Smart grid enabled DSM solutions

Utility CEO Forum on Demand Side Management

Eleventh meeting

Discussion Paper

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Table of Contents

Abstract

This paper is the eleventh in the series of background papers developed for the participants of the Utility CEO Forum on demand side management (DSM).

Smart grid is the next generation electricity grid – a solution to India's ageing and unreliable electricity infrastructure that can effectively balance power system capacity enhancements with DSM and distributed energy systems to create a more efficient, reliable, economical, environment friendly and sustainable grid. Intelligently planned smart grid systems that integrate DSM and energy efficiency as central goals will have tremendous potential to save energy, manage peak demand, optimize costs, and reap benefits for consumers, DISCOMs and society as whole.

This paper aims to discuss both established and emerging smart grid technologies, what systems they constitute, their key DSM functionalities and applications. The paper elaborates on the current status of development and implementation of these technologies, relevant policy framework and challenges for large scale roll out. The paper also highlights important synergies of smart grid deployment with other national policies and programs in order to highlight how they can help each other in achieving the common goal of smart and sustainable development. The paper concludes with concrete recommendations for the governments, utilities and regulatory authorities to emphasize their role in advancing smart grid technologies that can boost the DSM potential in the country.

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1. Introduction to DSM applications of smart grid technologies

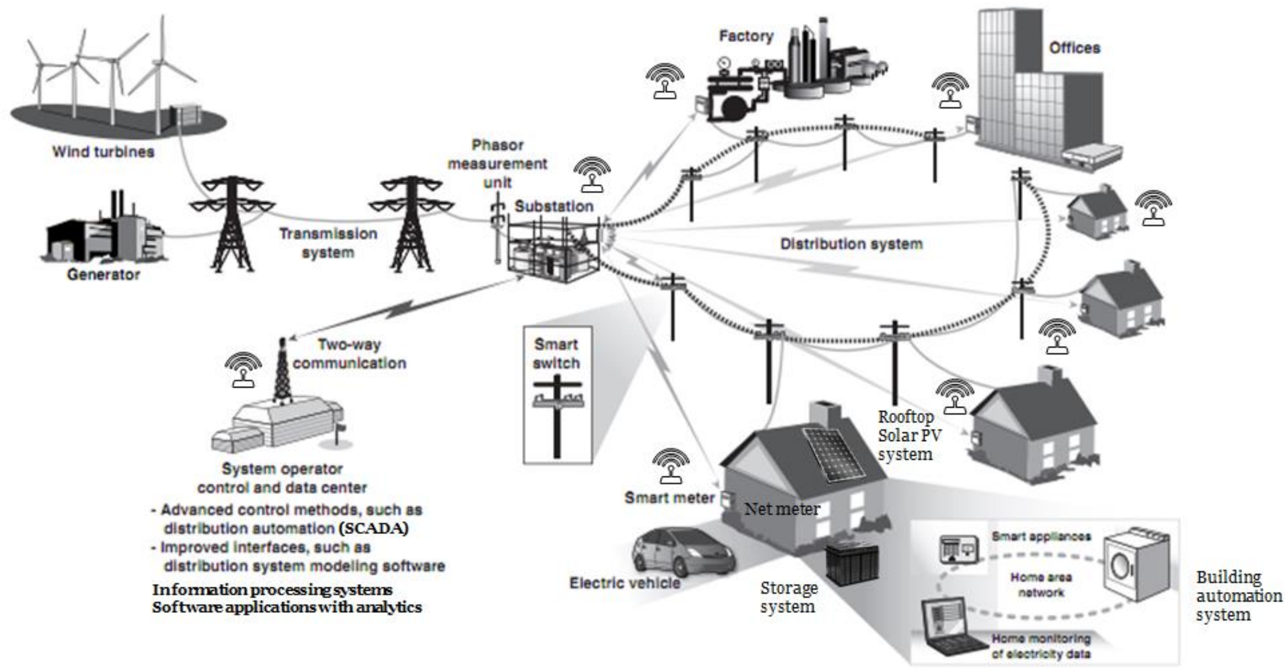
Smart grid is an intelligent electrical grid that uses information and communication technologies (ICTs) to gather, monitor and act on real time (interval) information about power system characteristics (viz. generation, end use / load, price/tariff, performance of power system components etc) in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production, transmission, distribution and end use consumption of electricity.

Smart Grid Characteristics

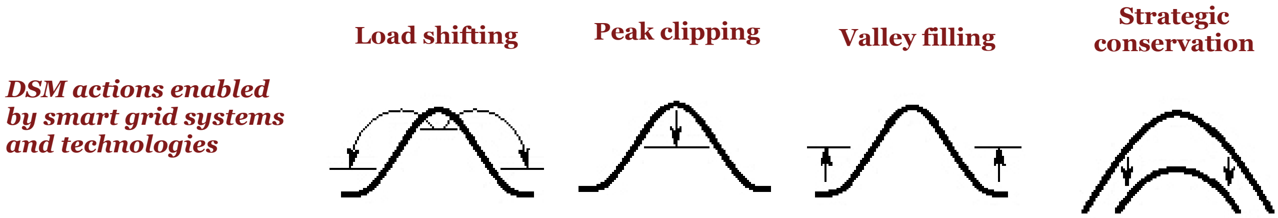
- Enabling active and informed participation by consumers (enhanced customer engagement)
- Providing quality (interruption free and reliable) power for the digital economy
- Accommodating all generation and storage options
- Enabling new products, services, and markets
- Optimizing assets and operating efficiently
- Anticipate and respond to power system disturbances (Self-Healing)
- Operate resiliently against physical and cyber attack

Source: US DOE

Schematic of Smart Grid Infrastructure



Data provided by smart grid systems enable consumers to make informed decisions about how much, when and at what cost they use energy at various end use applications. This means the consumers gain enhanced information over end use energy in order to respond to price signals or other Utility incentives thereby increasing the overall capacity for DSM. Worldwide experience of adopting smart grid systems and technologies has shown that they enable increased demand response[1], energy efficiency, integration of distributed variable renewable energy resources and electric vehicle recharging services, while reducing peak demand and stabilizing the electricity system.



The smart grid systems and technologies that enable DSM can be grouped into three broad categories.

Advanced Metering Infrastructure (AMI) is the principal smart grid system that constitutes smart meters, communication systems, computer based hardware (data storage centers / servers) and software applications to gather and act on real time information about end use energy in order to improve efficiency and economics of end use electricity consumption. Peak load management is the principal function of AMI among several other functionalities. AMI enables demand response by offering a variety of time based tariffs (e.g. time of day – TOD tariff, peak time rebate), demand bidding and direct load control programs[2] during periods of peak demand in exchange for financial incentives and lower electric bills. Smart meters expand the range of time-based rate programs that can be offered to consumers along with robust communication of real time energy usage and pricing information that can make it easier for consumers to change their energy use behavior and reduce peak period consumption. AMI can help electric utilities and governments defer construction of new power system capacity (generation, transmission and distribution systems), specifically those reserved for use during peak times.

Customer side systems[3] such as smart appliances, in-home displays / energy dashboards and building automation are emerging smart grid technologies that enable enhanced (remote) control over the operations of home electrical appliances in order to shift / reduce energy usage in manner that promote efficiency and economics. These systems completely integrated with AMI further enhance the capacity of consumers and utilities to fully capture the potential of DSM.

Distributed renewable energy generation and storage integration systems such as net meters, grid tied / hybrid inverters, and smart charging systems are evolving smart grid technologies that enable seamless grid integration of energy storage devices, solar photovoltaic rooftop systems, electric vehicles and other distributed generation systems to take full advantage of their DSM potential.

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[1] Changes in electricity usage by end-use customers from their normal consumption patterns in response to time-based rates or other forms of financial incentives offered by electric Utilities. Methods of engaging customers in demand response efforts include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real time pricing, and critical peak rebates.

[2] More advanced demand response effort that enable utilities to cycle air conditioners, water heaters and other critical loads on and off during periods of peak demand in exchange for a financial incentive and lower electric bills.

[3] It is important to note that there are several other customer side systems such as energy storage devices, solar photovoltaic rooftop systems, electric vehicles, energy efficient appliances (e.g. LED, BEE 5 star rated products, solar water heaters) and other distributed generation systems that can contribute to DSM and be perceived as smart grid systems and technologies, whose definition ultimately depends on the collective vision and goals of governments, utilities and consumers. This background paper does not discuss these smart grid technologies but instead aims to discuss the technologies that enable their seamless grid integration, which is crucial to realize DSM benefits of such technologies.

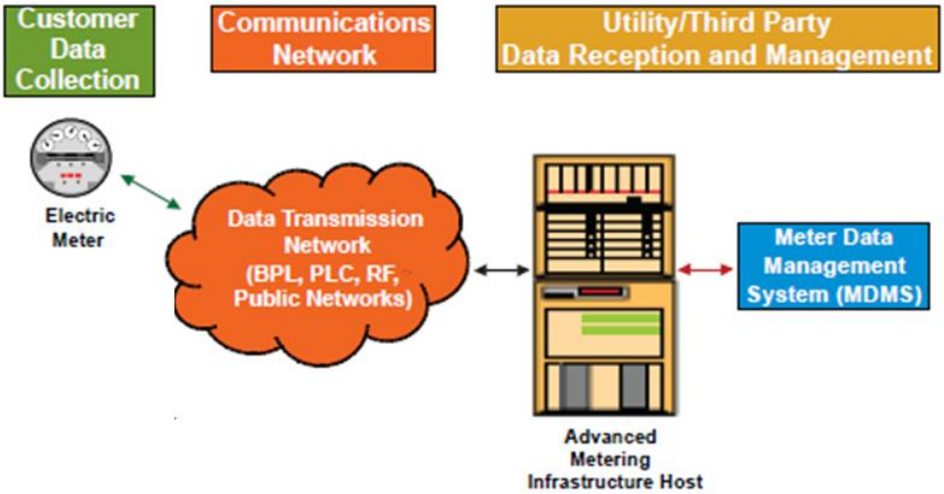
Smart grid systems and technologies	*DSM Applications*		
	Demand response *(time based tariffs, direct load control, demand bidding etc)*	***Energy efficiency*** *(remote control of home appliances, LED lamps with motion sensors, inverter technology products etc)*	***Distributed generation and storage*** (energy storage devices, solar photovoltaic rooftop systems, electric vehicles)
Advanced Metering Infrastructure (AMI) • Smart meters • Communications technology and infrastructure • Meter data acquisition and management systems (Data centers / servers / storage facilities, software applications / analytics)	✓	✓	✓
Customer side systems • Smart appliances • In house displays / energy dashboards • Building automation	✓	✓	
Integration of distributed renewable energy generation and storage systems • Net meters • Grid tied and hybrid (dual function) inverters			✓

2. AMI and its DSM applications in India

AMI is comprised of state of the art electronic/digital hardware and software, which combines interval data measurement with continuously available remote communications. These systems enable measurement of real time (in fixed intervals) information and two way communication of such information between consumers and electric Utilities. AMI typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and electric utility, data reception and management systems that make the useful information available to these parties.

The following figure shows the above building blocks of AMI.

The customer is equipped with smart meters that is capable of time-based interval data measurement of electrical energy parameters. These meters also have the ability to transmit the collected data through communication networks. The meter data is received by the AMI host (data acquisition system) and further sent to the Meter Data Management System (MDMS) that manages data storage and analysis to provide the information in useful form to the utility. AMI enables two-way communications, so communication from the utility to the meter could also take place.



2.1. AMI functionalities and standards for India

The central electricity authority (CEA) has recently (June 2016) specified the functional requirements of AMI in India along with detailed technical specifications for single and three phase whole current smart meters. As per these requirements, the AMI system should comprise of the following core components and shall support the following minimum functionalities:

Core components of AMI	Minimum functionalities of AMI
• Smart Meters • Communication infrastructure • Head End System (HES) • Meter Data Management System (MDMS) • Web application to view updated real time data • Mobile application to enable customer participation	• Remote meter data reading at configurable intervals (push/pull) • ***Time of day (TOD)/TOU metering*** • Pre-paid functionality • ***Net Meter Billing*** • Alarm/Event detection, notification and reporting • Remote load limiter and connection/ disconnection at defined/on demand conditions • Integration with other existing systems like IVRS, billing & collection software, GIS mapping, consumer indexing, new connection & disconnections, analytics software, outage management system etc. • Security features to prevent unauthorized access to the AMI

The TOD / TOU metering and net metering functionalities of AMI will play crucial role in scaling up demand response application and distributed generation systems respectively that are important and largely untapped DSM markets in the country.

The AMI functional requirements specify that the communication infrastructure should either be based on RF mesh network / PLC or cellular network or a combination of these. The communication network shall provide reliable medium for two-way communication between smart meters & HES. RF based network should use license free frequency band available in India. The communication network elements may be DCU (Data Concentrator Unit) based or router based. These elements form the gateway for communication of data between the Smart Meters and the HES. They receive information from the Smart Meter on a scheduled / need basis and store the data, which can be accessed by HES for onward transfer to MDMS. The main objective of HES is to acquire meter data automatically avoiding any human intervention and monitor parameters acquired from meters.

The MDMS shall act as a central data repository that supports storage, archiving, retrieval & analysis of meter data along with validation & verification algorithms. MDMS shall have capability to import raw or validated data in defined formats and export the processed and validated data to various other systems sources and services in the agreed format. It shall provide validated data for upstream systems such as billing, customer care, analytics, reporting, load analysis, load forecasting, PLM (peak load management) and OMS (outage management system) etc. One of the key functionalities of the MDMS is that it should allow configuring multiple TOU/TOD options (e.g. the number and duration of TOU rate periods) by customer type, tariffs and day type (weekend, weekdays, and holidays) and by season. The MDMS should also support the processing of interval data into billing determinants to include total consumption, consumption in different time blocks for TOU billing, maximum demand (in kW and kVA), On-Peak Demand among others. In addition to this, the MDMS shall support Demand Control/Demand Response solution. The solution shall support the following analysis:

- Totaling the actual consumption during the DR event.
- Totaling the actual consumption of different groups that participated in the DR event.
- Comparing the actual to baseline consumption for the groups in above.
- The MDM shall support the tracking, monitoring and managing of Smart Meter and events, and monitors customer response to facilitate payment of customer incentives.

Apart from DSM related functions, the other important functionalities supported by MDMS are as follows.

- Asset management (consumer information, status of meters and communication equipment, damage reports)
- Meter Data Validation, Estimation, and Editing
- Configuration of Billing Determinants Calculations
- Customer Service Support (SMS/email notifications, mobile application support)
- Meter data analytics (peak & off-peak load patterns by aggregating all loads of DT/Feeder/consumer group, DT/feeder wise energy audit, load analysis for different groups and categories of consumers, etc.)

It goes without saying that the AMI functional requirements stipulated by CEA supports energy accounting, auditing, theft detection, outage detection, prepayment and several other important functions that will help address commercial losses, revenue assurance, reliability of supply all of which are indispensable problem for Indian electric utilities in the foreseeable future. More importantly, AMI provides the platform for enhanced consumer engagement wherein the customers can take a more proactive role in managing their energy use and communicate their feedback to utility services. This will pave the way for enhanced DSM and also transform the dynamics of power supply industry as whole.

2.2. Policy framework for AMI roll out in India

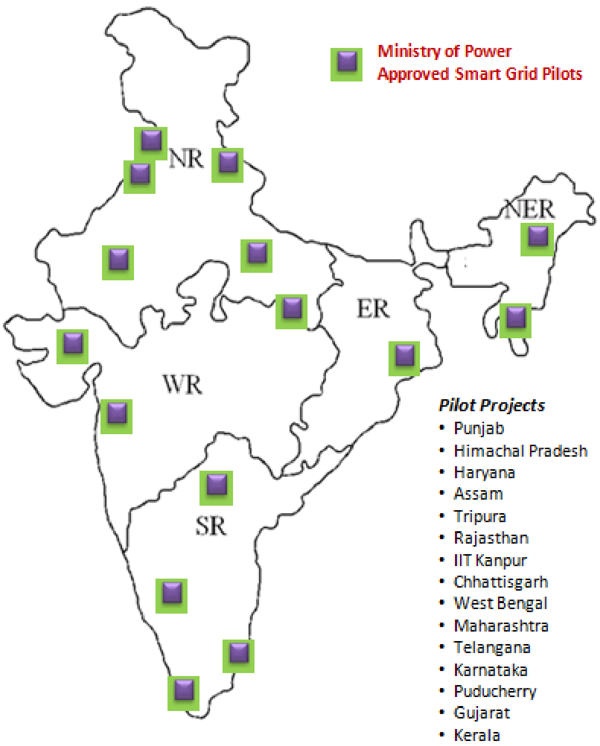
Smart meters are the heart of AMI and any other smart grid systems that enable DSM applications. In August 2015, the Bureau of Indian Standards (BIS) at the direction of the Ministry of Power (MoP), Government of India, published the new Smart Meter Standard, IS 16444: AC Static Direct Connected Watthour Smart Meter – Class 1 and 2 Specification covering single phase energy meters; three phase energy meters; single phase energy meters with Net Metering facility and; three phase energy meters with Net Metering facility. Another standard IS 15959: Data Exchange for Electricity Meter Reading, Tariff and Load Control — Companion Specification has been revised and published as IS 15959: Part 2-Smart Meter in March 2016. Also, as discussed in the earlier section, the CEA has recently (June 2016) specified the functional requirements of AMI in India along with detailed technical specifications for single and three phase whole current smart meters. As per these specifications, the Smart Meter should have the following minimum basic features:

- Measurement of electrical energy parameters
- Bidirectional Communication
- Integrated Load limiting switch
- Tamper event detection, recording and reporting
- Power event alarms such as loss of supply, low/ high voltage
- Remote firmware upgrade
- Net metering features
- On demand reading

MoP has recently announced the Government's vision to rollout smart meters on fast track for customers with a monthly consumption of 500kWh and above in Phase-1 by December 2017 and for customers with monthly consumption of 200kWh and above in Phase-2 by December 2019. This is one of the salient goals envisaged for operational efficiency improvement of DISCOMs under the UDAY scheme, which is the largest ongoing power sector reforms in the country. This goal is also reiterated in the recent National Tariff Policy Amendments announced by MoP.

In addition to this, the Government of India has established the National Smart Grid Mission (NSGM), under the administrative control of MoP, to achieve the smart grid developmental goals by adopting a coordinated and collaborative approach. NSGM has its own resources, authority, functional & financial autonomy to plan and monitor implementation of policies and programs related to Smart Grid activities in India.

Currently, there are about 15 pilots initiated across the country, all of which aim to implement AMI with different functionalities as per the needs and priorities the state. Also, the Forum of Regulators (FoR) published the 'Model Smart Grid Regulations' in 2015 to initiate and regulate smart grid investments by India's electric utilities.



Source: NSGM

2.3. Challenges for AMI roll out in India

In the present scenario, the following are the challenges for AMI rollout in India.

Functionalities and Standards

- What functionalities and design should be adopted?
- Are the current standards comprehensive and relevant to Indian context?

Economics

- Who will pay for the smart meter and rest of AMI? Utilities or third party?
- Poor financial health of DISCOMs
- Justification of business case? Quantification of benefits?
- Perceived impact on consumer bills

Regulations

- Lack of Smart Grid Regulations – targets for AMI roll out (despite the existence of model smart grid regulations, the state electricity regulatory commissions are yet to adopt this and notify comprehensive smart grid regulations)
- Data privacy - who all will have access to the meter data? What are norms for access?
- What are the cost recovery options? Should the DISCOM treat AMI traditionally as CAPEX (capital expenditure) or recover through On-bill charges from the beneficiaries only?
- Are there any options for "opt-out"? Will it be mandatory for consumers?

Capacity and resources

- Manpower limitations for deployment, usage, and management in the DISCOMs
- DISCOMs averse to complete outsourcing of AMI solutions

Communications

- Limitations in last mile connectivity (smart meter to DCU/HES)
- Is the license free RF spectrum adequate considering massive roll out targets?
- Selection of last mile communication technology?
- Interoperability standards to integrate AMI systems

Communications is the Achilles Heel for successful utility scale roll out of AMI in India.

2.4. The AMI roll out strategy and economics for India

The DISCOMs across the country are expected to roll out 35 million smart meters as a result of the government's vision under the existing policy framework. The investment required to achieve this vision is a whopping INR 11,280 crores.

Investment potential for national smart meter roll out

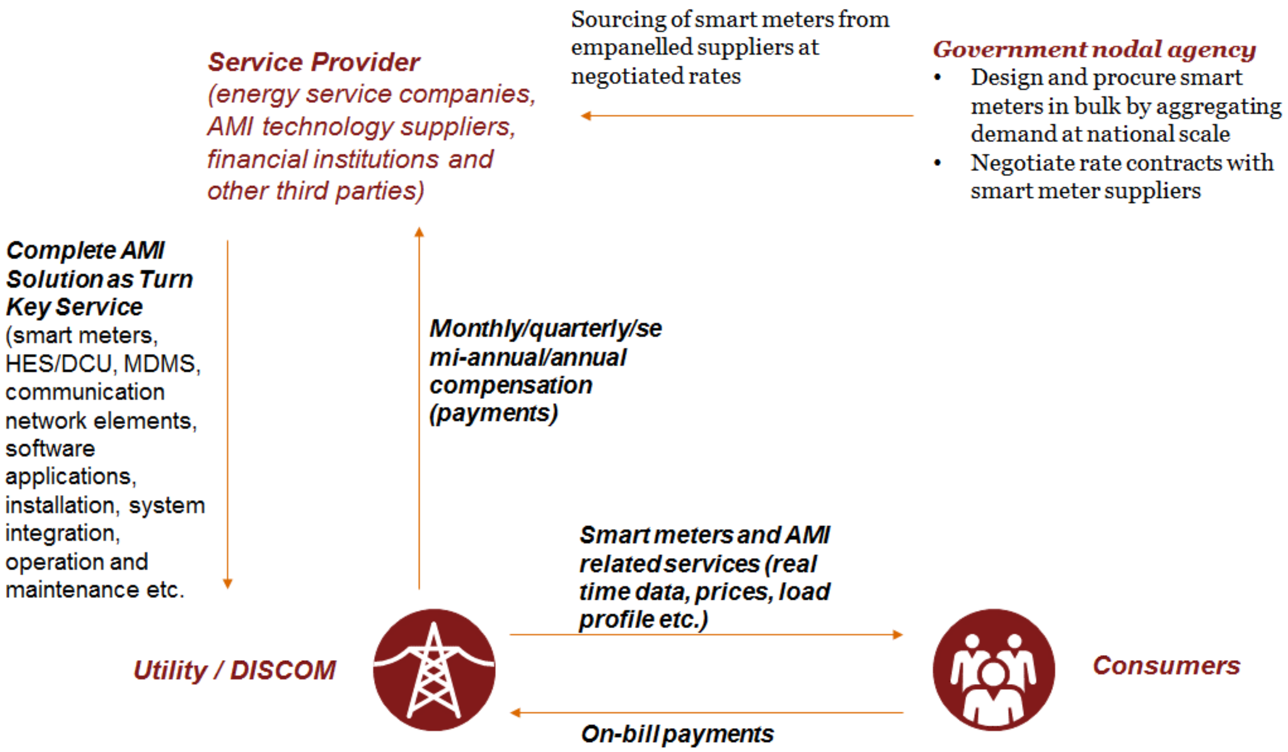
Total no. of electricity connections in India (approx.)	***250 million***
No. of establishments expected to be covered under UDAY (200 – 500 kWh and > 500 kWh monthly consumption) by 2019	*35 million*
Total investment potential for 35 million smart meter roll out under UDAY (@ INR 3223 per smart meter)	*INR 11,280 crores*
Total investment potential for all 250 million connections (@ INR 1500 per smart meter)	*INR 37500 crores*

Source: PwC analysis based on GOI announcements

DISCOMs are perceived as the weakest link in the electricity value chain as they have accumulated losses of approximately INR 3.8 lakh crore and outstanding debt of approximately INR 4.3 lakh crore (as on March, 2015)[4]. Considering the huge capital investment required for the rollout of millions of smart meters, the present financial condition of the majority of DISCOMs can be perceived as the principal barrier in achieving the government's vision.

In this scenario, the 'AMI as a Service' concept can be very effective in overcoming the financing barriers for expanding the AMI footprint in the country. The concept allows utilities to engage energy service companies, AMI technology suppliers, financial institutions and other third party service providers to outsource (lease) the entire AMI solution (viz. smart meters, HES/DCU, MDMS, communication network elements, software applications, installation, system integration, operation and maintenance etc.) as a turn-key service for monthly/quarterly/semi-annual/annual compensation. Innovative business models driven by leasing and other variants of services can be adopted to establish a self-sustaining AMI market in the country. While the Indian utilities have historically shied away from outsourcing operations, such attitudes can be on the verge of shifting. The complexity of smart grid deployments and systems integration and a shortage of qualified internal human resources within the utilities are just a few of the drivers behind this concept.

[4] http://pib.nic.in/newsite/PrintRelease.aspx?relid=130261



The governments and utilities must leverage the economies of scale in rolling out smart meters. They should be able aggregate at a national scale through a designated agency, undertake bulk procurement of smart meters and then lease them out for DISCOMs for installation.

The DISCOMs can recover the smart meter costs through on-bill charges levied on the beneficiary consumers and compensate the service providers for their upfront investment. The DISCOMs can engage different service providers for smart meters and the rest of AMI.

The MoP has recently announced that the cost of smart meters has been reduced to INR 3223 through demand aggregation and bulk procurement at the national level. At this cost, the tentative impact on consumer bill considering one year lease period can be approx. INR 288 per month per consumer. This is approx. 29% and 12% of monthly electricity expenditure for consumers with 200 kWh and 500 kWh monthly consumption respectively (@ INR 5 per kWh). The rest of AMI[5] can have an impact of approx. INR 38 per month per consumer considering only the one time hardware, software, installation, testing, and integration costs for one year lease period. Additionally maintenance charges for software license and hardware can be approx. INR 10 – 15 per month per meter. This impact is a variant of the term of lease period / service contract tenure negotiated between the DISCOM and the service provider. For greater tenure, the impact can be as low as 5%/2%.

Illustrative economics of smart meter rollout

Cost of smart meter in INR per unit (single phase meter, communication module, meter box and installation)	**3223**
Cost of capital	13%
Project tenure in years	1
Impact on consumer bill for smart meter roll out (INR per month)	*288*
Impact on consumer bill for rest of AMI roll out (INR per month)	*38*
Total impact on consumer bill (INR per month)	326

Source: PwC analysis

[5] Source: ISGF; Without considering maintenance costs for software license renewal, and hardware maintenance costs

Sensitivity Analysis of the cost impact of AMI rollout (illustrative)

Project tenure in years (Period of cost recovery from consumers)	Impact on Consumer Bill for AMI Roll Out (excluding smart meter) (INR per Month)	Impact as % of monthly electricity expenditure (for 200 units per month @ INR 1000)	Impact as % of monthly electricity expenditure (for 500 units per month @ INR 2500)	Impact on Consumer Bill for Smart Meter Roll Out (INR per Month)	Impact as % of monthly electricity expenditure (for 200 units per month @ INR 1000)	Impact as % of monthly electricity expenditure (for 500 units per month @ INR 2500)
1	38	3.80%	1.52%	288	29%	12%
2	20	2.02%	0.81%	153	15%	6%
3	14	1.43%	0.57%	109	11%	4%
4	11	1.14%	0.46%	86	9%	3%
5	10	0.97%	0.39%	73	7%	3%
6	9	0.85%	0.34%	65	6%	3%
7	8	0.77%	0.31%	59	6%	2%
8	7	0.71%	0.29%	54	5%	2%
9	7	0.67%	0.27%	51	5%	2%
10	6	0.63%	0.25%	48	5%	2%

Source: PwC analysis

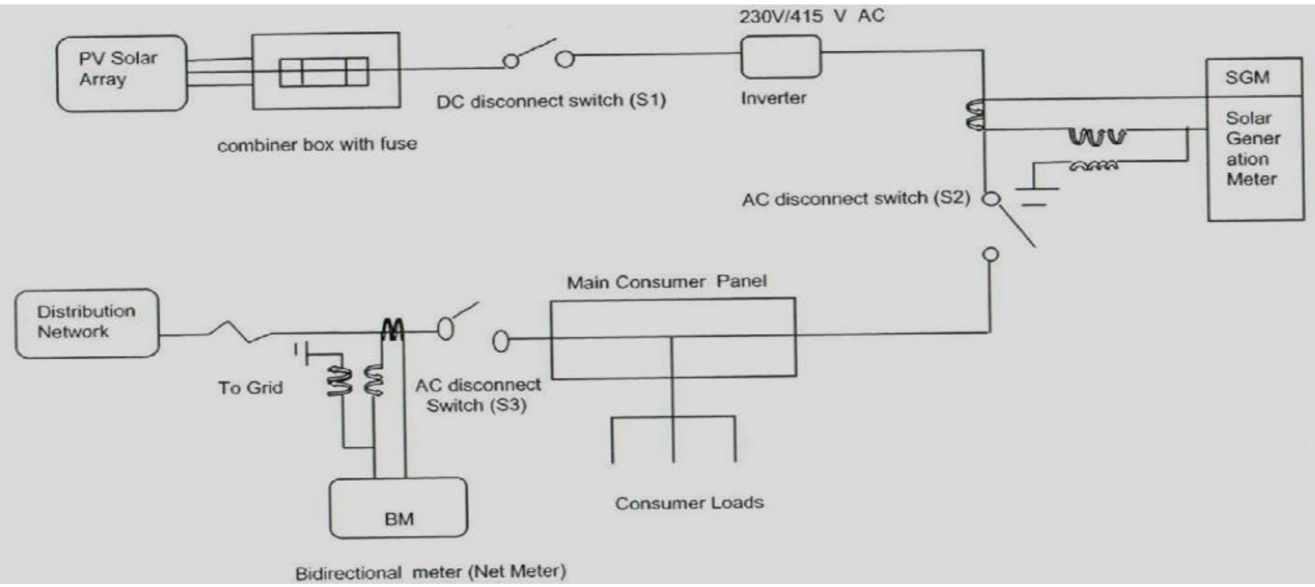
3. Integration of distributed renewable energy generation and storage systems

As per the recent estimates of MNRE (Ministry of Renewable Energy, Govt. of India), the total realistic market potential for rooftop SPV in urban settlements of India is estimated as 124 GWp. The payback period for small scale SPV systems for domestic and commercial purposes range from 6 - 10 years and any grant/subsidy sponsored by central / state policies will help in further reducing this payback period.

Net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. Net metering is a key enabler for making rooftop SPV solutions more cost effective and lucrative for consumers.

The technical specifications for single and three phase whole current smart meters specified by CEA has included net metering as the basic minimum feature for smart meters.

Schematic for representing the architecture of net metering facility



Currently, the majority of rooftop SPV projects implemented in India are driven by national and state specific policies driven by net and gross metering concepts coupled with capital subsidy for rooftop SPV systems. The government of India has committed to achieve 100 GW of solar capacity in the country by 2020, of which 40 GW is expected to be achieved through decentralized and rooftop scale solar projects. Electricity Regulatory Commissions, in more than 15 different states, have notified the regulations for grid connected rooftop SPV projects. The state policies mostly encourage self-consumption and sale of surplus power to Utility at predefined rates. Some states (e.g. Kerala) have also initiated mandatory rooftop SPV installations for domestic and commercial buildings falling under specified conditions pertaining to connected load and/or built up/plot area.

The important challenges for large scale deployment of rooftop SPV systems in the country are primarily on the policy and technology fronts.

On the policy front, net-metering allows customers who generate their own electricity from solar to feed unused electricity back into the grid and be compensated for that. Most of the states have fixed this compensation as the tariff at which the consumer is buying electricity from the grid. Only few states have allowed special feed-in tariffs that permit consumers to sell unused electricity into the grid at higher rates than the tariffs. Residential tariffs are subsidized either through cross subsidies or direct subsidies from state governments. In this scenario, the economics for residential rooftop SPV systems is not attractive for residential consumers to make the investment. This is despite the fact that Utilities benefit more by promoting rooftop SPV systems in this segment of consumers, because they help in bridging the revenue gap resulting from subsidies. For commercial consumers, where the rooftop SPV system makes a clear economic case for investment because of high tariffs, the Utilities are usually reluctant to encourage net metering as they perceive loss of revenue.

On the technology front, one of the key requirements for any energy source to connect to the grid is the availability of ‘anti-islanding protection’. Anti-islanding protection is a way for the inverter to shut itself off and stop feeding power into the grid, when it senses a problem with the power grid, such as a power outage. This requirement is crucial to ensure safety of Utility engineers working to fix outages and other grid related problems. Most of the states in India suffer from frequent power outages, mostly due to load shedding rather than problems in the grid’s infrastructure. Thus when the grid shuts off, the solar PV inverter will also turn off completely, preventing the owner from using the generated energy for themselves. With high unreliability of the grid, a lot of the electricity generated by the solar PV system will be wasted. The anti-islanding protection is an essential safety feature that cannot be removed.

The hybrid inverters provide the essential smart grid technology that is capable of cutting off the connection of rooftop SPV system to the grid in case of grid failure, while still being able to operate (acquire reference voltage) and provide solar energy for self-consumption.

However, consumers have to acquire other back up sources such as diesel generators or battery banks, which make the rooftop SPV solution more costly and commercially unviable.

4. Customer side smart grid systems

Smart Appliances

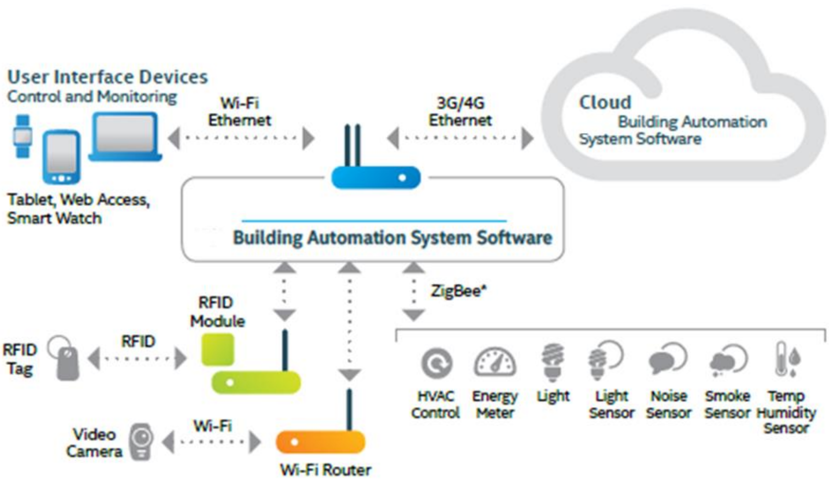
In chapter 2, the importance of real time electricity use information generated by AMI and its potential for DSM was extensively discussed. However, it is not just the information, but control is also an important function to make use of information and act on demand side. Smart appliances/equipment that simply allow consumers remotely turn off/on (through a programmable device) in advance of their need is one such control feature that is the key to better management of energy demand. Smart appliances that can effectively communicate with meters and respond to utility signals are critical components of auto DR solution discussed earlier. Smart appliances could include typical appliances (refrigerators, air conditioners, water heaters, pump sets etc.), electric and smart building components like lighting and window shading. For example about half of refrigerator's energy use is for defrosting and ice-making cycles that can be run at any time of day. Dishwashers and clothes washers can often have delayed start times. Air conditioners and water heaters can be turned off briefly, or even run in advance of their need. Agriculture and domestic pump sets can be remotely controlled (on/off) using smart control panels. Many Indian Utilities experience early morning peak loads driven by water heating or late morning / afternoon peak load driven by air conditioning. In this regard, smart appliances present a massive potential to manage such peak loads when deployed at sufficient scale.

Building Automation Systems

The main ingredients of building automation systems comprise of the following:

- Sensors and actuators
- User interface devices and software
- Robust communication network

All these ingredients are designed for optimal energy efficiency, cost effectiveness and can be integrated into new and existing electrical equipment. The solution can also integrate surveillance systems such as CCTVs and smart appliances to capture the full potential of energy efficiency and demand management.



Key features and applications of customer side systems

- Enable consumers respond to dynamic electricity pricing information by remotely adjusting appliance usage to reduce energy costs
- Enable consumers to establish their own operating parameters, while providing reminders to move appliance usage to off-peak periods
- Enable consumers to monitor and manage a home's overall energy usage

- Enable consumers to remotely shift between grid supply, captive energy generation and back-up systems during favourable conditions

Challenges for scaling up customer side systems

- Evolving technology
- Need to integrate AMI and building automation systems for enhanced control, efficiency and benefits
- Retrofitting options are limited in the market
- High upfront cost and justification of business case

5. Synergies with National Policies and Programs

Smart Cities Mission

Smart Cities Mission is an urban renewal and retrofitting program by the Government of India to develop 100 cities all over the country in order to make them citizen friendly and sustainable. The Union Ministry of Urban Development is responsible for implementing the mission in collaboration with the state governments of the respective cities. The mission aims to drive economic growth and improve the quality of life of people by harnessing smart technologies.

As per the smart city mission guidelines, published by the Ministry of Urban Development, assured electricity supply should be one of the core infrastructure elements of Smart Cities developed under the program. In order to ensure this, energy management is one of the important category of smart solutions, which include smart meters, renewable energy generation, energy efficient street lighting and energy efficient green buildings as important smart solutions to be developed under the mission to achieve the envisaged goals.

The stimulus to these elements is provided by increased adoption of smart grid technologies discussed in the earlier sections of this report.

Digital India

Digital India is a campaign launched by the Government of India to ensure that Government services are made available to citizens electronically by improving online infrastructure and by increasing Internet connectivity or by making the country digitally empowered in the field of technology.

The Government hopes to achieve growth on multiple fronts with the Digital India Program, specifically targeting nine areas that are recognized as 'Pillars of Digital India'.

1. Broadband Highways
2. Universal Access to Mobile Connectivity
3. Public Internet Access Program
4. e-Governance – Reforming Government through Technology
5. eKranti - Electronic delivery of services
6. Information for All
7. Electronics Manufacturing
8. IT for Jobs
9. Early Harvest Programs

The development of first three pillars strengthen the communication network in India and help resolve last mile connectivity problems for AMI solutions that is perceived as a key challenge in the current scenario.

On the contrary, scaling up smart grid systems and technologies shall provide a boost to the e-Governance, eKranti, information for all, electronics market and create jobs for the IT professionals.

National Solar Mission (NSM)

Under the national solar mission, the country has embarked upon an ambitious journey of installing 100 GW of solar power generation capacity by 2022, of which 40 GW is envisaged to come from Solar Rooftop PV applications.

Smart meters with net metering features is a key enabler for driving the distributed renewable energy generation systems in the country and achieve the NSM goals. The smart meters enable energy accounting and ensure the delivery of the policy incentives to the consumers who adopt SPV based rooftop systems. Advanced smart grid technologies further enable consumers to shift between distributed renewable energy generation systems and grid supply for enhanced benefits during favorable generation /grid conditions.

National Electric Mobility Mission

The National Electric Mobility Mission Plan 2020 is one of the most important and ambitious missions of the Government of India that has the potential to facilitate a paradigm shift in the automotive and transportation sector in the country. The mission aims to achieve 6-7 million electric/hybrid vehicles sales by the year 2020.

Government aims to provide fiscal and monetary incentives to kick start this nascent technology under the 'Faster Adoption and Manufacturing of Hybrid & Electric Vehicles' (FAME India) scheme.

Smart grid systems and technologies can complement the missions goals to achieve schedule "Vehicle to Grid" and "Grid to Vehicle" charging cycles in an optimum manner that can reduce peak loads and stabilize grid in the process.

6. Conclusion

DSM provides the scale and scalability to make smart grid solutions cost effective, economical and convenient for all stakeholders. Smart meter roll out along with the rest of AMI can significantly enhance the demand response potential for Indian DISCOMs and consumers. The customer side systems and integration solutions for distributed renewable energy systems when fully integrated with AMI can further boost the DSM potential to unprecedented levels. Intelligently planned smart grid systems that integrate DSM and energy efficiency as central goals will have tremendous potential to save energy, manage peak demand, optimize costs, and reap benefits for consumers, DISCOMs and society as whole. In fact, DSM helps establish a strong business case for smart grid deployment in India.

Smart grid systems and technologies provide the tools and platform for enhanced customer engagement that is central to successful and sustainable DSM efforts. More importantly, smart grid solutions help monitor, measure, assess and evaluate DSM resources[6] in a transparent and reliable manner that ultimately helps establish a strong policy framework for scaling up DSM efforts in India.

The Governments, DISCOMs and regulatory authorities play an important role in realizing the DSM potential from smart grid solutions in a manner that is economically justifiable for all stakeholders.

Some of the key recommendations in this regard are outlined below.

Governments and Regulatory Authorities

- Notify and enforce Smart Grid Regulations, especially smart meter rollout targets, cost recovery mechanisms, financial incentives etc.
- Create effective financing mechanisms for smart meter rollout
- Strengthen the communication infrastructure for seamless last mile connectivity
- Leverage synergies among various national policies and programs

DISCOMs

- Implement effective awareness campaigns to build consumer confidence in smart meters
- Establish a strong business case to justify smart grid roll out
- Leverage leasing and services options for overcoming financing challenges
- Adopt BIS standards and CEA guidelines effectively to harmonise functionalities
- Undertake DSM pilots focusing on smart appliances and building automation systems

[6] "Demand Side Resource" means a saving in consumption (kWh) and/or demand (kW/KVA) available as a result of implementation of DSM program, to be expressed in the following three important dimensions:

- Quantum – as to how much is available (kWh and/or kW)
- Time – as to when is it available (at what time of day, on what days, in what season)
- Cost – as at what would be the cost.