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Empowering Retail Customers: Improve Efficiency, Lower Costs and Reduce Emissions

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Executive Summary

India has set very ambitious climate change goals. As a tool in combating greenhouse gas emissions, the country is aggressively adding renewable energy resources to its electric system resource mix to displace fossil fuel and meet future electric load growth. Much of this is being accomplished using competitive procurement processes, as well as using private capital for the massive investment needs. At the same time the country is also rapidly implementing wholesale competitive electric markets to improve the efficiency of the electric system.

Deploying Distributed Energy Resources (DER) in scale provides another key opportunity to improve electric system efficiency and combat emissions. DERs include elements such as energy efficiency, demand response, storage resources, distributed generation closer to load such as rooftop solar, and more. DERs empower customers to modify their electric usage in a way that would save them money, offer reliability products to electric system operators to increase reliability and efficiency of the system, and help reduce emissions. The promotion of DERs, however, requires affirmative action by utility regulators and policy makers. There is a real need to allow private sector participants to assist customers and bring private capital in implementing DERs. Applying advanced metering, while not mandatory, would also be very helpful to facilitate full utilization of DERs. Advanced metering and sophisticated tariffs would allow customers to react to granular wholesale granular price signals, help reduce distribution utility operating and capital costs, and improve efficiency and system reliability.

This first paper describes the benefits of deploying DER and advanced metering for customers and the electric system, discusses different business models that can be used, and recommends key actions regulators and policy makers must take.

Future papers will delve into more detail on the specific regulatory actions that would be required to:

- allow customers to participate in DER programs;
- motivate utilities to actively facilitate and promote DERs; and
- facilitate the entry of DER providers that would allow them to deploy their technical expertise and private capital in the space.

Introduction

In its 2024 Vision, the India's Ministry of Power (MoP) articulated several goals for a viable distribution business in the country.[1] They include:

- Improving the financial viability and sustainability of distribution companies (discoms)
- Reducing transmission and distribution losses to normative or better
- Introducing competition in the retail supply business
- Enhancing end-use efficiency and promote efficient consumption
- Empowering users through new, customer-centric technologies and applications
- Improving the reliability of the distribution network
- Inducting and scale renewable energy and demand-side management in the distribution system.

India's MoP issued a vision and road map for smart grid implementation in India in August 2013. The vision statement states: "Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality electricity for all with active participation of stakeholders." It also states: "Enable on-demand access and availability of affordable reliable quality power for all with optimal mix of conventional and renewable energy (RE) sources."[2] This is also in line with supporting India's climate goals of net-zero emissions by 2070, achieving non-fossil fuel energy capacity of 500 GW by 2030, achieving 50% of energy requirements from renewable sources, reducing total projected carbon emissions by 1 billion tonnes, and reducing the carbon intensity of the economy to less than 45%.

This brief articulates some approaches that could fulfill many of the elements in these visions. India has made tremendous progress in adding a significant number of renewable resources to its

[1] Chugh, G.& Singla, A. (2020). *The need for private sector participation in India's electricity distribution sector*. ICF. https://www.icf.com/insights/energy/private-sector-participation-india-electricity-distribution

[2] National Smart Grid Mission, Ministry of Power of India. (2018). *National Smart Grid Mission Implementation Framework*. https://www.nsgm.gov.in/sites/default/files/NSGM-Framework-Final.pdf

generation supply portfolio to meet climate goals. Notably, the country has utilized the private sector and competitive markets and solicitations to secure enormous private capital and expertise needed to add these resources quickly and at a large scale. India is also moving at a fast pace, implementing major changes to the electric wholesale markets. A similar approach is needed on the retail side of the business to empower the customer by using competitive markets to unleash private capital, ingenuity, business model innovation and expertise needed to help accomplish many of the goals laid out in the MoP's visions.

The time is now, as there have been significant drops in distributed energy resources (DER) costs and advanced metering, and there is increased customer acceptance. New Internet-enabled communication modes between customers and electric system operators are proliferating. Electric customers and the general public are more environmentally conscious and want to contribute to the climate change goals. Customers are demanding easy-to-use tools to modify their electric usage and help control their electric bills. Investors are ready to invest in this space, especially as they contribute to climate change goals.

We will discuss some enablers that would help tremendously with accomplishing these goals. While there are many enablers, we will limit the discussion here to the deployment of smart grid technologies. Within that, we will also discuss the initiatives associated with DER and advanced metering infrastructure (AMI). We will then talk about the benefits of each and some of the activities that need implementation, especially by utility economic regulators, to realize them. We will review business models that would help bring in the private capital and expertise to the table. We also address the key concerns that are generally raised in realizing these measures.

Deployment of Smart Grid Technologies

The traditional utility infrastructure is built to move power from generation to load via transmission and distribution networks, a one-way power flow. A smart grid is based on digital technology that also allows for two-way power flows where consumers can inject power into the system from their DERs, which allows for data transfers among various market players. The smart grid is an overarching concept that encompasses several functionalities, including:

1. DERs
2. advanced metering infrastructure
3. electric vehicles
4. wide-area situational awareness
5. demand response
6. distribution grid management.[3]

[3] Department of Energy, Office of the Special Counsel. (2010). *Communications Requirements of Smart Grid Technologies*. https://www.energy.gov/gc/downloads/communications-requirements-smart-grid-technologies

The smart grid system is expected to improve the efficiency of the electric system, reduce costs and improve reliability.

Of the many elements that constitute the smart grid, we will limit our discussion here to the promotion of DERs and advanced metering infrastructure as these areas offer significant opportunities for private capital deployment and innovation from entrepreneurs and customer empowerment for managing electric bills. Further, DERs contribute to improving system reliability by providing various reliability products that system operators need in a competitive and transparent manner.

Promotion of Distributed Energy Resources

DER is an umbrella term to include all the resources behind the meter that are closer to the load, including energy efficiency; demand response; local generation, such as roof-top solar or other distributed generation; thermal or battery or other storage systems, and more. Collectively these DER resources can be counted on to provide energy, capacity and ancillary services needs of the individual customer or the local distribution utility, or even the wholesale electric system operator in an aggregated mode.

Energy Efficiency

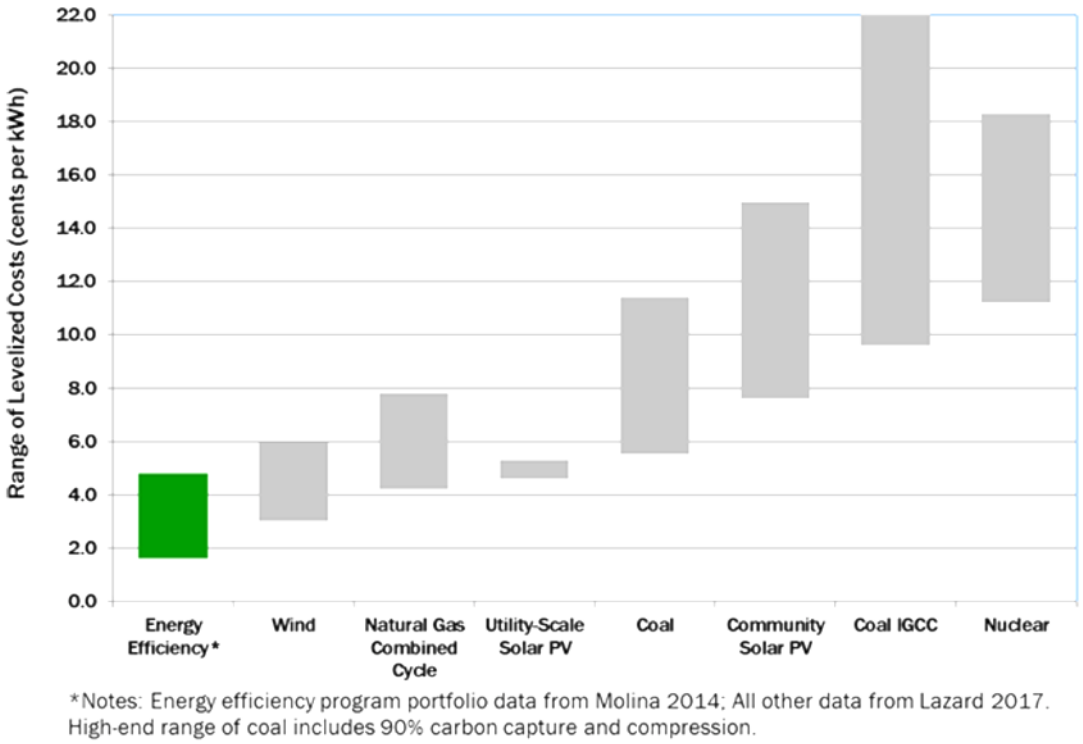
At the recent COP 26 climate summit, India announced that it will achieve net-zero emissions by 2070. Among the commitments made, two of them have a major energy efficiency component, namely, that the country will reduce its carbon intensity to 45% and will reduce 1 billion tons of carbon emissions from the total projected emissions by 2030.[4]

Energy efficiency is considered as one of the cheapest resources available. It would help reduce the overall energy use of an energy efficient customer and also help decrease the overall system load. For example, ACEEE's analysis of the levelized cost of energy (LCOE) shows that energy efficiency is the cheapest cost resource (as seen in Figure 1).[5]

[4] Padmanaban, P. (2022) *Reimaging Energy Efficiency: Case for Institutional Repositioning*. [LinkedIn post.] https://www.linkedin.com/pulse/reimaging-energy-efficiency-case-institutional-padu-s-padmanaban/

[5] Gilleo, A. (2017). *New data, same results – Saving energy is still cheaper than making energy*. ACEEE. https://www.aceee.org/blog/2017/12/new-data-same-results-saving-energy

Figure 1. Levelized Cost of Energy of Various Technologies



Source: Gilleo, A. (2017). *New data, same results – Saving energy is still cheaper than making energy*. ACEEE. Used with permission.

As customer load is reduced, avoided generation is even higher due to the eschewal of technical line losses, which is an additional benefit of energy efficiency. Further, as the country moves to decarbonize not only its power sector but the whole economy, including transportation, an increased level of renewable resources would be needed. Cost-effective energy efficiency would eliminate or reduce the need for some of the expensive renewable energy resources.

Finally, energy efficiency creates jobs and employs a significant number of workers in the economy. In the U.S., nearly 2.4 million were employed in 2019 in energy efficiency-related industries.[6]

[6] NASEO & EFI. (2021). *2020 U.S. Energy & Employment Report*. Table 40 on Page 127. https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5ee78423c6fcc20e01b83896/1592230956175/USEER+2020+0615.pdf

Demand Response

Demand-side solutions are typically considered to be the more cost-effective solutions for providing flexibility in the grid. Demand response can be used to clip system peak loads or fill valleys and overall help modify the system load shape. It's increasingly being used to assist system operators to curtail load during times of system stress.

SIDEBAR

Bureau of Energy Efficiency

The Bureau of Energy Efficiency (BEE) was set up by the Government of India in 2002 to assist in developing policies and strategies with a focus on self-regulation and market principles, and a primary objective of reducing India's economic energy intensity. BEE has been instrumental in driving energy efficiency for commercial and residential buildings through codes, certifications and technologies. BEE also supports demand side management (DSM) programs for agricultural, municipal, small and medium enterprises, and discoms. Between 2014 and 2018, efficiency gains were mostly in the industrial sector, but the focus on efficiency in buildings and transport has been on the rise since then. With India's residential electricity supply expected to at least double by 2030, energy efficiency will play a key role in strengthening India's electric system and in achieving India's climate goals.

Additionally, modifying the load shape using demand response can help improve system efficiency by increasing the utilization of existing infrastructure and reducing the need for new electric infrastructure, thus lowering system costs. One metric for utilization of assets is the load factor that measures the system-average peak load to peak load. The higher the system load factor, the higher the utilization of assets that leads to lower per-unit fixed costs, all else equal. For example, the All-India Annual Electric Load Factor (AELF) was 84% in 2015-2016, 86% in 2017-2018 and 80% in 2019-2020. It is expected to be 79.18% in 2021-2022 as per the 19th Electric Power Survey (EPS) survey report by CEA.[7]

One tool to improve the system load factor is through demand response utilization, including storage. It can help increase a discom's financial viability by improving utilization of existing assets and reducing costs. Further, discoms can strategically use demand response to meet peak system demand needs during times of system stress and minimize load curtailment. As Distribution System Operator (DSO) formation is contemplated, it should be noted that demand response would provide a foundational tool to assist DSOs in managing the utility system.

Demand response is also being increasingly used as a flexible resource and providing market based ancillary services to meet wholesale system needs with increased penetration of renewable intermittent resources.

[7] Posoco. (2021). *Seasonal Analysis of Load factor: Indian power system perspective*. Second edition. https://posoco.in/wp-content/uploads/2021/07/All-India-and-regionwise.pdf

Further, implementation of demand response allows customer participation in the wholesale market and thus improving the market's competitiveness and efficiency. Generally, a system is planned as if the demand side is inelastic and is a price taker, and provides selling generators more opportunity to exercise market power. Demand response participation in the wholesale market can reduce the market power potential of sellers. Finally, demand response can help individual customers manage electric bills better.

Strategic use of demand response helps cut back on using fossil fuel power plants and reduces global (carbon) and local emissions (SOx, NOx etc.), thus contributing to achieving climate goals and improving local health conditions.

We do note that the National Conservation Act (2003), Electricity Act (2003), National Electricity Policy (2005), National Tariff Policy (2006), National Mission on Enhanced Energy Efficiency (2010) and the Forum of Regulators Model DSM Regulations (2010) support and promote load management and energy efficiency. The State Electricity Regulatory Commissions (SERCs) of some states — including Punjab, Delhi, Haryana, Uttar Pradesh, Maharashtra, Goa, Karnataka, Tamil Nadu and Telangana — have issued DSM regulations based on the Forum of Regulator's (FOR) Model DSM regulations. The regulations have supported the scaling up of DSM through institutional support, technological models and implementation efforts. Utilities in India are engaged in pilot programs in major cities to demonstrate the applications and benefits of DSM solutions, such as automated demand response, battery energy storage and behavioral energy efficiency in Delhi, appliance exchange and thermal energy storage in Mumbai, and domestic lighting replacement in Bangalore. However, demand response programs on the consumer side in India are at a nascent stage in India.

Advanced Metering Infrastructure

Advanced metering infrastructure is an umbrella term to denote how various advanced metering technologies can be deployed to provide additional functionalities to customers and utilities.

More sophisticated metering technologies, such as smart metering, allow for passing more granular wholesale market price signals to customers to facilitate active DER participation. Modern communication devices allow household and business customers to remotely control their load or allow the host utility to remotely control their electric load. As discussed before, for customers to participate and benefit from the DER programs and provide services to the discom or wholesale system operator, they need to be able to receive wholesale price signals. The level of tariff sophistication varies from simple time-of-use pricing programs to hourly pricing programs and more. The resulting increased DER participation leads to the benefits discussed in the previous section.

Smart metering technologies also allow for more efficient operations in the distribution sector that would help reduce utility operational costs including reduction in meter reading and operations and field services and reduce capital costs including avoiding transmission and distribution capital investments. They can also facilitate DER activities that would help avoid generation capital investments.

Smart metering would also improve reliability of the system by reducing the duration of interruptions as the utility will have increased outage notification accuracy.

Additionally, there will be environmental benefits in terms of declining carbon and local pollutant emissions. Energy usage reduction and especially peak usage load reduction would lead to lower use of power plants that have higher emissions.[8]

SIDEBAR

Smart Meter National Programme

The Smart Meter National Programme (SMNP) by Energy Efficiency Services Limited (EESL) focuses on replacing 25 crore conventional meters with smart meters in India. These smart meters will be connected with an Internet-based monitoring system that helps in reducing commercial losses of utilities and enhancing revenues. The program is currently being implemented in Andhra Pradesh, Uttar Pradesh, Haryana, Bihar, Delhi, Rajasthan and Telangana.

Implementation

Implementing DERs or advanced metering infrastructure does not happen without active policy intervention by regulators. As the DERs for the most part require customer acceptance and participation, they require buy-in from customers. Utilities on the other hand need to be assured they would be no worse off by implementing the programs, especially when the programs reduce sales. Additionally, the DER construct creates a new market player in the industry who is a provider of DER aggregation. DER aggregators provide technical assistance to customers participating in the DER programs and aggregate several customer loads to help them participate in utility or wholesale market DER programs. Each of these segments requires different regulatory strategies to motivate them.

Customers need to be convinced that the benefits of participating in DER programs exceed any costs they may incur. For example, for customers to see the benefits of participating in the DER programs, tariffs need to be unbundled, so customers are exposed to unbundled prices associated with supply (generation), transmission and distribution. To the extent that customers use less power at different hours in a day or export power to the system at certain times, there need to be DER tariffs that price the transactions granularly. Customers also need to be educated on DER opportunities and the benefits and costs associated with them.

On the other hand, utilities may not be warm to the idea of implementing DER programs. They often reduce sales of the utilities and thus decrease the potential contribution to utility fixed costs and profits. Utilities need to be assured that they will be no worse off if customers implement DERs.

[8] For a complete listing of the quantitative and qualitative benefits, see: NEEP. (2017). *Advanced Metering Infrastructure: Utility Trends and Cost-Benefit Analyses in the NEEP Region.* https://neep.org/sites/default/files/resources/AMI%20FINAL%20DRAFT%20report%20-%20CT%20format.pdf

Rate making mechanisms, such as revenue decoupling, make the utilities whole for lost revenues associated with loss of sales. Further incentives through performance-based regulatory ratemaking mechanisms may also be needed to motivate utilities to promote DERs that benefit the system and all customers.

Third party DER providers and aggregators are private entities who bring private capital to the industry; they bring new business models and new technologies to the customers to enable them to participate in DER programs. These market players require market rules for how they should interact with customers, utilities and system operators. They require regulatory clarity in how they can operate and regulatory stability so they can invest for the long term.

Implementation of advanced metering requires careful analysis and planning. Smart metering is being implemented worldwide in phases by customer class. For example, in the U.S., advance meters implemented grew from about 13 million (about 9% penetration rate of all meters) in 2009 to about 95 million (about 60% penetration) in 2019.[9] In India, as of 2020, about 4.2 million smart meters, or under 2%, have been installed.[10] Smart metering may not be cost effective for all customers in all areas. Cost benefit analyses will help utilities and regulators decide where smart metering makes the most sense.

Advanced metering implementation also would have to be combined with tariff unbundling, adoption of more sophisticated tariffs, and customer education as discussed earlier. The same concerns mentioned for utilities and customers need to be addressed.

Business Models to Help Implement the Enablers

To implement the activities discussed earlier, clearly the utility regulators need to take policy steps to initiate the markets, rules and regulations to facilitate DERs and advanced metering. There needs to be an examination of the business models that can best accommodate and promote the changes required. While status-quo is one idea, other approaches where the reliance is placed on private entities should be seriously considered.

Utilities, for the most part, are public sector undertakings with little profit motivation. Many of them have tariffs that are plain vanilla and simply pass-through average aggregate bundled prices. This is not a critique per se, but an acknowledgment of the legacy arrangements. Most are not equipped to develop multiple tariffs to meet the needs of various customer segments, as well as their niche needs that allow passing through granular wholesale market prices. Further, utility activities are limited to those in front of a customer meter but not behind it. They do not necessarily understand how various customers use energy or what steps the customers must take to optimize their energy use, and how they can take advantage of DER programs. Additionally, utilities are not into taking investment risks in devices or tools behind customer meters to help them participate in

[9] Federal Energy Regulatory Commission. (2021). 2021 *Assessment of Demand Response and Advanced Metering*. https://www.ferc.gov/media/2021-assessment-demand-response-and-advanced-metering

[10] See status updates at the Indian Government Smart Grid: National Smart Grid Mission, Ministry of Power, Government of India. (n.d.). *Smart Metering Status* [website]. https://www.nsgm.gov.in/en/sm-stats-all

DER programs, or provide them value-added services.

On the other hand, most of these functions can be opened to participation by private entities. There are numerous entrepreneurs and private capital ready to invest in activities that enable customers to participate in DER programs and provide them value-added services. Investing in activities that also help climate change goals is attracting even more private players and capital.

Regulators need to define the rules for the participation of private players and how they interact with customers and utilities. The interaction between customers and private DER providers can be lightly regulated for consumer protection. Utilities and DER provider interactions can be tariff based, with tariffs approved by the regulator. Regulators need to implement policies that motivate utilities to cooperate and promote DER programs.

Smart metering requires significant investments in the metering and data collection and sharing among various market players. This area can also be opened to private players on a shared savings-based approach. Private players can invest, own and operate smart metering system and keep some of the resulting benefits that are more than the costs. Rules defining the shared savings approach and other rules, such as how to deal with privacy, need to be developed. Regulatory transparency and stability are needed to provide confidence to investors.

Conclusion

India has made significant commitments towards carbon reduction goals. The country is procuring ambitious quantities of renewable energy resources to meet the goals, with private capital investments in these resources. India is also making progress in establishing wholesale power markets to drive efficiency and reduce costs, as well as progressing with developing technology-based solutions for support. Discussion on creating new DSOs is already underway. There is more opportunity for the country to make great strides in the retail area to empower retail customers.

DERs are proven technologies that contribute to resource and reliability needs, , improving efficiency, and helping reduce emissions in the system. More importantly, DERs provide added value to customers. Similarly, advanced metering initiatives are also improving system efficiency, and are becoming essential to facilitate promotion of DERs. There are private entrepreneurs and private capital waiting to enter the market and fulfill the government vision. Regulators and policy makers need to open these markets through their policy making to allow the new players to enter the market and add value to retail customers and the system. Increasing consumer awareness of DER solutions and approaches is key to enhancing customer acceptance levels. Finally, the legitimate concerns of utilities resulting from the deployment of DERs should be addressed. Future papers will discuss in more detail each of these three areas.

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