AMI Rollout Plan for India

ISGF–BNEF Knowledge Paper
Abstract
This Paper showcases the evolution of the metering Industry in India. It covers the benefits of Advanced Metering Infrastructure (AMI), key challenges in implementing AMI, popular communication standards and innovative business models for rolling out AMI in India. The AMI market share is also calculated based on three distinct scenarios, namely, Conservative, Moderate and Aggressive. Furthermore, this Paper provides recommendations for deploying large scale rollout of AMI in India.

About India Smart Grid Forum (ISGF)
India Smart Grid Forum (ISGF) is a public private non-partisan initiative of the Ministry of Power (MoP), Government of India for accelerated development of smart grid technologies in the Indian power sector. ISGF was set up in 2010 to provide a mechanism through which academia, industry, utilities and other stakeholders could participate in the development of Indian smart grid systems and provide relevant inputs to the government’s decision making.

About Bloomberg New Energy Finance (BNEF)
Bloomberg New Energy Finance is a research organization that helps energy professionals generate opportunities. Leveraging the most sophisticated new energy data sets in the world, Bloomberg New Energy Finance synthesizes proprietary data into clear narratives that frame the financial, economic and policy implications of emerging energy technologies. We work with the largest corporations across utilities and generation, oil & gas, equipment manufacturers, banking and finance, and government. Our team of experts, spread across six continents, provides independent analysis and insight by looking at specific sectors in depth, as well as cross-sector and cross-geography trends and implications. BNEF helps you navigate an evolving energy economy.

Disclaimer
The information and opinions in this document were prepared by India Smart Grid Forum (ISGF) and Bloomberg New Energy Finance (BNEF). ISGF has no obligation to communicate with all or any readers of this document when opinions or information in this document change. We make every effort to use reliable and comprehensive information but we do not claim that it is accurate or complete. In no event shall ISGF/BNEF or its members be liable for any damages, expenses, loss of data, opportunity or profit caused by the use of the material or contents of this document.

Authors
Reji Kumar Pillai – President, ISGF
Rupendra Bhatnagar – General Secretary, ISGF
James Sprinz – Associate, BNEF

India Smart Grid Forum (ISGF)
CBIP Building, Malcha Marg
New Delhi, India
www.indiasmartgrid.org
# Table of contents.

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>2</td>
</tr>
<tr>
<td>About India Smart Grid Forum (ISGF)</td>
<td>2</td>
</tr>
<tr>
<td>About Bloomberg New Energy Finance (BNEF)</td>
<td>2</td>
</tr>
<tr>
<td>Disclaimer</td>
<td>2</td>
</tr>
<tr>
<td>Authors</td>
<td>2</td>
</tr>
<tr>
<td>1. Introduction</td>
<td>4</td>
</tr>
<tr>
<td>2. Brief description of AMI</td>
<td>5</td>
</tr>
<tr>
<td>3. AMI benefits</td>
<td>6</td>
</tr>
<tr>
<td>3.1. Economic benefits</td>
<td>6</td>
</tr>
<tr>
<td>3.2. Operational benefits</td>
<td>7</td>
</tr>
<tr>
<td>3.3. Other benefits</td>
<td>8</td>
</tr>
<tr>
<td>4. Challenges for AMI in India</td>
<td>8</td>
</tr>
<tr>
<td>5. AMI market in India</td>
<td>9</td>
</tr>
<tr>
<td>5.1. Financing models</td>
<td>9</td>
</tr>
<tr>
<td>5.2. Project component costs</td>
<td>10</td>
</tr>
<tr>
<td>5.3. Model scenarios and costs</td>
<td>11</td>
</tr>
<tr>
<td>5.4. Rollout targets</td>
<td>13</td>
</tr>
<tr>
<td>6. Communication technologies for Smart Metering</td>
<td>14</td>
</tr>
<tr>
<td>6.1. Uptake</td>
<td>15</td>
</tr>
<tr>
<td>6.2. Avoiding vendor lock-in</td>
<td>16</td>
</tr>
<tr>
<td>7. Global AMI Market</td>
<td>16</td>
</tr>
<tr>
<td>7.1. Installations</td>
<td>16</td>
</tr>
<tr>
<td>7.2. Investment</td>
<td>17</td>
</tr>
<tr>
<td>8. Recommendations</td>
<td>18</td>
</tr>
</tbody>
</table>
1. Introduction

The metering industry has taken rapid strides in the past few years by traversing from automated meter reading (AMR) to smart metering, using bidirectional communication, thereby enabling greater benefits to electricity distribution companies (DISCOMs), customers and society. The Ministry of Power (MoP) has come out with several transformational policy initiatives for reforming the power sector in India. The Bureau of Indian Standards (BIS) published standards for smart metering (IS 16444 in August 2015 and IS 15959 Part 2 in February 2016). The Central Electricity Authority (CEA) followed with functional requirements for advanced metering infrastructure (AMI) and technical specification of smart meters in August 2016.

The UDAY program, announced in November 2015, aims to financially restructure and enhance the performance of electricity distribution companies. It includes directives to deploy smart meters for all customers whose electricity consumption is greater than 200 kWh per month by December 2019. Furthermore, the National Tariff Policy released in January 2016 re-iterated this deployment plan.

In July 2016, India Smart Grid Forum (ISGF) submitted a White Paper, AMI Rollout Strategy and Cost-Benefit Analysis for India, to MoP that presents a detailed cost-benefit analysis of different rollout scenarios. ISGF strongly advocates deployment of smart meters to all customers on a feeder primarily because of the potential to reduce aggregate technical and commercial (AT&C) losses and the substantially lower communication cost per endpoint when the full feeder is covered. Subsequently, in September 2016, CEA published an amendment to the AMI rollout strategy by stating that deployment of smart meters should be done by area or feeder.

The major milestones in India’s journey in the field of metering are depicted below:
2. Brief description of AMI

Typically, AMI comprises smart meters connected over a neighborhood – or field – area network to data concentrator units (DCUs). These, in turn, relay aggregated metering data over the wide area – or ‘backhaul’ – network to the utility head-end system. The meter data management system (MDMS) collects data from the head-end system for processing before sharing it with other utility IT systems.
The key features that make a meter ‘smart’ is the addition of a communications module capable of two-way communication. A remote connect/disconnect switch is also typically included.

An in-home display (IHD) is a device kept in the consumer’s premises that visualises metering data. They are intended to increase awareness of energy use and support energy efficiency and demand response applications. However, with the widespread adoption of smartphones, there is less demand for dedicated energy monitoring displays. Utilities may prefer to develop smartphone apps for customers rather than invest in IHDs.

3. AMI benefits

AMI is expected to achieve the following benefits:

3.1. Economic benefits

Reduced metering reading and data entry cost

Without smart meters, utilities must send personnel to customer premises to manually read the meter. Implementation of AMI enables remote meter reading both regularly and on-demand. Data entry and processing is performed automatically. Overall AMI should deliver greater convenience at reduced cost relative to traditional meter reading.

Loss reduction

AMI can remotely detect meter tampering and enable real time energy accounting. This reduces theft through by-passing the meter, thereby substantially reducing aggregate technical and commercial (AT&C) losses. AMI will also streamline the billing, or meter-to-cash, process considerably.

Reduction in peak power purchase cost

With meter data time stamped at 15 minute intervals, AMI enables near real-time estimation of customer demand. This improves utility load forecasting and enhances their ability to procure the right volumes of power. Utilities can also implement time-of-use (ToU) tariffs for different categories of customers and encourage load shifting with demand response programs. These measures could reduce utility exposure to expensive power during the peak hours.
3.2. Operational benefits

**Enabling faster service restoration after faults**

Traditionally utilities know about an outage when they receive complaints from affected customers. Service restoration requires utility crews to identify the area and rectify the fault – a time consuming and expensive process. The Bureau of Indian Standards requires all smart meters to be capable of sending ‘last gasp’ and ‘first breath’ messages, which inform utilities when power has failed or resumed. This will reduce outage restoration times leading to financial savings and improved customer satisfaction.

**Reduction in errors**

There are always chances of human errors when meters are read manually or even via automatic hand-held devices. In addition, the process is time-consuming. By delivering meter data automatically over communication networks, AMI eliminates human error from the meter reading process.

**Power quality measurement**

Smart meters are capable of measuring specific aspects in near real-time, such as power factor, over or under voltage, and over current. This helps utilities to enhance system power quality in conjunction with power quality data from other sources. Improved power quality also leads to lower power losses.

**Asset optimization**

AMI data supports granular monitoring of power flows on the distribution network which can help utilities identify segments of over- and under-loading. This is valuable information for system planning and optimizing network upgrades. AMI data can also help balance load, which reduces power losses. Furthermore, network monitoring can decrease the failure rate of distribution transformers by identifying phase imbalances in advance which can be corrected.

**Remote functionality**

Smart meters typically include remote switching, which allows utilities to
3.2. Operational benefits

- Enabling faster service restoration after faults: Traditionally, utilities know about an outage when they receive complaints from affected customers. Service restoration requires utility crews to identify the area and rectify the fault, a time-consuming and expensive process. The Bureau of QGLDQ6WDQGDUGVUHTXLUHVDOOVPDUWPHWHUVWREHFDSDEOHRIVHQGLQJµODVWJDVS¶PHVV ages, which inform utilities when power has failed or resumed. This will reduce outage restoration times leading to financial savings and improved customer satisfaction.

- Reduction in errors: There are always chances of human errors when meters are read manually or even via automatic hand-held devices. In addition, the process is time-consuming. By delivering meter data automatically over communication networks, AMI eliminates human error from the meter reading process.

- Power quality measurement: Smart meters are capable of measuring specific aspects in near real-time, such as power factor, over or under voltage, and over current. This helps utilities to enhance system power quality in conjunction with power quality data from other sources. Improved power quality also leads to lower power losses.

- Asset optimization: AMI data supports granular monitoring of power flows on the distribution network which can help utilities identify segments of over- and under-loading. This is valuable information for system planning and optimizing network upgrades. AMI data can also help balance load, which reduces power losses. Furthermore, network monitoring can decrease the failure rate of distribution transformers by identifying phase imbalances in advance which can be corrected.

3.3. Other benefits

- By slashing truck rolls for meter reading and mitigating AT&C losses, smart meters can potentially reduce the carbon footprint of a utility’s service area.

- With the use of web-portals, mobile apps, or in-home displays, customers can monitor and potentially lower their energy consumption.

- Some AMI systems allow customers to use their smart meter as central hub from which to monitor or control other electrical loads.

4. Challenges for AMI in India

India faces a number of challenges with respect to deployment of AMI:

**Financial strength**

Indian utilities are highly indebted and are undergoing financial restructuring as part of the UDAY reforms. The typically high upfront costs of smart meter projects can be prohibitive for utilities with limited access to capital.

**Absence of skilled manpower**

AMI is a new concept that involves in-depth knowledge of three distinct domains: metrology, telecommunications and IT. The DISCOMs are well versed with the electrical technologies of the electricity grid, but when it comes to telecommunications and IT, their expertise is limited. Furthermore, the fact that AMI is an evolving technology adds to the challenge.

**Limited awareness**

As AMI is new in India, regulators and DISCOMs are still trying to understand its nuances. As a result, regulators and DISCOMs often find it hard to justify investments in AMI. Also, limited availability of information on successes in AMI deployments leads to an unclear picture in the minds of the decision makers.
Weak procurement framework

In most government tenders in India, the lowest bidder is awarded the contract. This often leads to the deployment of unproven technologies and systems by inexperienced parties. Often the lifecycle cost of such systems comes out to be much higher than the anticipated cost.

Lack of universal standards

DISCOMs in India tend to choose different technical specifications, independent of each other, for the smart meters in their AMI rollout. This leads to increased costs and unnecessarily inflated time-to-market. In Europe, several large, quasi-national, rollouts went this route and have suffered delays after creating additional burdens for vendors.

Customer engagement

Many potential benefits of an AMI project rely on robust customer engagement. In India, this is an often overlook aspect by most DISCOMs. Customers will take part in AMI and demand response initiatives only when they understand the importance and benefits to them.

Implementation of AMI

DISCOMs do not have one officer or business unit responsible for AMI. Instead, multiple officers and distinct working groups look after different aspects of smart meter projects. This leads to delayed and incorrect implementation of the technology.

5. AMI market in India

5.1. Financing models

The greatest barrier India faces to implementing widespread AMI is finance. Many Indian DISCOMs do not have the financial muscle to undertake large AMI projects as the initial capital cost is too high. Hence the typical model, in which engineering, procurement and construction (EPC) are done by the utility may not be the right way forward for Indian DISCOMs.

The India Smart Grid Forum proposes several leasing and service models instead. These are explored below:
AMI Rollout Plan for India

**ISGF-BNEF Knowledge Paper on AMI Rollout Plan for India published at ISGW 2017**

Weak procurement framework
In most government tenders in India, the lowest bidder is awarded the contract. This often leads to the deployment of unproven technologies and systems by inexperienced parties. Often the lifecycle cost of such systems comes out to be much higher than the anticipated cost.

Lack of universal standards
DISCOMs in India tend to choose different technical specifications, independent of each other, for the smart meters in their AMI rollout. This leads to increased costs and unnecessarily inflated time-to-market. In Europe, several large, quasi-national, rollouts went this route and have suffered delays after creating additional burdens for vendors.

Customer engagement
Many potential benefits of an AMI project rely on robust customer engagement. In India, this is an often overlooked aspect by most DISCOMs. Customers will take part in AMI and demand response initiatives only when they understand the importance and benefits to them.

Implementation of AMI
DISCOMs do not have one officer or business unit responsible for AMI. Instead, multiple officers and distinct working groups look after different aspects of smart meter projects. This leads to delayed and incorrect implementation of the technology.

5. AMI market in India

5.1. Financing models
The greatest barrier India faces to implementing widespread AMI is finance. Many Indian DISCOMs do not have the financial muscle to undertake large AMI projects as the initial capital cost is too high. Hence the typical model, in which engineering, procurement and construction (EPC) are done by the utility may not be the right way forward for Indian DISCOMs.

The India Smart Grid Forum proposes several leasing and service models instead. These are explored below:

**Meter leasing model**
Since the quantity of meters is expected to be in the tens of millions, the capital requirements are likely beyond the capacity of the DISCOMs. Instead, a financial intermediary – a bank, Power Finance Corporation (PFC) or another financial institution – will buy the meters, communication devices and other equipment and lease it to the DISCOMS in return for monthly payments over a period of 10 years.

A third-party agency will be responsible for tendering meters and selecting a group of eligible vendors that meet the national standards. The agency will determine rates at which utilities can lease the meters, and separately, the communication modules. DISCOMs will have the option of procuring this equipment from a variety of vendors supported by the financial intermediary.

**Metering services agency model**
AMI requires expertise across three distinct domains: metering, telecommunication and IT. Global experience indicates that utilities have often struggled to master all three. System integrators can mitigate this challenge either in an advisory role or more directly overseeing and managing the project.

ISGF proposes that utilities use a metering services agency (MSA) responsible for project management and O&M. These services would include selecting and testing equipment, communication infrastructure, and software to standards defined by the DSICOM and region. Installing meters at customer premises and establishing the communication network. Commissioning the AMI system and integrating it with other utility IT. Finally, operating and maintaining the system for at least 10 years and ensuring it meets standards specified in mutually agreed service level agreements.

Utilities can either finance the project themselves while leaving O&M to the MSA, or they can outsource the entire process and bring in a financing agency to back the project.

5.2. Project component costs
Metering projects involve equipment, communication and software costs in addition to labor and system integration. By speaking with industry stakeholders, we have developed the following costs estimates for project...
components:

Table 1: Project costs for AMI in India

<table>
<thead>
<tr>
<th>Project component</th>
<th>INR</th>
<th>USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meters</td>
<td>3,800</td>
<td>56.5</td>
</tr>
<tr>
<td>Communication infrastructure</td>
<td>350</td>
<td>5.2</td>
</tr>
<tr>
<td>HES and MDMS</td>
<td>80</td>
<td>1.2</td>
</tr>
<tr>
<td>Installation</td>
<td>775</td>
<td>11.5</td>
</tr>
<tr>
<td>System integration</td>
<td>120</td>
<td>1.8</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>1,608</td>
<td>23.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,733</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: ISGF. Note: costs per meter assuming installation of 500,000 meters and O&M for 10 years. Costs are nominal, converted to dollars using average 2016 rates.

The above costs assume utilities rollout meters to customers in groups of 500,000 of which 80% of meters are single-phase and 20% are three-phase. RF mesh networking technology is used and one data concentrator is required per 200 meters. We have not accounted for taxes and duties that may be levied on various elements of the projects.

5.3. Model scenarios and costs

Using the above costs we can assess the costs of rolling out smart meters across four financing scenarios:

1. **Engineering, procurement and construction (EPC):** the utility takes full responsibility for procuring, financing and managing the project.
2. **Partial EPC and services:** the utility is responsible for procurement and financing but outsources project management and maintenance to a third-party.
3. **Leasing and partial EPC:** the utility leases meters and equipment from a third-party but is responsible for project management and maintenance.
4. **Leasing and services:** the utility leases the meters from a third-party and outsources project management and maintenance to a metering agency.

Assuming the life of the metering project is 10 years, the cost and complexity for utilities in each scenario is the following:
Table 1: Project costs for AMI in India

<table>
<thead>
<tr>
<th>Project component</th>
<th>INR</th>
<th>USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meters</td>
<td>3,800</td>
<td>56.5</td>
</tr>
<tr>
<td>Communication infrastructure</td>
<td>350</td>
<td>5.2</td>
</tr>
<tr>
<td>HES and MDMS</td>
<td>80</td>
<td>1.2</td>
</tr>
<tr>
<td>Installation</td>
<td>775</td>
<td>11.5</td>
</tr>
<tr>
<td>System integration</td>
<td>120</td>
<td>1.8</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>1,688</td>
<td>23.9</td>
</tr>
<tr>
<td>Total</td>
<td>6,733</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: ISGF. Note: costs per meter assuming installation of 500,000 meters and O&M for 10 years. Costs are nominal, converted to dollars using average 2016 rates.

The above costs assume utilities rollout meters to customers in groups of 500,000 of which 80% of meters are single-phase and 20% are three-phase. RF mesh networking technology is used and one data concentrator is required per 200 meters. We have not accounted for taxes and duties that may be levied on various elements of the projects.

5.3. Model scenarios and costs

Using the above costs we can assess the costs of rolling out smart meters across four financing scenarios:

1. **Engineering, procurement and construction (EPC)**: the utility takes full responsibility for procuring, financing and managing the project.

2. **Partial EPC and services**: the utility is responsible for procurement and financing but outsources project management and maintenance to a third-party.

3. **Leasing and partial EPC**: the utility leases meters and equipment from a third-party but is responsible for project management and maintenance.

4. **Leasing and services**: the utility leases the meters from a third-party and outsources project management and maintenance to a metering agency.

Assuming the life of the metering project is 10 years, the cost and complexity for utilities in each scenario is the following:

**Table 2: Financing costs and utility requirements for Indian rollout scenarios**

<table>
<thead>
<tr>
<th>Business model</th>
<th>Total cost (INR)</th>
<th>Total cost (USD)</th>
<th>Financial strength</th>
<th>Technical expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPC</td>
<td>3.3bn</td>
<td>50.1m</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Partial EPC and services</td>
<td>4.4bn</td>
<td>65.5m</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Leasing and partial EPC</td>
<td>5.2bn</td>
<td>77.3m</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Leasing and services</td>
<td>5.8bn</td>
<td>86.8m</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: ISGF. Note: costs per meter assuming installation of 500,000 meters. Costs are nominal, converted to dollars using average 2016 rates. Assumes third-party leasing and service agencies have a hurdle rate of 12.5%.

The breakdown between upfront and monthly recurring costs is illustrated in Figure 1.

**Figure 1: AMI rollout scenario costs (INR bn – nominal)**

![Figure 1: AMI rollout scenario costs (INR bn – nominal)](image)

Source: Bloomberg New Energy Finance; ISGF. Note: costs are nominal, converted to dollars using average 2016 rates. Assumes third-party leasing and service agencies have a hurdle rate of 12.5%.

Despite being the highest cost per meter per month, the **leasing and services** model requires the least technical knowledge and financial strength from DISCOMS and is therefore recommended by ISGF. The low risk, and benefits of financial and technical support outweigh the additional costs.
5.4. Rollout targets

With the Ministry of Power (MoP) announcing its ambitious target of deploying smart meters for all customers with monthly consumption over 200 kWh by December 2019, the DISCOMs are scrambling to fulfill this directive. Many DISCOMs have already released large tenders to purchase smart meters (Table 3) and many more are expected to follow suit.

Table 3: Recent meter tenders released/yet to be released by Indian utilities

<table>
<thead>
<tr>
<th>Utility</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>KESCO, Kanpur</td>
<td>539,000</td>
</tr>
<tr>
<td>Reliance, Mumbai</td>
<td>300,000</td>
</tr>
<tr>
<td>PVVNL, Varanasi</td>
<td>225,000</td>
</tr>
<tr>
<td>Tata Power, Delhi</td>
<td>200,000</td>
</tr>
<tr>
<td>MSEDCL, Amravati, Maharashtra</td>
<td>148,495</td>
</tr>
<tr>
<td>MSEDCL, Congress Nagar, Maharashtra</td>
<td>125,000</td>
</tr>
<tr>
<td>Jammu and Kashmir</td>
<td>70,000</td>
</tr>
<tr>
<td>CED, Chandigarh</td>
<td>29,443</td>
</tr>
<tr>
<td>UGVCL, Gujarat</td>
<td>22,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,658,938</strong></td>
</tr>
</tbody>
</table>

*Source: ISGF*

The estimated number of customers who consume more than 200 kWh per month is about 35 million. However, following the rollout strategy White Paper published by ISGF in July 2016, the Central Electricity Authority (CEA) announced in August that smart meters must be installed by feeder or by area. As a conservative estimate, we assume that about 10 million smart meters will be installed by December 2019.

To assess the potential size of the AMI market in India, we consider 3 scenarios: *conservative*, *moderate* and *aggressive*, in which 10, 20 or 40 million meters are installed. Assuming meters are deployed using the leasing and services model, cumulative investment would range 13.1—you 46.9 billion rupees ($204—you 729 million) from 2017 to 2019 (Figure 2).

While the government’s policy is more in line with the aggressive scenario, we expect that the conservative scenario to play out. This is due to the current level of activity in the market and the limited time DISCOMs have to meet the
5. Rollout targets

With the Ministry of Power (MoP) announcing its ambitious target of deploying smart meters for all customers with monthly consumption over 200 kWh by December 2019, the DISCOMs are scrambling to fulfill this directive. Many DISCOMs have already released large tenders to purchase smart meters (Table 3) and many more are expected to follow suit.

Table 3: Recent meter tenders released/yet to be released by Indian utilities

<table>
<thead>
<tr>
<th>Utility</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>KESCO, Kanpur</td>
<td>539,000</td>
</tr>
<tr>
<td>Reliance, Mumbai</td>
<td>300,000</td>
</tr>
<tr>
<td>PVVNL, Varanasi</td>
<td>225,000</td>
</tr>
<tr>
<td>Tata Power, Delhi</td>
<td>200,000</td>
</tr>
<tr>
<td>MSEDCL, Amravati, Maharashtra</td>
<td>148,495</td>
</tr>
<tr>
<td>MSEDCL, Congress Nagar, Maharashtra</td>
<td>125,000</td>
</tr>
<tr>
<td>Jammu and Kashmir</td>
<td>70,000</td>
</tr>
<tr>
<td>CED, Chandigarh</td>
<td>29,443</td>
</tr>
<tr>
<td>UGVCL, Gujarat</td>
<td>22,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,658,938</td>
</tr>
</tbody>
</table>

Source: ISGF

The estimated number of customers who consume more than 200 kWh per month is about 35 million. However, following the rollout strategy White Paper published by ISGF in July 2016, the Central Electricity Authority (CEA) announced in August that smart meters must be installed by feeder or by area. As a conservative estimate, we assume that about 10 million smart meters will be installed by December 2019.

To assess the potential size of the AMI market in India, we consider 3 scenarios: conservative, moderate, and aggressive, in which 10, 20 or 40 million meters are installed. Assuming meters are deployed using the leasing and services model, cumulative investment would range 13.1 ± 46.9 billion rupees ($204 ± 729 million) from 2017 to 2019 (Figure 2).

6. Communication technologies for Smart Metering

A number of communication technologies are available for utilities to choose from for home, neighborhood and wide area networks. These are summarized in the table below.

Table 4: AMI communication technologies

<table>
<thead>
<tr>
<th>Technology / protocol</th>
<th>Home area network</th>
<th>Last mile</th>
<th>Wide area network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless</td>
<td>RF mesh, ZigBee, Wi-Fi, Bluetooth, Z-Wave, NFC</td>
<td>RF mesh, ZigBee, Wi-Fi, Millimeter Wave Technology</td>
<td>Cellular, Satellite, LPWA, Long Wave Radio, TVWS, Private Microwave Radio</td>
</tr>
<tr>
<td>Wired</td>
<td>PLC, Ethernet, Serial interfaces (RS-232, RS-422, RS-485)</td>
<td>PLC, Ethernet, Serial interfaces (RS-232, RS-422, RS-485), DSL</td>
<td>Optical Fiber, Ethernet, PLC, DSL</td>
</tr>
</tbody>
</table>

Source: ISGF
6.1. Uptake

There is significant regional variation in which communication technologies are deployed. Globally PLC is slightly more widespread than RF mesh, but the location of these endpoints diverges considerably. PLC has been widely deployed throughout Europe. The technology was chosen by early movers in European smart metering, such as Enel in Italy and Iberdrola or Gas Natural Fenosa in Spain, and cemented its position thereafter. Outside of Europe, however, uptake is limited. In contrast, RF mesh has been widely deployed in all regions other than Europe. It is by far the most popular choice in North America and commands a leading position in Asia-Pacific.

![Market share of AMI communication technologies](image)

*Source: Bloomberg New Energy Finance. Note: excludes China. Smart electricity meters only, data through July 2016.*

New project announcements indicate that PLC is losing favor. The bulk of contracts awarded for AMI networks since 2015 have gone to wireless technologies – in particular RF mesh and cellular. In part this reflects regional trends: although EMEA will be the leading market, excluding China, for smart meter installations through 2020, much of the communication infrastructure has already been contracted or selected. New announcements are predominantly outside of Europe, where other communication protocols are preferred. It is also due to the increasing popularity of cellular. Historically used to ‘fill in the gaps’ where coverage from the primary technology was poor, today cellular is increasingly the leading choice. In the Netherlands and Uzbekistan, for example, the majority of endpoints will be connected over cellular.
6.2. Avoiding vendor lock-in

Interoperability remains a challenge for smart grid technologies. Utilities are often locked into particular vendors, limiting options for future upgrades or replacements. Device-level interoperability can be achieved if the correct approach is taken. Utilities must select a communication system based on standards available to multiple communication providers and certified globally. The result is a network in which smart meters can be replaced with units from various manufacturers. The network interface card (NIC), or communication module is often produced with a standardized form factor and can also be purchased from multiple vendors and integrated with different meters. This approach avoids vendor lock-in and allows the utility to purchase meters and communication modules from multiple, and distinct, vendors.

7. Global AMI Market

7.1. Installations

Global cumulative smart electricity meter installations hit 674m in 2016 and will expand a further 50% past 1bn by 2020. Today the vast majority of global smart meters reside in Asia-Pacific, primarily China. State Grid Corporation of China and the smaller China Southern Grid have 444m units since 2009. This burst of activity overshadows other regions globally. The US more than tripled its smart meter base in the same period and by the end of 2016 more than 70m customers have smart meters. Italy, the earliest smart meter market, finished its rollout in 2010 and is now starting a second phase of deployments.

Figure 4: Cumulative smart meter installations (millions), 2010–20e
Outside of China, Europe will be the leading market globally – Bloomberg New Energy Finance expects 143m smart meters to be installed between 2017 and 2020. Countries such as France, the Netherlands and the UK will race to meet the EU’s deadline of 80% smart meter penetration by 2020. In Asia, Japan takes second place after China, installing an annual average of 11m meters through the rest of the decade. By 2020 the rest of the Americas will be installing more smart meters than the US as markets such as Mexico and Brazil pick up the pace.

The outlook for India rests heavily on which options within this paper are pursued. But Bloomberg New Energy Finance’s base case assumes 14.5m smart meters are installed by 2020.

**Figure 5: Annual smart meter installations excluding China (millions), 2016–20e**

7.2. **Investment**

Despite large volume of meters installed, China was only briefly, over 2012–14, the largest market by investment. Low cost smart meters have limited the dollar size of this market. The global smart meter industry has moved through two distinct investment cycles and is now entering a third. The first was led by a boom in US smart metering – caused by the Smart Grid Investment Grant – which peaked in 2012. The second period saw Asia-Pacific become the largest market, led by China but then Japan from 2015. We are now in a period of
transition as European investment accelerates. Bloomberg New Energy Finance forecasts that Europe, the Middle East and Africa will be the largest region globally by 2018, expending $7.7bn. If smart gas meters are included in the figures that switch would take place this year.

**Figure 6: Annual smart meter investment ($bn - nominal), 2010–20e**


### 8. Recommendations

**Services and leasing model**

Considering the significant financial commitments and technical expertise required to undertake a smart metering rollout, ISGF recommends Indian DISCOMs pursue a services and leasing model. The majority of utilities are currently in weak financial positions and lack the requisite proficiency to manage these projects themselves. Appointment of a metering services agency is strongly recommended. Those utilities in better financial shape could opt for to procure meters themselves while still outsourcing the project management, as discussed in the partial EPC and services model.

**Common standards and planning**

By opting for an open standards based communication system, DISCOMs can avoid vendor lock-in and attract a broader range of suppliers, ultimately improving quality and lowering costs. Examples include the Wi-SUN, ZigBee and G3-PLC or PLC Prime alliances.
When selecting technology, DISCOMs should think not only of what smart meter applications their networks will be required for but of other potential smart grid or utility use cases. Low latency, high bandwidth networks will be more capable diverse applications, such as distribution automation, but these come with added cost. International metering vendors increasingly offer a broad spectrum of additional services that can be applied once a metering rollout is complete. Utilities should investigate these before deciding on a network technology to ensure they are making the most of their investment.

**Internal capacity**

There is a significant shortage of skilled man-power for AMI amongst Indian DISCOMs. To rectify this, DISCOMS must develop smart metering and smart grid training programs. The National Smart Grid Mission of India has provisionally allocated 80 million rupees ($1.2 million) for training and capacity building. To successfully implement AMI projects, ISGF suggests that utilities appoint Chief AMI Officers, responsible for deploying managing and operating the smart meter system. This should also improve accountability.

**Customer awareness**

While operational and economic benefits can be achieved by DISCOMs that follow best practice, for customers to share in the gains requires widespread consumer awareness of the technology. International experience has demonstrated that when utilities do not actively engage with consumers before installing smart meters, there is frequently widespread pushback. This leads to cost overruns, delays and general declines in customer satisfaction.

The National Smart Grid Mission has allocated 2 million rupees ($29,759) for each of the 60 state-owned DISCOMs to implement customer engagement programs. Utilities should take this opportunity to ensure their metering rollouts are inclusive of, and beneficial to, all customer groups.

**Arbitrary requirements**

DISCOMs should refrain from imposing unnecessary requirements on vendors. In the past DISCOMs have demanded that vendors demonstrate positive cash-flow for the preceding six quarters or are jointly responsible for the performance of all vendors within a consortium. Instead DICOMs should focus on the experience of vendors and the quality and cost of their products and services.
When selecting technology, DISCOMs should think not only of what smart meter applications their networks will be required for but of other potential smart grid or utility use cases. Low latency, high bandwidth networks will be more capable of diverse applications, such as distribution automation, but these come with added cost. International metering vendors increasingly offer a broad spectrum of additional services that can be applied once a metering rollout is complete. Utilities should investigate these before deciding on a network technology to ensure they are making the most of their investment.

Internal capacity

There is a significant shortage of skilled man-power for AMI amongst Indian DISCOMs. To rectify this, DISCOMs must develop smart metering and smart grid training programs. The National Smart Grid Mission of India has provisionally allocated 80 million rupees ($1.2 million) for training and capacity building. To successfully implement AMI projects, ISGF suggests that utilities appoint Chief AMI Officers, responsible for deploying, managing and operating the smart meter system. This should also improve accountability.

Customer awareness

While operational and economic benefits can be achieved by DISCOMs that follow best practice, for customers to share in the gains requires widespread consumer awareness of the technology. International experience has demonstrated that when utilities do not actively engage with consumers before installing smart meters, there is frequently widespread pushback. This leads to cost overruns, delays and general declines in customer satisfaction. The National Smart Grid Mission has allocated 2 million rupees ($29,759) for each of the 60 state-owned DISCOMs to implement customer engagement programs. Utilities should take this opportunity to ensure their metering rollouts are inclusive of, and beneficial to, all customer groups.

Arbitrary requirements

DISCOMs should refrain from imposing unnecessary requirements on vendors. In the past DISCOMs have demanded that vendors demonstrate positive cash-flow for the preceding six quarters or are jointly responsible for the performance of all vendors within a consortium. Instead, DISCOMs should focus on the experience of vendors and the quality and cost of their products and services.