

ADVANCED METERING INFRASTRUCTURE (AMI)

ROLLOUT STRATEGY FOR INDIA

March 2016

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India Smart Grid Forum

INDIA SMART GRID FORUM

India Smart Grid Forum (ISGF) is a public private 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.

INTRODUCTION

The Ministry of Power (MoP) mandated Central Electricity Authority (CEA) to prepare the functional requirements and technical specifications for indigenous smart meters. CEA released the first edition of the Smart Meter Specifications in June 2013. However, the distribution companies implementing 14 smart grid pilot projects issued different specifications in different states. This issue was brought to the attention of MoP by India Smart Grid Forum (ISGF). MoP requested the Bureau of Indian Standards (BIS) for formulating a national standard for smart meters. Subsequently, BIS assigned this task to the Technical Committee under Electro Technical Division (ETD- 13) to prepare the standards for smart meters.

In August 2015, BIS 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.

Ministry of Power has recently announced the Government's vision to rollout smart metering 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 goal is reiterated in the UDAY program and in the Tariff Policy announced by MoP. In view of the massive investment required for smart metering or Advance Metering Infrastructure (AMI) to cover about 50 million customers in next 4 years ISGF presents an innovative financing and implementation model in this paper.

AMI ROLLOUT FRAMEWORK ON LEASING AND SERVICES MODEL

Considering huge capital investment required for the rollout of millions of smart meters and the present financial health of the electricity distribution companies (Discoms), it is proposed to undertake the AMI rollout on 'Leasing' and 'Service Model' as explained below:

1. Meter Procurement on Leasing Model

It is proposed to engage a nodal agency who will issue tender for procurement of smart meters as per BIS Standards (IS 16444 and IS 15959 – Part 1 and 2). The rates will be finalised on annual basis. Manufacturers with BIS-certified smart meters may be empanelled with rates of meter and different communication devices which the Discoms can choose based on their unique requirements. The cost of the smart meters and cost of the communication devices/Network Interface Cards (NIC) to be specified separately.

Once manufacturers are empanelled, capacities declared and rates finalized (valid for a specified duration), each Discom can buy from these empanelled organisations provided they have the capacity to supply according to the rollout schedule of the Discom.

Since the quantity of the meters to be installed is in tens of millions and the capital expense will be large, neither the meter manufacturer nor the Discom will be able to fund the program. Hence in the interest of faster roll out, it is proposed to have a financial intermediary (a bank, PFC or other financial institutions) who will buy meters and

communication devices from the manufacturers and lease it to the Discoms against a monthly rent for a period of ten years.

2. AMI Implementation and Maintenance on Services Model

AMI involves expertise in three distinct domains, namely, metering, telecommunication and information technology (including both software and hardware). Experience from around the world shows that no one agency could master these distinct components of AMI. Early-mover utilities tried to invest and own all these systems and have seen mixed results. All successful AMI projects have a strong system integrator playing the major role either as a prime contractor or as a utility's consultant (like a Master Systems Integrator) who tests and approves each sub-components of the AMI system and ensures its interoperability and integration with other utility applications.

We propose to appoint a Metering Services Agency (MSA) who will be responsible (along with their sub-contractors and associates) for a variety of functions related to implementation of AMI and its maintenance. Typical scope of services of a MSA would include:

- I. Testing and certification of the meter and communication devices to be procured by the Discom for the defined scope of AMI in a given area/town with chosen communication technology/technologies
- II. Taking delivery of meters and communication devices from the Discom and installing them at customer premise; and return of old meter to the Discom
- III. Establishing and maintaining the last mile communication connectivity for smart meters for a period of at least 10 years
- IV. Selecting the appropriate communication technology for providing a Wide Area Network (WAN)/backhaul network
- V. Leasing of bandwidth (wherever required) and maintaining for 10 years
- VI. Sizing of software and hardware of HES, MDMS and associated IT systems, and providing O&M services for at least 10 years. The MDMS, HES and associated IT systems to be housed at Discom premises or hosted in a sovereign public cloud
- VII. Integrating, testing and commissioning of the entire AMI system
- VIII. Creation of middleware (if required) and integration of MDMS with middleware
- IX. Integration of MDMS with other systems such as billing, collection, connection/disconnection, OMS etc.
- X. Ensuring availability of complete AMI system at mutually agreed Service Level Agreements (SLAs)

The proposed AMI Rollout framework is described below:

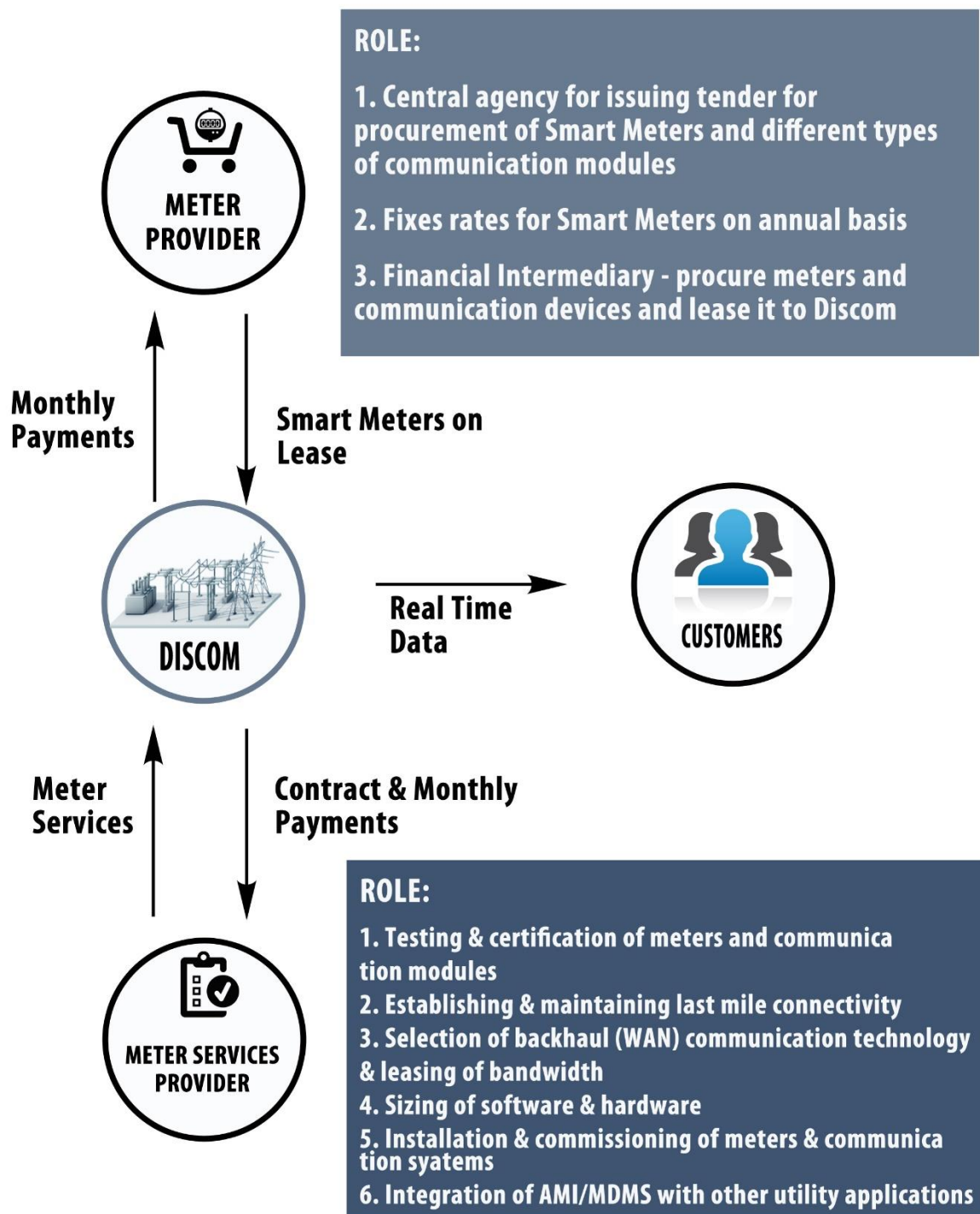


Figure 1: Proposed AMI Rollout Framework

ROLL-OUT PHILOSOPHY

The new Meter Standards (**IS 16444: AC Static Direct Connected Watthour Smart Meter – Class 1 and 2 Specification** and **IS 15959 - Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specifications pertaining to smart metering** have been issued by BIS. All new meters should conform to these standards.

The electricity consumer statistics in India are:

Total no. of electricity connections in India (approx.)	250 million
Total no. of unmetered connections (approx.)	25 million
Households without electricity connection	54 million
Commercial and other establishments expected to be connected to electric grid by 2020	25 -30 million

In order to facilitate large scale deployment of smart meters,

- All feasible communication technologies may be allowed to operate in order to encourage innovation in view of the fact that the communication technologies advance much faster compared to other electrical technologies
- IPv6 shall be made mandatory as this is in line with the IPv6 roadmap of the Ministry of Communications & IT, which states that:
 - All new service provider-owned Consumer Premises Equipment (CPE) deployed after June 30, 2014 to be IPv6 ready
 - Replacement/upgradation of 25% of CPEs by December 2014
 - Replacement/upgradation of 50% of CPEs by December 2015
 - Replacement/upgradation of 75% of CPEs by December 2016
 - Replacement/upgradation of 100% of CPEs by December 2017
- MoP may advise all Discoms to strictly abide by the new BIS meter standards. Hence, all meters procured by Discoms may be IS 16444 and IS 15959 compliant
- A neutral agency may be appointed to assess the efficacy of the various communication technologies deployed in successful AMI projects around the world and in pilot projects in India and prepare a technology selection guide and roadmap for smart meter deployments in the country
- Neutral agencies may be engaged for customer awareness and engagement programs related to smart metering and smart grids
- Discoms to deploy smart meter on such feeders that have a large number of customers with monthly consumption greater than 500 kWh. Subsequently, customers with monthly consumption lesser than 500 kWh may be deployed. **Deployment to be done on feeder-wise and NOT customer-wise so that the last mile communication network can be established and maintained at reasonable cost**
- As per IS 16444, the communication module has to be a part of the smart meter (either in-built or pluggable units). Hence retrofitting will not be possible. This was a decision taken by the technical committee at BIS as the stakeholders cited the following concerns if the communication module is retrofitted on existing meters:

- Theft of communication module
- Increased points of failure
- The unsuccessful use case of AMR in R-APDRP (where meter manufacturers were blaming the MODEM makers who in turn blamed the telecom network operators for poor bandwidth and vice versa)

Sending engineers and technicians to customer premises again and again to check and rectify the meter-modem-bandwidth issues is several times more expensive than the cost of new meter and communication device. **Hence retrofitting communication modules on already-installed meters should not be practiced.**

COST ESTIMATE

Following cost has been considered for the modelling exercise (for a customer base of 1 million):

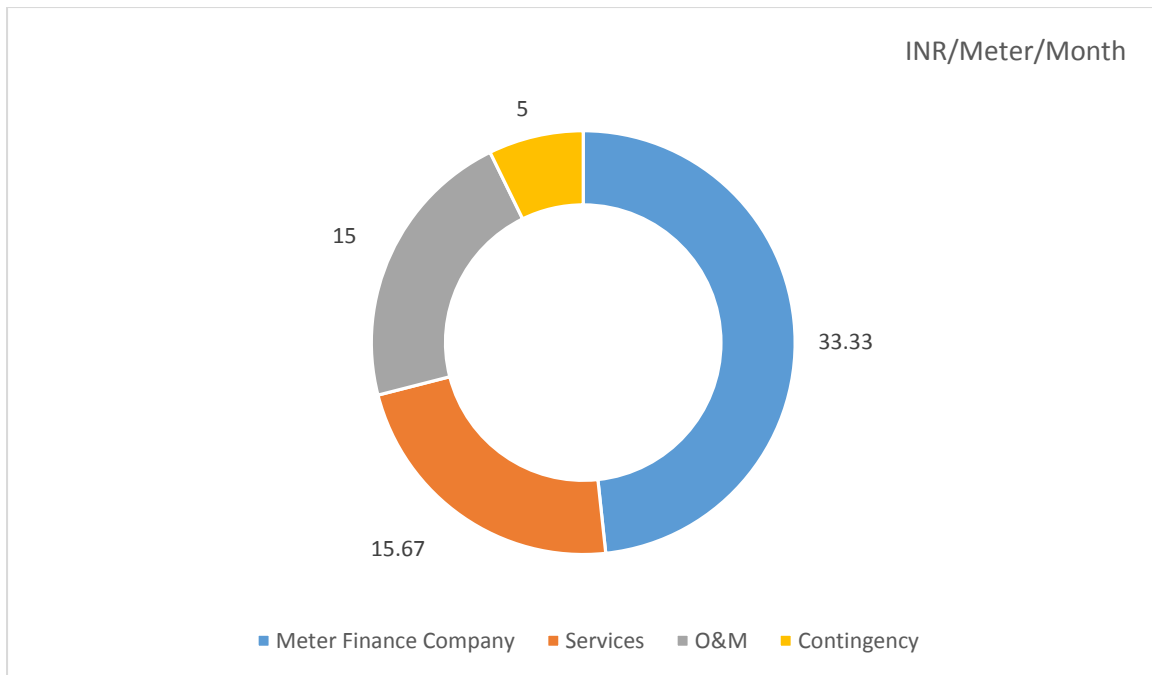
A	ITEMS	Unit Cost (INR)	Quantity
1	Capital cost per meter	1250	1 Million
2	Communication Module	1000	1 Million
3	DCU	50000	5000
4	Meter Box & Installation Charges	1000	1 Million
5	DCU & COMMS Installation, Testing and Commissioning Charges	5000	5000
6	Computer hardware and software and networking equipment	50000000	Lump sum
7	Head End and Operating System Software and MDMS	40000000	Lump sum
8	System Integration	50000000	Lump sum
9	Misc	10000000	Lump sum

Discoms and Metering Services Agencies could opt for Sovereign Public Cloud as a service which will provide scalability on demand and reduce overall costs of owning and managing captive IT infrastructure. Adoption of public cloud will convert hardware and software Capex to Opex which will help utility to streamline their cash-flows and also helps with business continuity. Discoms could consider cloud providers offering sovereign secured public cloud services complying with ISO: 27018 security and privacy standards. With the explosion of metering data over years, Discoms can look at advanced metering analytics on cloud for decision support systems to remove capacity constraints. This is the recommended robust and scalable model for long term business continuity with optimal costs.

Discoms with existing DC/DR could also look at hybrid cloud models which allow seamless migration of virtual machines between on-Premise DC and Public Cloud and can plan for the metering data storage and analysis on cloud to win over capacity constraints.

Depending on the SLA, geographical conditions and other requirements of the Discoms, it is feasible to undertake AMI implementation on LEASING and SERVICES MODEL at approximate cost of INR 69/meter/month (16% RoI on capital cost for ten years).

In the calculation presented in this model, we have not considered cost of 3 phase meters as in case of 3 phase smart meters, only the cost of meter will vary and rest all components (including communication devices) will remain same. As the 3 phase customers are higher income groups and are much less in numbers as compared to single phase customers, Discoms may recover the marginal cost of the 3 phase meter (over and above Rs 69/month/customer) from the 3 phase customers.



Details given at Appendix-A

CONCLUSION

From our studies and analysis, we have reason to believe that it is possible to undertake AMI rollout on the suggested framework at a cost of INR 69/month per customer. We suggest splitting this amount between Discoms and the customers. Discoms obviously stand to gain from accurate meter data, avoided meter reading expenses, human errors and fraud, faster detection of outages and restoration etc. Hence, Discoms should bear 50% of the cost – say INR 35/customer/month. For customers there are several benefits in terms of availability of energy consumption data that can help save energy, options to save money by shifting certain consumption to non-peak hours at lower tariff slabs (possible with ToU tariff), reduced billing errors, faster restoration of outages, remote monitoring and control of smart appliances etc. A customer with monthly consumption of 500 kWh pays average INR 2000 or more per month today and an increase of INR 34/month should not upset their monthly budgets. Once large scale deployments starts, the prices of equipment and systems are expected to come down so that by the time we approach customers with monthly consumption below 200 kWh, the cost indicated here may be nearly half. It is recommended for Discoms to consider adopting sovereign secured public cloud infrastructure for AMI deployment to reduce CAPEX further. There could be innovative business models where in third party players might step in to offer a variety of services which could absorb the entire AMI cost - **the smart meters could evolve as a smart hubs that could offer several other services to the customers**. We believe that market forces and innovation will evolve in this direction at a fast pace once we unleash this revolution – 300 million smart meters in India in next 5-7 years!

Notes:

1. *One million smart meters polling sending data at 15 minutes interval (96 times in 24 hours) with 1.5kb/ per poll generates 5GB data per month which needs to be retained for at least 7 years as per guidelines of the Govt. This is base raw data and will need further storage and computing power for analytics which will run in to Petabytes over the years and Discoms would find it impossible to handle it with in their own data centres; hence we recommend sovereign public cloud.*
2. *Smart Hub is customer premise equipment that is connected to the electricity network and the telecom network which could act as a smart meter (or collect the meter data and send to the Discom) as well as offer telephony, internet, IP TV and several other services to the customer.*

APPENDIX A – FINANCIAL MODEL FOR ADVANCED METERING INFRASTRUCTURE ON LEASING & SERVICES MODEL

Typical cost would include:

- Cost of meter (without communication module)
- Cost of communication module
- Cost of DCU/gateway/router
- Cost of meter box
- Cost of meter installation
- Cost of MDMS
- Cost of HES
- O&M expense
- Cost of server
- Cost of storage
- Cost of operating system
- Cost of database
- Cost of system integration
- Cost of network installation (LAN and WAN)
- Annual Maintenance Charges (AMC) on software Licence Fee to software OEMs (average 22% of licence fee per annum for 3 years)
- Application Maintenance Support (AMS) to System Integrators (average 10% of SI charges per annum for 3 years)
- Annual Maintenance on Hardware (average 5% of hardware cost for 10 years)

Return on Investment - 16% p.a on capital cost for ten years.

In this model we have considered only a single phase smart meter (without net metering) purchased at Rs 2250 including the chosen communication module. It is assumed that bulk procurement will reduce the cost of smart meters. Also, we have considered one DCU per 200 smart meters. On the Leasing and Services Model, the monthly charges work out to Rs 69/meter/month.

The following table contains the detailed financial model:

All cost figures in INR

ASSUMPTIONS						
Total number of customers			1000000			
PART A: Meter Finance Company						
A	METER		Unit Cost	Quantity		Cost for 1000000 customers
1	Capital cost per meter		1250	1 million	Cost/Meter	1250000000
2	Communication Module		1000	1 million	Cost/Meter	1000000000
3	Per Meter Cost (with communications module)		2250	1 million	Meter	2250000000
4	DCU		50000	5000	Nos.	250000000
5	Total Cost		-	1 million	Meter	2500000000
6	Paid Amount @ 16% ROI		33.33	1	Meter/Month	-
PART B: Services						
7	Meter Box & Installation Charges		1000	1 million	Meter	1000000000
8	DCU & COMMS Installation Charges		5000	5000	DCU & COMMS	25000000
9	Computer hardware and software and networking equipment	Additional racks, servers and storage, operating systems, database, UPS etc. This will be housed in the Data Centre and DR Centre of the Discoms	50000000	1	LS	50000000
10	Head End and Operating System Software		20000000	1	LS	20000000
11	MDMS		20000000	1	LS	20000000
12	System Integration		50000000	1	LS	50000000
13	Misc		10000000	1	LS	10000000

14	Cost		1175	1	Meter	-
15	Paid Amount @ 16% ROI		15.67	1	Meter/Month	-
PART C: Operation & Maintenance						
16	Maintenance Charges Per Meter Per Month including bandwidth		15	1	Meter/Month	-
17	Contingency		5	1	Meter/Month	-
TOTAL COST TO UTILITY						
	Total Cost Per Meter Per Month		69.00	1	Meter/Month	-