



Ministry of Power
Government of India



HANDBOOK ON SMART METERING

Technical and business perspective: Launch during Conference

Objective of this handbook:

The objective of this hand book is to provide a platform for understanding Smart and prepaid metering requirements, and deployment approaches in Indian context. This handbook also highlight various aspects of metering including new and emerging technologies, design and testing, data acquisition and management, and smart applications.

The role of metering in India has evolved significantly over the years. Apart from assisting DISCOMs in energy accounting and revenue management, it plays a crucial role in improving billing efficiencies, integration of renewable energy and load management. As per government directives, no new connections are to be released without meters. At the Conference of Power and New & Renewable Energy Ministers of States and UTs held on December 7, 2017, the government reiterated the need to adopt prepaid and smart meters to bring down the AT&C losses. The installation of prepaid meters has been made mandatory for various government departments. Few of the states have already initiated the installation of smart meters. With increase in the deployment of smart meters,

there will be huge volumes of data available with the utilities. Going forward, Smart Metering and AMI is expected to be the key focus area of the DISCOMs. To facilitate the implementation of AMI in India, CEA (Central Electricity Authority) has formulated guidelines on the functional requirements of AMI as well as advised the states about the roll-out strategy. AMI is also being demonstrated as a key component of the smart grid pilot projects funded by the Ministry of Power. Another subsequent need in the metering segment is for net meters. Net metering assumes a critical role in light of the 40 GW solar rooftop capacity target to be achieved by 2022. Further, a number of issues including interoperability, standardisation and quality of meters, meter tampering and power theft continue to afflict the segment. Meanwhile, the implementation of advanced metering technologies as part of the 14 pilot projects along with 5 million Smart metering rollout in selected towns of UP and Haryana by EESL and the development of innovative business models are likely to provide the necessary push for a faster adoption.

<Quote from NDMC Chairman> to be filled by EESL

<Quote from UPPCL PS> to be filled by EESL

“In next three years metering will go smart prepaid, and gone will be the days of bills reaching your house. So need of the hour is to scale up manufacturing of smart prepaid meters and to bring down their prices,”

Hon. Power Minister Sh. R. K. Singh, June 07, 2018

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1. What is a Smart Meter?

BIS has defined **Smart Meters** as a basic static watt-hour meter with time of use registers, internal connect and disconnect switches with two way communication capacity. In addition Smart meters provide facility for remote diagnosis, near real time events and alarms and remote firmware upgrade to cater a feature request or a bug fix. Smart meters also support prepaid mode, with Time of Day (ToD) tariff along with net metering for supporting micro-grids. However, Smart meter is not a panacea but a tool of information on which analytics can be applied to achieve desired objectives.



Figure 1: Smart Metering Components

“We have committed to raising billing efficiency, which means monetizing the cost required to bill and also resolving inefficiencies like under or inadequate billing, thereby increasing revenues for the DISCOM,” – Saurabh Kumar, Managing Director, EESL. 17th Aug, 2017.

2. How will SM implementation impact DISCOMs?

“We have committed to raising billing efficiency, which means monetizing the cost required to bill and also resolving inefficiencies like under or inadequate billing, thereby increasing revenues for the DISCOM,”

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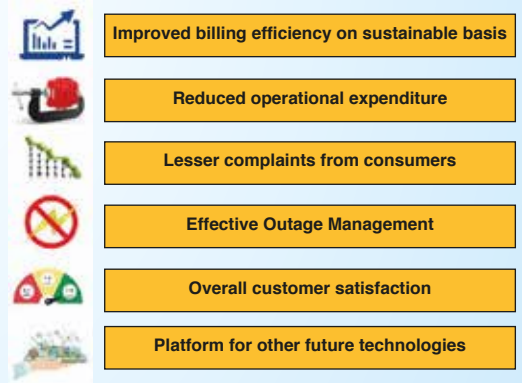


Figure 2: Impact Areas

3. Benefits of Smart Metering

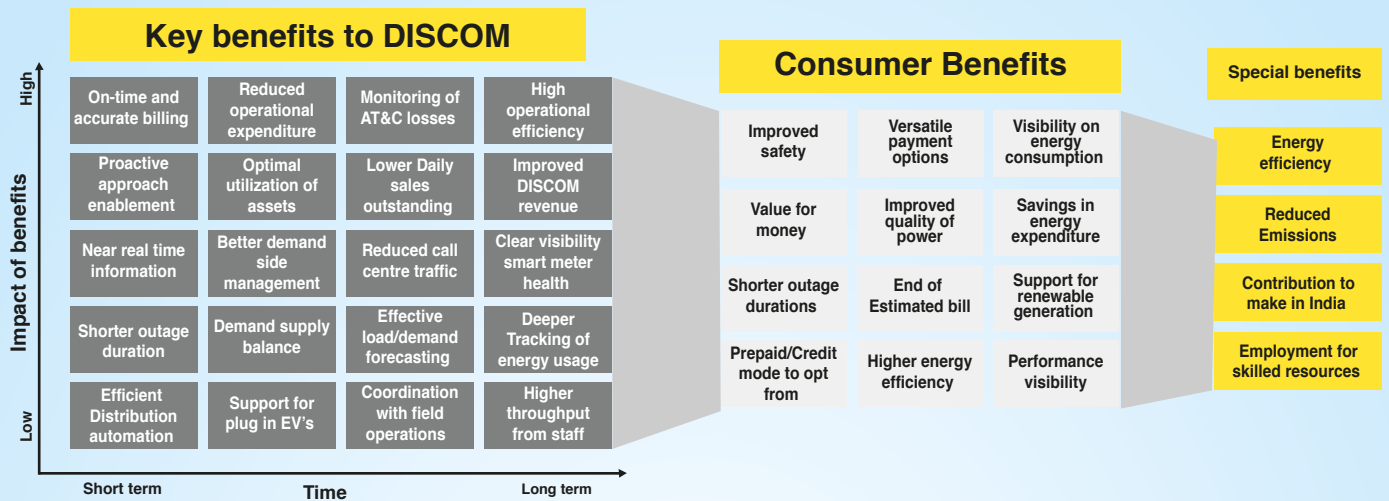


Figure 3: Illustrative Benefit to Stakeholders

It is observed globally that smart metering provides a range of benefits from supporting network optimization and controlling energy consumption to securing cash collection and cutting non-technical losses. However, at the same time, managing this transformational effort presents major strategic, operational and technological challenges. This presents DISCOMs with multiple new challenges, which requires expertise that are fit for purpose.

"With better complaint management, the state's grid will also achieve faster restoration from outages, while delivering improvements in system stability, reliability and transparency," - **Saurabh Kumar**, Managing Director EESL. 11th Jul, 2018.

Benefits of Smart Metering can be broadly categorised into 3 parts:

1. Benefits to DISCOMs: There will be short term benefits and long term benefits having low and high impact on DISCOM or Utility business. In the beginning phase of Smart metering implementation once the data will be available in DISCOM systems, the quick wins would be in the form of As the implementation gets matured with more data points in the form of Smart meters deployed in the field, DISCOMs will observe better demand side management, optimal utilization of assets This will have cascading improvement in effective load/demand forecasting, accurate monitoring of losses and which will strengthen one of the key objective of Smart metering i.e., customer satisfaction. In long term DISCOMs will be benefitted with enhanced throughput from DISCOM staff, improved revenues and higher operational efficiency. Power procurement process can also be optimised with all the relevant information available with DISCOM whenever it is required. DISCOMs will have a wider range of services for consumers in terms of prepaid metering and net metering. Smart Metering will also contribute to working capital availability for DISCOMs.

2. Benefits to consumer: End consumer will be benefitted on the grounds of safety, value for money, shorter outage durations and metering options to choose from (pre-paid or post-paid) supported convenience given by multiple platforms for payment or recharge. Further Consumers will get improved power quality, monitoring of energy usage and an overall visibility on energy consumption. There will be no need of an additional meter for measuring energy from solar panel. Smart metering will be a cost effective solution for both Consumer and Utility

3. Benefits to society: Smart metering implementation will benefit society on the policy initiatives like contribution to make in India, and employment for skilled resources energy efficiency. From environmental perspective, Smart Metering can contribute towards reduced carbon emissions and improved energy efficiency.

4. Smart Metering Journey for India

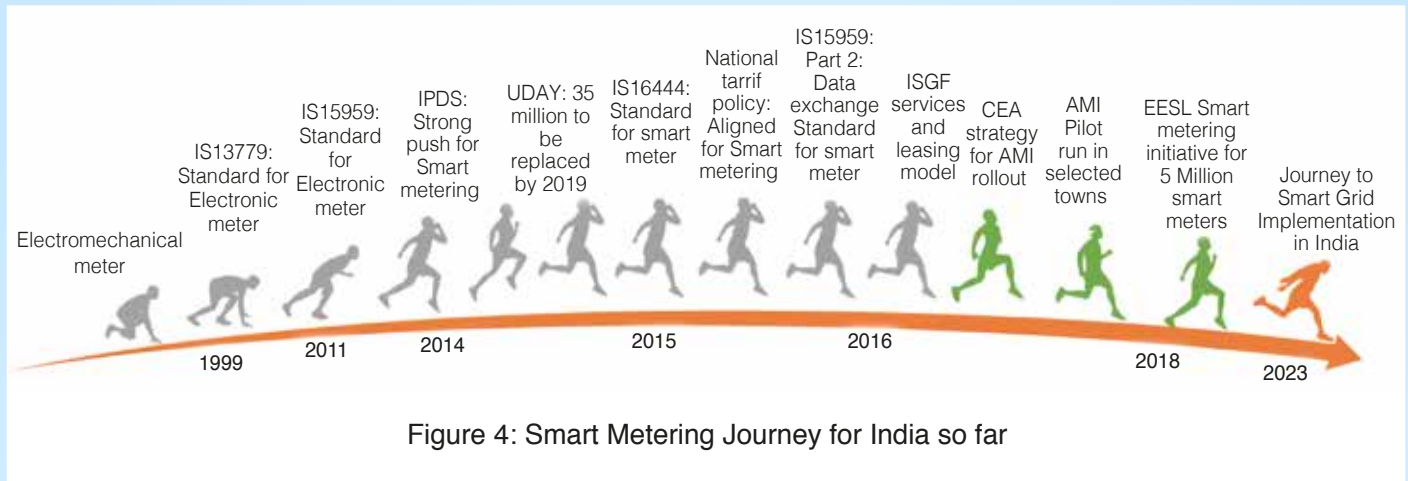


Figure 4: Smart Metering Journey for India so far

The Ministry of Power (MoP) has been proactive in issuing policies and directives for benefiting the nation. This journey started long back with the introduction of electronic meters. Later on, The Central Electricity Authority (CEA) guidelines have mandated the use of static meters, have seen the Indian energy meter market shift largely to static meters from earlier electromechanical meters. Standards for IS13779 were published by The Bureau of Indian Standards (BIS) to defined specifications of static watt-hour meters.

Later on, The Bureau of Indian Standards (BIS) has published standards for smart metering (IS 16444 in August 2015 and IS 15959 Part 2 in February 2016) and the Central Electricity Authority (CEA) has published functional requirements of AMI and technical specification of smart meters in August 2016.

The National Tariff Policy released in January 2016 re-stated this deployment plan. Another

key landmark was the publication of the AMI rollout strategy by CEA in September 2016 which stated that deployment of smart meters to be done area-wise or feeder-wise instead of segregated deployment based on monthly consumption.

Recently, Energy Efficiency Services Limited (EESL) has led to a disruption in the smart metering market in India by releasing tenders for procuring 5 million smart meters (certified as per IS 16444) and associated IT applications for selected towns in Haryana and Uttar Pradesh states of India. The key principle behind this move is to aggregate the demand thereby leading to a reduction in cost. This will be accelerated by introduction of other similar companies in smart Metering deployment.

Ministry of Power objective is to rollout 250Mn smart meters across India so as to bring sustainable operational and financial turnaround of DISCOMS.

5. Government of India initiatives on Smart Metering

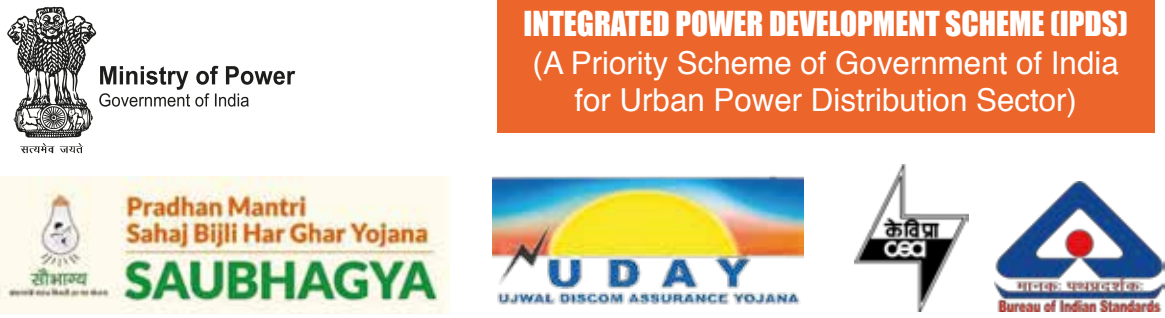


Figure 5: Flagship programs of GoI around smart Metering

Driving forces behind Smart Metering and AMI:

Demand on our electricity system is growing

According to Central Electricity Authority (CEA), Electrical energy requirement in the next 10 years is expected to grow by 79%. The country will need 1,743 billion units (BU) of energy in the FY27. Energy requirement in FY17 was close to 1,142 BU. The report noted that energy efficiency schemes and aggressive demand side management would lead to savings of 206 BU in FY22 and 273 BU in FY27.1

Technology Need:

Today's technology is more reliant on electricity than ever before, but our grid structure remains unchanged. Fuel operated appliances are gradually shifting towards electricity, e-vehicles are the best example.

Optimization of DISCOM operations

Optimisation of operating expenses and management of capital expenditure is the need of the hours for DISCOMs. Further to avoid any risk on the regulatory aspect in terms of outage time, cost to serve, compliance and emission reduction, Smart metering can be very beneficial.

The Government of India (GoI) announced the UDAY program for financial restructuring and performance enhancement of electricity distribution companies (DISCOMs). Under UDAY, GoI mandated DISCOMs to deploy smart meters (conforming to latest Indian Standards IS 16444 and IS 15959 Part-2) for all customers with monthly electricity consumption above 200 kWh. In the Electricity Tariff Policy announced in February 2016, GoI reiterated the goal of smart meters envisaged in the UDAY program. It is estimated that there are about 35 million customers who consume above 200 kWh/month. The onus is now on the state government owned DISCOMs to choose the most optimum deployment strategy. While the traditional AMI approach is to deploy smart meters for all customers on a feeder, another option is to deploy only for customers having monthly electricity consumption greater than 200 kWh. Thirty one states have joined the Ujwal DISCOM Assurance Yojana (UDAY) program which is likely to result in a potential deployment of about 35 million by December 2019.

Ministry of Power, Government of India notified "Integrated Power Development Scheme" (IPDS) on 3rd December'14 with clear objectives around Strengthening of sub-transmission and distribution networks in the urban areas, Metering of distribution transformers / feeders / consumers in the urban areas, IT enablement of distribution sector and strengthening of distribution network under R-APDRP for 12th and 13th Plans by carrying forward the approved outlay for R-APDRP to IPDS, Schemes for Enterprise Resource Planning (ERP) and IT enablement of balance urban towns are also included under IPDS. RAPDRP part A include AMR of HT and DT meters. Scope of IT enablement has been extended to all 4041 towns as per Census 2011, underground cabling to include additional demand of States and smart metering solution for performing UDAY States and Solar panels on Govt. buildings with net-metering are also permissible under the scheme wherein all DISCOMs will be eligible for financial assistance under the scheme. Funding pattern for IPDS would be Government of India Grant = 60% (85% for special category States) and Additional Grant = 15% (5% for special category States) - linked to achievement of milestones.

6. Building blocks of Smart metering architecture

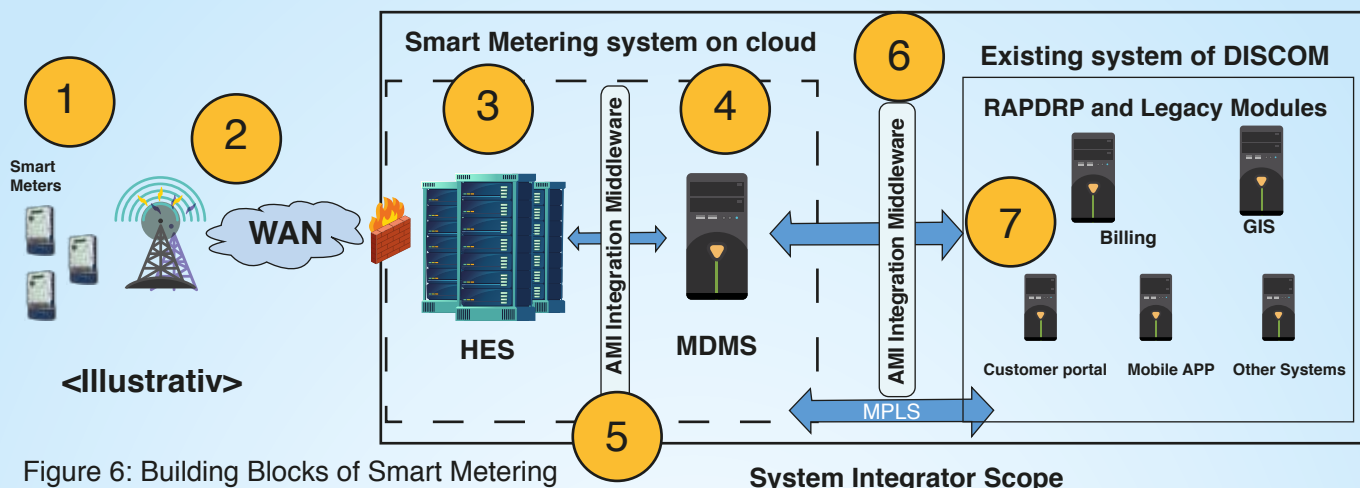


Figure 6: Building Blocks of Smart Metering

System Integrator Scope

1	Smart Meters
2	Communication Infrastructure
3	Head End System Software (HES)
4	Meter Data Management System (MDMS)
5	Integration between HES and MDMS
6	Integration between MDMS and DISCOM system (billing etc.)
7	DISCOM system (billing, customer portal, etc.)

Smart metering System Software will be hosted over cloud and MPLS connectivity can be provided to the DISCOM's existing data centres.

End to end Smart metering system consists of Smart Meter to two way-communication network to control center equipment and all the applications that enable the gathering and transfer of energy usage information in near real-time. The objectives of Smart Metering can be remote meter reading for error free data, network problem identification, load profiling, energy audit and partial load curtailment in place of load shedding.

Smart Meters- Smart meters in India need to be compliant to IS16444, IS15959 and BIS certification. Smart meters have the capacity to collect information about energy usage at various intervals and transmitting the data through fixed communication networks to utility, as well as receiving information like pricing signals from utility and conveying it to consumer. Smart meters are also compliant to prepaid and net metering

Communication Network: Advanced communication networks which supports two way communication enables information from smart meters to DISCOMs IT systems and vice-versa. Networks such as Fixed Radio Frequency or public networks, GPRS, 3G/4G, LTE, Broadband over PowerLine (BPL), Power Line Communications (PLC), fiber Optic Communication, are used for such purposes. Futuristic technologies like NBIoT are also being explored for the purpose of faster and reliable communication.

Head End System- Software applications hosted over cloud, designed and developed for communicating with the Smart meters and receiving scheduled data from Smart meters on a predefined frequency. Head end system remains as an interface between Smart Meter and AMI systems. Further Head end system ensures security and scheduling of activities with Smart Meters.

Meter Data Management System (MDMS): Host system which receives, stores and analyses the metering information and provide billing determinants to the DISCOM billing systems for generation of bills. Further MDMS also does validation, estimation and editing of consumer data and generates different reports for further actions to be taken by DISCOMs.

Cloud: AMI software can be hosted over virtual machines called cloud hosting infrastructure. Cloud hosting provide additional security and scalability features with ease of maintenance.

7. How does Smart Pre-paid Metering works

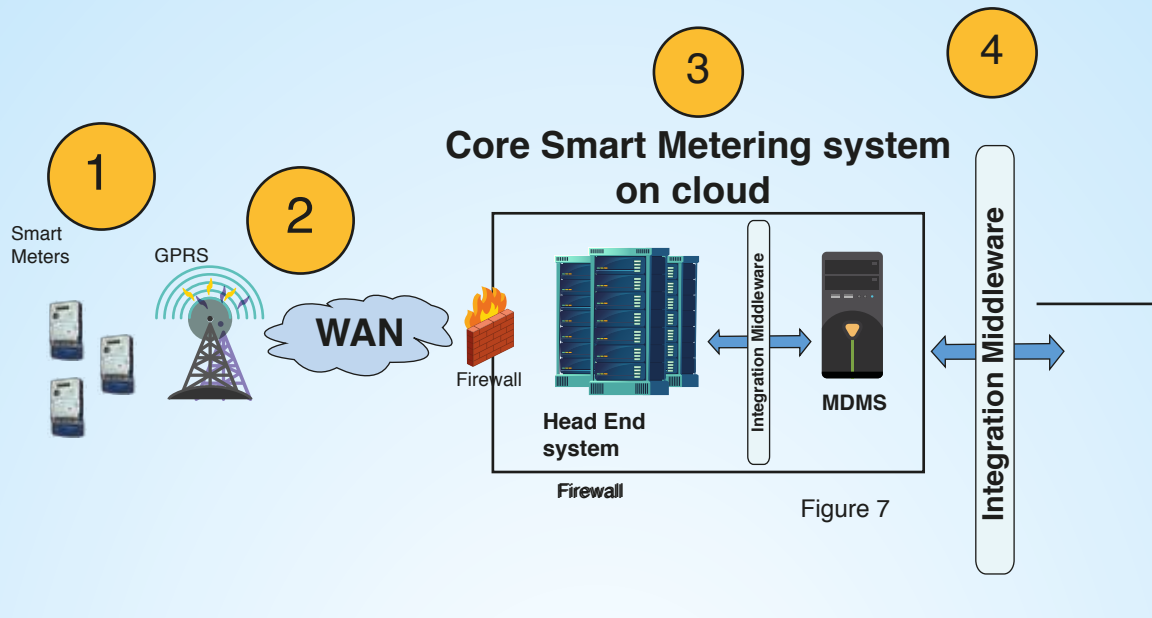
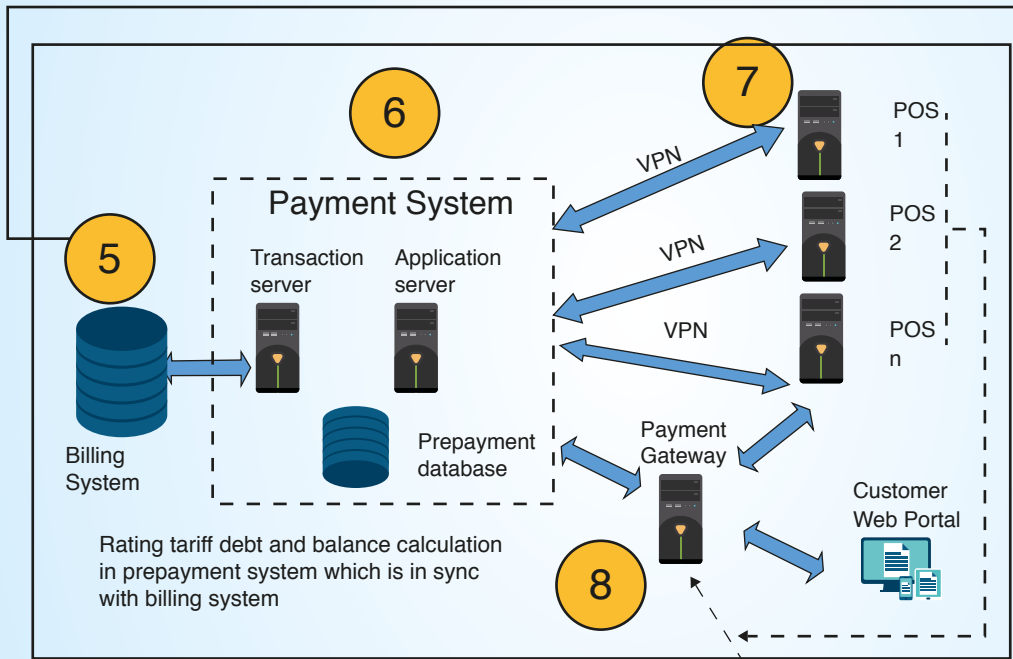


Figure 7



Key Pointers:

1. DISCOM backend system need to be equipped with prepayment infrastructure including servers for application, database and transaction which is connected with Point of Sale (POS) terminals and other recharge mechanism like web portal/mobile app etc.
2. With slight logical modification in CIS and billing system of DISCOMs, prepayment can be initiated.
3. Consumer can recharge through POS or Internet using web portal/Mobile application etc.
4. Cash flow for DISCOM in case of pre-paid metering will be almost similar to the existing billing cash flow

1	Smart Meters
2	GPRS communication infrastructure
3	Smart Metering system software
4	Integration with DISCOM CC&B system
5	Oracle CC&B (DISCOM)
6	Prepayment System Software
7	Prepayment mechanism
8	Payment Gateway
9	DISCOM accounts in bank



“Just like you recharge your mobile, you will be able to recharge electricity. This will make it viable for the poor. With this pre-paid facility, the consumer will not get disconnected,” –**Hon. Power Minister Sh. R. K. Singh.**

8. Interoperability: Important point to be thought upon



Interoperability is the ability of two or more devices, systems, networks, applications or components to seamlessly exchange information and complete the desired action. In the current context of Smart Metering, Interoperability has been considered as a very critical factor for ensuring sustainability and optimal utilization of the hardware, software and infrastructure deployed. **Proposed AMI system of EESL Smart metering is capable of integrating with n types of Smart Meters with GPRS as communication media.**



Figure 6: Interoperable model (Illustrative)

Implementation model for Interoperability

Interoperability layer	Key tasks	Advantages
Layer 1 Meter level interoperability (Mandatory)	<ol style="list-style-type: none"> 1. Define standards for NIC card. 2. Meter manufacturers can provide meters basis NIC standards. 	<ol style="list-style-type: none"> 1. Availability of multiple Meter manufacturers. 2. Scalability from meter point of view. 3. Moderate system lifetime cost.
Layer 2 NIC level interoperability (Mandatory)	<ol style="list-style-type: none"> 1. Ensure meter level interoperability is in place. 2. Define specifications for communication network 3. NIC manufacturers can provide interoperable NIC 	<ol style="list-style-type: none"> 1. Complete elimination of vendor lock-in 2. Most scalable solution. 3. Least system lifetime cost.
Layer 3 System level interoperability (Optional - Can be decided basis results of Layer 2 implementation)	<ol style="list-style-type: none"> 1. Defining standards for common HES and MDM. 2. Defining standards for vending. 3. Integration with minimal changes in existing DISCOM operating processes. 4. Ensure cybersecurity at all level. 	<ol style="list-style-type: none"> 1. Common Head end system and MDM. 2. Prepayment vending from multiple sources. 3. Single system to be used by DISCOM for Prepaid and Smart metering

9. Roadmap for DISCOMs to implement Smart Metering

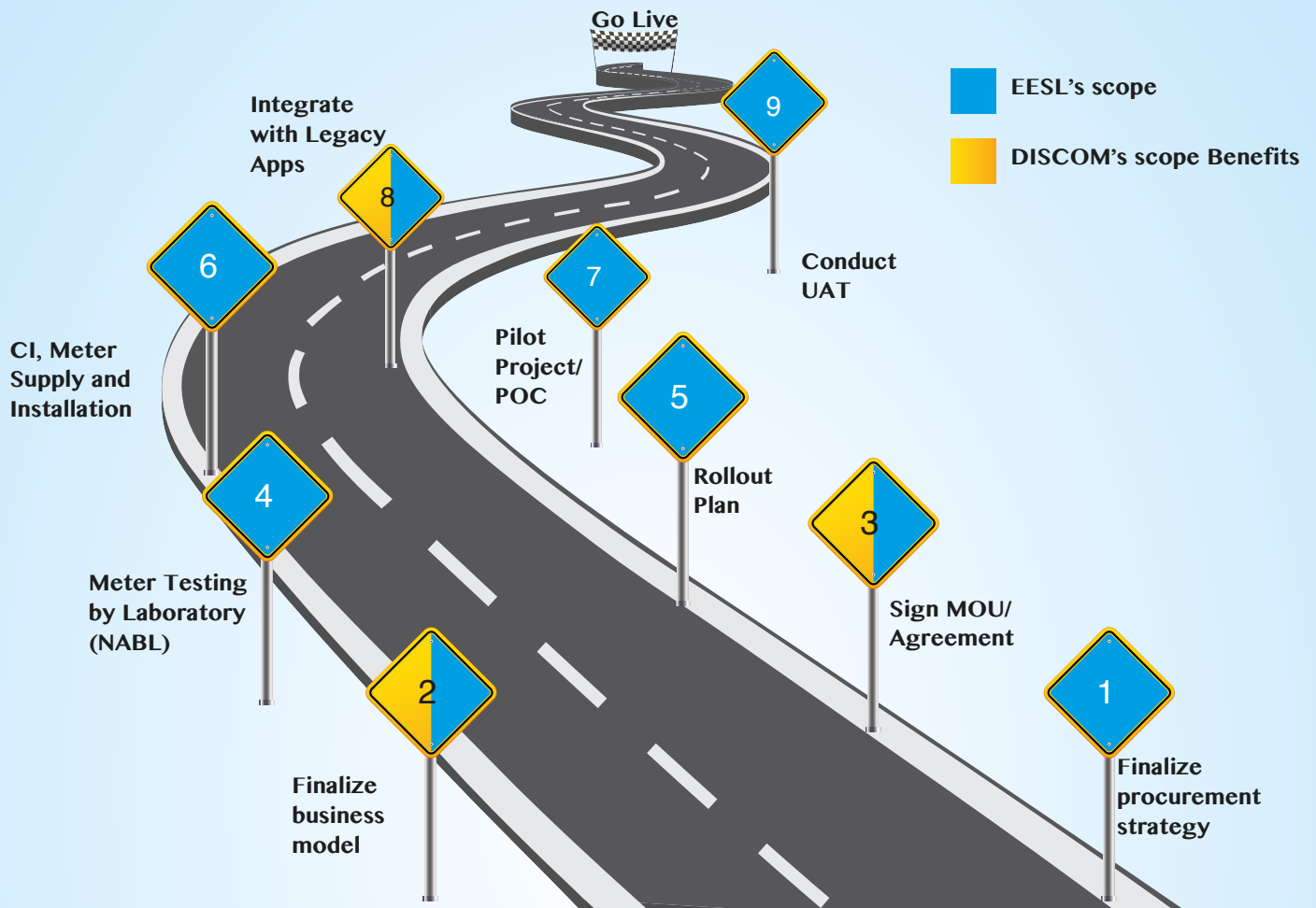


Figure 7: Roadmap for DISCOMs for implementing EESL's Smart metering model

DISCOMs can opt following methodology for effective adoption and deployment of Smart Metering system:

1. Finalize procurement strategy for various components of Smart metering
2. Finalize business model for the project
3. Sign MOU / Agreement with Smart metering Implementing Agency
4. Ensure testing of meters (NABL) and required BIS certification.
5. Prepare detailed rollout plan for Smart metering deployment
6. Prepare plan for CI, Meter Supply and meter installations
7. Pilot project for proof of concepts
8. Co-ordinate with Smart metering Implementing Agency to integrate with existing legacy systems.
9. Conduct user acceptance testing (UAT) on sample cases
10. Declare Go Live (post successful UAT)

10. EESL's Smart metering model

Under the SMNP, EESL is implementing its proven model of bulk procurement, aggregation of demand, and monetization of savings to roll out smart meters. This roll-out is proposed under the Build-Own-Operate-Transfer (BOOT) model, wherein EESL will undertake all the capital and operational expenditure with zero upfront investment from states and DISCOMs. EESL will therefore, receive a nominal Internal Rate of Return that is reflected in a mutually agreed upon, automated payback structure.

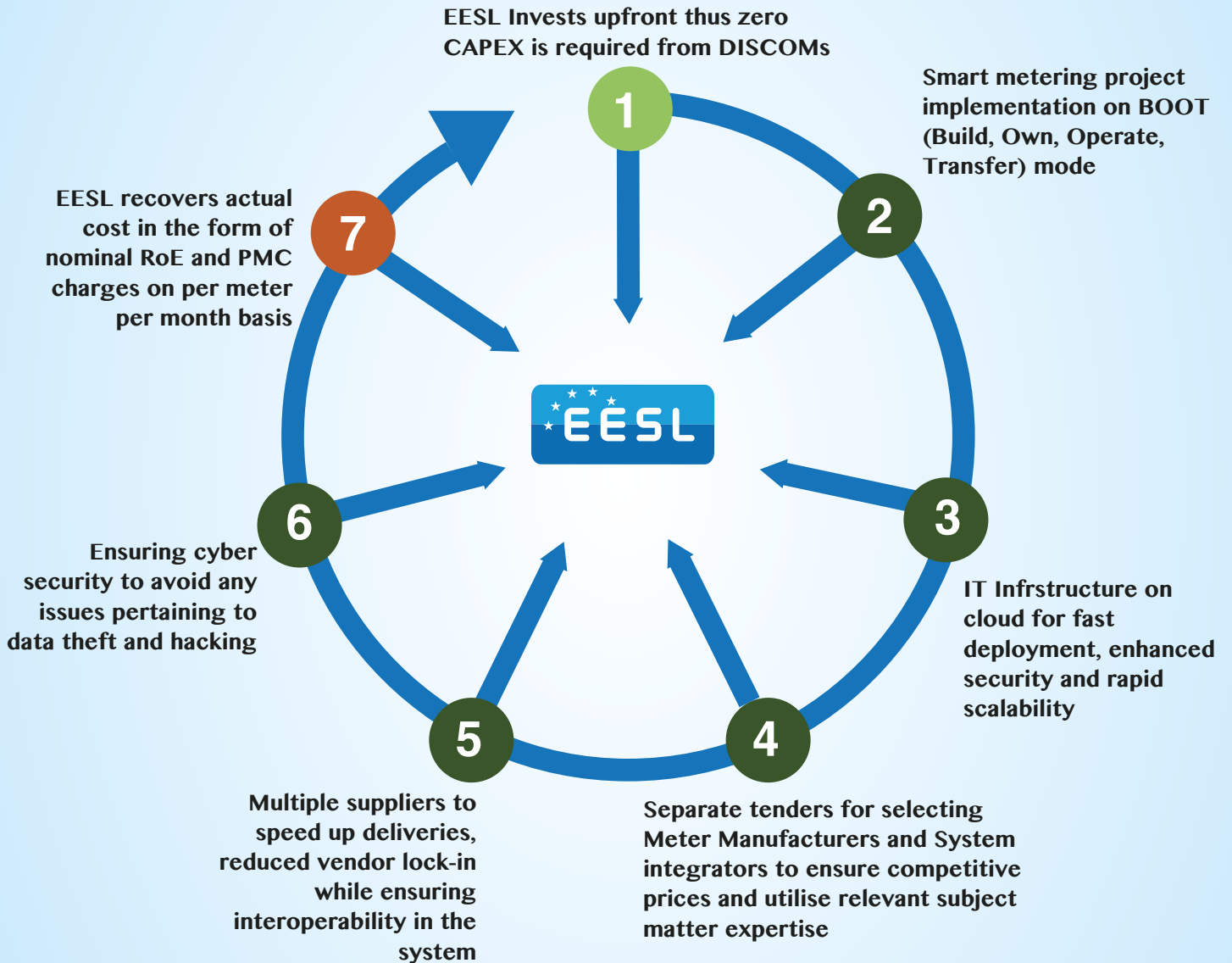


Figure 9 EESL Business Model

- EESL Benefits
- Joint Benefits
- DISCOM Benefits

11. EESL's Financial Model



1. Smart meter/ AMI equipment cost
2. IT system cost
3. Consumer Indexing and Training
4. Installation and Integration cost

1. Operations and Maintenance charges
2. Annual Technical Support charges
3. Recurring operating cost on GPRS
4. Cloud hosting charges

EESL financial model address following key challenges

1. Unavailability of High CAPEX at DISCOMS for such programs
2. This monthly outflow will become self-sustainable due to the benefits Smart meters bring to the DISCOMS in terms of increase in billing efficiency
3. Pre-payment functionality of Smart metering system will increase collection efficiency, reduction of revenue management costs, increase in operational efficiency in overall business process and increasing customer satisfaction.
4. Flexibility to DISCOMS on investing part of CAPEX to bring per meter per month rental down and reap the benefits on capital cost.

Increased adoption of smart meters in a country with the size and population of India can create bulk demand and facilitate economies of scale in reducing manufacturing costs. Smart meters thus not only act as a pathway to resolve DISCOM woes with newfound efficiencies but can create an entire non-existent domestic smart meter industry. This will be hence aligned to “Make in India” objective and will create jobs.

EESL envisages aggregation of demand from various states which has already resulted in 20% reduction in prices in 2nd phase for smart meters. Under the aegis of Ministry of Power, aggregation of demand of various states if done, will greatly benefit the SNMP and give boost to the industry for deploying infrastructure required for this programme.

12. Key features of EESL Memorandum of Understanding (MoU)

The MoU covers the understanding between EESL and DISCOM regarding their intention to enter into transaction or service pertaining to smart metering solution implementation. Key features of MoU include

- 1. Implementation Methodology:** Smart metering system solutions, Criterion for load growth, Smart Metering Rollout and Project Management, Operations Management, Common scalable IT solution for catering aggregated demand of different states coupled with cyber security, standardization of business processes
- 2. Business Model:** Based on Cost-plus model, Upfront investment, Payment claims based on CAPEX, OPEX, RoE, PMC etc. resulting in enhanced efficiency for overall operations of DISCOMs and additional revenue generation for DISCOMs after discounting the cost of the project.
- 3. Project timelines:** Clear defined timelines for Built-up / Go live phase, Operations and Maintenance phase (O&M) along with key activities involved.
- 4. Roles and Responsibilities of stakeholders:** This part consist of detailed responsibilities of DISCOM, detailed responsibilities of EESL, Service Level agreement and associated payment terms.
- 5. Business and functional proposal:** Proposal covering technical, commercial and financial details, on-binding MoU for future cooperation and General terms and conditions are mentioned in this section.

13. Service levels in Smart Metering

Service level agreement plays a very crucial role in assuring quality of hardware, software and operations of the system. Service levels need to be defined considering all possible aspects of the project pre-rollout and postrollout of Smart Metering System. Service levels should cover the deliverables of all the parties involved and contributing to the success of the project and should be system generated and measurable

System Integrator SLA		System Integrator SLA	
<p>Meter SLA are defined around:</p> <ul style="list-style-type: none"> a) Delivery of meter b) Meter failure rate c) Replacement of faulty meters d) Meter software support e) Sim care update If needed f) Deployment of bidder representatives during projects 	<p>Availability services levels:</p> <p>This Service level is defined to ensure HES/MDMS/VPN connectivity will be available 24 hours a day 7 days a week (Normal Service Hours); except for scheduled maintenance will be in accordance with agreed date and time</p>	<p>Operational service levels:</p> <p>This group of service levels are defined for monitoring and measurement of operations carried out at HES, MDM, applications, deployment, release management, change management reporting and dashboard performance timelines.</p>	<p>Other service levels:</p> <p>This group include service levels related to:</p> <ul style="list-style-type: none"> a) Cloud services b) FMS (facility management system) c) Vulnerability management. d) Security incident and management reporting <p>*above SLAs are measured under defined severity levels</p>

FAQ's:

01

What's the suitable Business model - "High capex- Low Opex" or "Zero capex- High Opex" or Hybrid? What funds do I have for this project (IPDS, NSGM, Smart City, etc)

02

What are the key business driver to implement Smart metering in DISCOM (Loss, billing, customer satisfaction, Smart grid, VAS, PLM etc)? What's next once this is done.

03

How will this implementation impact by tariff and to what extent?

04

What is my selection criterion for city / feeder / DT / number of consumers- Drivers, Guidelines (CEA, NTP, Uday etc)?

05

What is best solution for me- Post-paid, Pre-paid or both; what does regulator suggest?

06

Which coms should I go for- GPRS or RF or LORA or Hybrid- Shall I define or leave it to SI

07

What the impact on my existing processes, skill requirement, existing contracts, customer engagement etc.?

08

How much I can depend on my existing Consumer Indexing- Shall I ask new SI to do it again or just the Consumer Survey?

09

How this Smart metering platform can be leveraged as a base for other futuristic digital applications so that DISCOM gets maximum benefits of Smart metering

10

How should I engage with consumer: Online, Media, Bills, CHDs etc

11

What is preparedness in terms of existing team's competency, resources availability, existing vendor willingness to support new SI, existing IT application SoA supportiveness etc.

Glossary:

MAP: Meter Asset Provider

MOP: Meter Operations provider:

AMI: Advanced Metering Infrastructure

SM: Smart Meter

GPRS: Gateway GPRS Support Node

POS: Point of Sale

WAN: Wide area network

POC: Proof of concept

UAT: User acceptance test

NIC: Network interface card

DISCOM: Distribution Company (Electricity)

SI: System Integrator