology that is available today (but not yet commonly used in India) at 30-35W is twice as efficient as commonly used technology (at about 60-90W), and four times more efficient than the technology that was used 15 years ago. The challenge here is that the cost of such efficient fans is more than double the cost of ordinary fans. While in most cases, the payback of additional costs is less than three years, consumers tend to purchase less efficient fans, owing largely to a lack of awareness or motivation.

Recognizing the need for intervention, the government is working with Discoms to influence consumers through awareness building campaigns, standard setting and incentives. The Bureau of Energy Efficiency has floated a request for proposals (RFP) for the selection of manufacturers and will incentivise them to offer efficient fans at costs comparable to standard fans under the Super-Efficient Equipment Programme (SEEP). In addition to fans, efforts are also being made to develop policy guidelines and infrastructure frameworks to expand SEEP to other appliances.

Space Cooling (Air Conditioners) - According to 'India Air Conditioners Market Forecast and Opportunities, 2020', the Indian air conditioner (AC) market is likely to grow at a Compound Annual Growth Rate (CAGR) of over 10% during 2015-20. The AC market is divided into two major segments: commercial ACs (Variable Refrigerant Flow (VRF), Chillers and Others) and Room ACs (Split and Window air conditioners), among which, residential AC segment witnessed a higher revenue share in 2014. This rise in ownership of residential ACs is mainly associated with rising incomes

[9]All numbers under 'Cooling (fans)' can be found here: file:///C:/Users/Vrinda/Downloads/ceiling_fans_the_overlooked_appliance_107A01%20(2).pdf

and urbanisation, falling technology costs and rising temperatures for most part of the year in almost all areas of the country.

Box 1: Super-Efficient Equipment Programme (SEEP)

SEEP has been designed by the Bureau of Energy Efficiency under the National Mission for Enhanced Energy Efficiency (NMEEE). It aims to bring accelerated market transformation for super-efficient (SE) appliances by providing financial stimulus in an innovative manner at critical points of intervention.

SEEP has been initiated to cover ceiling fans with the aim of leapfrogging them to an efficiency level that is around 50% more than the market average. The program will provide manufacturers financial incentives to enable them to produce SE ceiling fans and sell them at a discounted price. It focuses on introducing SE fans of 35W or less in the market as against the current average ceiling fan of 70W.

The selection of manufacturers is based on the reverse bidding mechanism. The BEE will provide an incentive to manufactures subject to a maximum of 500 per unit to produce and sell it at price equal to the price of conventional ceiling fans. More details about the program are expected to be available soon in the public domain.

A study by the Lawrence Berkeley National Laboratory (LBNL)[10] projects that the electricity demand from just room ACs is expected to increase from 8 BUs in 2010 to 239 BUs by 2030, which in turn translates to a peak demand contribution of 143 GW. It is expected that meeting such a demand will require significant amounts of new generating capacity. This will have a huge impact on the power sector and the emission inventory envisaged for India. While most of this AC stock is yet to be purchased, there is a potential for peak demand savings of 60 GW by 2030 if urgent and appropriate measures are taken to enhance efficiency of room ACs. Coordinated efforts must be made by taking care of both market push (standards) and market pull (awards, labels and incentives) options. Efforts such as DSM and DR programs targeting ACs, and improved building design are necessary to drive this change.

[10]https://ies.lbl.gov/sites/all/files/lbnl-6674e.pdf

Here too, Discoms can play a critical role, primarily for domestic ACs, and also for commercial ACs by enhancing awareness levels, and offering incentives for the adoption of efficient technologies.

Pumping - Pumping involves lifting or transferring water or other liquids in a variety of applications like agriculture (irrigation), municipalities (water supply and waste water), industry and domestic (houses, commercial buildings). According to the 'India Water Pumps Market Forecast and Opportunities, 2020', the water pump market is expected to grow at a CAGR of around 12% till 2020. Despite the availability of efficient pumps, the sector has remained inefficient in both agriculture and municipalities. The huge subsidy allocation to the agriculture sector aids farmers to install independent irrigation facilities, giving them no reason to opt for efficient pumps, thus leading to the depletion of groundwater as well as energy resources. Similarly, most municipal authorities being public have no incentives to be energy-efficient. Interventions by Discoms make perfect sense here, as both the agriculture and municipal sectors are subsidized and energy savings will help Discoms improve their financial condition.

For the agriculture sector, energy efficient electric pumps make an excellent business case for a third party like an Energy Services Companies (ESCo), provided clear policy and business models are made available by Discoms. There is also a need for government intervention for solar pumps due to their high cost. Realising this, the Union Budget of 2014-2015 has allocated 400 crores for the installation of 1 lakh solar agricultural pump sets. Further, various models are being adopted based on funding and subsidy structures and implementation institutions in Uttar Pradesh, Andhra Pradesh and Bihar[11] , amongst other states.

In the municipal pumping sector, most efficiency interventions have been largely implemented for large municipal corporations under ESCO based models. However, it was assessed that there is immense potential and economies of scale for the development of

[11]Please view this for more details: http://shaktifoundation.in/report/guideline-design-implementation-framework-solar-agriculture-pump-programme/

models around utility-DSM projects even in small and medium size municipalities. A study for a utility in Gujarat suggested a payback period of less than a year for the replacement of inefficient electric pumps with efficient ones. Further, a detailed energy audit of water pumps at Nagarpalikas revealed an average energy efficiency potential of 23%. Therefore, the need and rationale for the implementation of DSM projects by the utility in Nagarpalikas becomes important not only from the perspective of demand management but also as an opportunity to reduce its commercial losses.

In addition to applications cited above, there are other possible interventions like motors (industrial and small), demand response, demand shifting – all of which have the ability to offer significant savings to Discoms, if designed and implemented appropriately.

OPPORTUNITIES FOR ADVANCING UTILITY LED DSM IN INDIA

Despite significant developments in the sector, there is still widespread disagreement on whether DSM is a cost effective proposition. As a result, DSM implementation has been restricted to pilots for the most part. Discoms continue to rely on (involuntary) load shedding during supply constraint situations, which they often term as one of their traditional ways of 'load management'. The lack of adequate regulations on load shedding is also the biggest deterrent in establishing the need and urgency for DSM.

DSM programmes can be rapidly scaled up if there is an appropriate focus on relevant technical, financial and institutional factors. These are discussed in the following table.

Table 1: Upscaling DSM in India

Technical	Financial	Institutional and Operational	Legal and Policy
• Standard program models and commercial arrangements	• Improved financial health of the distribution companies	• Enhanced understanding and expertise regarding DSM amongst the Discom staff	• Specific provision related to Utility driven DSM program in either

• Proper frameworks for assessing the baseline leading to more cost effective DSM programs • Standard measurement and verification protocols • Sufficient market players – manufacturers, retailers, service providers.	• Adequate incentives and rebates for consumers • Lowering down the cost of the some of the prohibitively costly energy efficient appliances • Lowering down transaction costs incurred by the implementer during the disposal of old appliances	• Availability of sufficient and trained (on DSM) manpower in Discoms • Stability in the Discom leadership • Sorting out of legacy issues of the power sector.	the Energy Conservation Act, 2001 or the Electricity Act, 2003. • Effective enforcement of DSM regulations by State Electricity Regulators

To realize the opportunity in the DSM space, there is a need for the Central Government and State Governments to work in tandem with Discoms. The adoption of a national mandate on DSM can lay the foundation for the demand side of the power sector. This mandate must be complemented with a robust regulatory framework to help assess the benefits of DSM programs in a transparent manner. And then, regulations that require Discoms to improve reliability by avoiding load shedding must be strictly enforced.

Discoms will require support to bring the aforementioned goals to fruition. A few examples of such support could include technical assistance through professional training, consumer awareness and outreach, liaising with ESCOs and providing financial incentives through rebates, soft loans, etc. On the technical front, cost-effective implementation frameworks, stronger M&V protocols and increased third party auditing of DSM programs will further foster the Discom's interest and faith in the concept and benefits of virtual energy generation or energy savings.

It is important to highlight the recently enhanced government focus on DSM and energy efficiency with an active role envisaged for Discoms on this front. The BEE has initiated a DSM capacity

building program for Discoms in collaboration with EESL. Under the program, 30 Discoms are being provided with capacity building and technical support to conduct load research studies, design DSM program and develop DSM action plans. In addition, efforts like DELP and SEEP will be able to provide a level playing field for energy efficient appliances and expand the market opportunity for third party technology and service providers. Above all, continuous stakeholder consultations involving Discoms and regulatory leadership and their cooperation will enhance the implementation of such programs.

CONCLUSION

DSM programs have been successful in many countries and are gaining pace in India. While it is true that the Discoms have immediate priorities such as power procurement, tariff rationalisation and distribution operations, there is nothing that will keep Discoms and consumers from implementing DSM programs, once the value proposition of DSM is well understood. Demand side resources can be used in tandem with supply augmentation efforts to meet the make the power sector more reliable and environmentally sustainable.

For such interventions to be successful, it is important that the true costs of power are reflected across all consumer segments building the value for each unit of power generated. At the same time, Discoms must be mandated to serve load and enhance supply quality and standards so that the consumers do not resort to non-payment of their electricity bills or rely on polluting and costly alternatives like diesel generator sets. Policy makers and regulators must realise that providing subsidies to the agriculture sector or repeated restructuring of the tenuous financial position of Discoms may not be sustainable solutions.

In addition to DSM, other recent developments that will require a transformational shift in the way the power sector include:

- Deployment of new and disruptive technologies like variable renewable energy, small distributed generation and energy storage changing the technical aspects of power sector e.g.

wind and solar variability requires that they be integrated over large balancing areas.

- Transformation of consumers into 'prosumers' with individual homeowners and communities becoming legitimate electricity generators e.g. in case of solar rooftop systems.
- Changing market dynamics with the introduction of policy support mechanisms for clean energy, and increased competition.
- Introduction of information and communication technology in all electricity system processes.

These developments pose a new set of questions regarding the technical, institutional, and economic structures necessary for their integration in mainstream power sector planning and hence turn these seemingly system threats (to the Discoms, and in some cases to regulators) into opportunities.

It is high time to put necessary policies and institutional frameworks in place, and start implementing large scale programs around unconventional resources like DSM, Energy Efficiency and Renewable Energy. In line with the well-known proverb that "Energy Saved is Energy Generated", the potential of a demand side acting as a major resource will have to be realised, if not today, then later and at par with the incumbent power generators since it provides a way for optimizing infrastructure investments by assuring clean and efficient growth.

**The views in the article are individual views and do not necessarily reflect those of Shakti Sustainable Energy Foundation.*