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Smart Grid Initiatives and Experiences in India: Updates and Review

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Abstract

In Indian electricity sector with peculiar characteristics of an energy-deficit, populous and geographically diverse and spread out country, Smart Grid lie solutions for energy poverty and universal energy access. The paper discusses the present Indian power sector scenario and the relevance of smart grid in India. The main aim of this technical paper is to highlight the present scenario of those selected Smart Grid pilots in India, including proposed state-of-the-art Technology Integration, Consumer Coverage (Base), and status.

Keywords: AMI, EV, MNRE, OMS, PLM, PMU, RE, Smart Grid, WAM

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1. Indian Power System Scenario

With the growth of 8 to 10% per year in its power sector, India has become third largest electricity producer and consumer in the world[1]. The country has achieved generation capacity upto 284.303 GW with addition of 37GW of Renewable Energy capacity per year[2]. Peak Demand met as on 31-12-2015 is 148.46GW which is 3.2% less than the required demand during the year[1].

Estimated potential energy demand by 2032 will rise up to 900GW, out of which renewable energy contribution will be approximately 183 GW[4,5]. Targeted increase in Renewable energy is 175GW by 2022[2]. The contribution of various Renewable energy resources is shown in Table 1 as on 31 Dec 2015.

Figure 1 shows country's total installed capacity and the amount contributed by different energy sources[1,5].

Indian Transmission Sector has achieved highest transmission level of 1200kV. 220kV & above Transmission line length achieved is 336460CKM till 31 Dec 2015. Substation transformation capacity has reached upto 633056MVA. Inter-regional transmission Capacity has reached upto 47450MW[1].

With such growing scenario electricity sector is still facing huge demand and supply gap, poor power quality and high AT&C losses. Weakest link of in power sector is power distribution sector. In the country Aggregate Technical and Commercial losses (AT&C) losses are in the range of 25%-30%[1]. Inefficiency, low production, repeated interruption in supply and poor voltage, are some factors that characterized distribution sector.

Inspite of launching of various ambitious programmes to provide 24x7 electricity to all countries per capita power consumption is 1010 kilowatt-hour (kWh) in 2014-15[1] which is among the lowest in the world.

One-fourth of the households in the country still have no access to electricity. Rural part is facing frequent blackouts. Only 84.9% of Indian villages are having minimum electricity line, out of them access to electricity is having by only 46 % of rural households[5]. The losses due to India's state utilities, over the past five years, were as high as 30%[4].

About one-third of that loss is technical, but the rest is either given away for free or at subsidized rates to farmers, or lost to pilferage. High technical losses in our country takes place due to overloading, sub transmission and distribution growth without forecasting. The causes of commercial losses are mainly pilferage, defective meters, meter tampering, and human errors in meter reading.

2. Smart Grid Concept

The twentieth century concept of power flow business model consisted of unidirectional flow of power starting from the generation to consumer end due to limited numbers of generators

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Table 1. The contribution of various Renewable energies

Small Hydro Power	Wind Power	Bio Power	Solar Power	Total Capacity
41.46GW	24.3 GW	44.18GW	43.46 GW	37.41GW

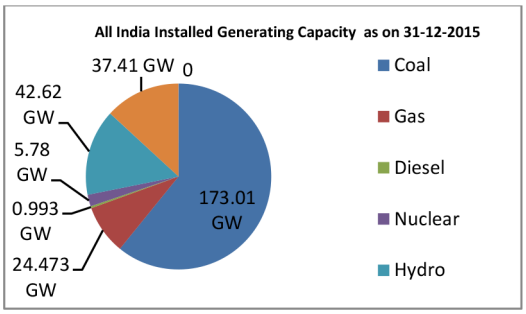

Figure 1. All India installed capacity from different energy sources.

Table 2. Basic differences between traditional grid and smart grid

TRADITIONAL GRID	SMART GRID
Electromechanical, Solid State	Fully Digital/Microprocessor Based
One way and local two way communication	Global Integrated two way communication
Centralized Generation	Distributed Generation
Limited monitoring ,protection and control system	Adaptive protection
Blind	Self monitoring
Manual Restoration	Automated Restoration
Check equipment manually	Monitor equipment remotely
Consumers are uninformed and nonparticipative	Motivates & includes the consumer
Minimum Optimization	Optimizes assets and operates efficiently

and energy providers in the market. This structure has changed with restructuring and deregulation around the world, including India. The new Electricity Act (EA), 2003 (with amendments in 2004 and 2007) and downstream policies have brought out a fundamental change in the Indian power sector with the last decade by various outcomes in the form of competition, responsibility and answerability and private sector participation. Concept of power market and power trading and active participation of consumers created an interactive atmosphere in the power sector. Also, the power flow has become multidirectional due to the distributed energy sources. Smart grid concept can bring better load forecasting, load dispatch capability and integration of renewable generation to manage peak demand and supply ratio. Advanced technologies like Distribution Automation (DA), Substation Automation, and Advanced Metering Infrastructure (AMI) with two way communication and Meter Data Management System (MDMS), Electronic Billing System and Customer Care Centers will definitely help in increasing proper metering and reduction in energy theft.

Smart grid is an integration of new technologies like SCADA, Outage Management System (OMS), Geographic Information System (GIS), Renewable Energy Integration (RE), Advanced Metering Infrastructure (AMI), Peak Load Management System (PLM) comprising of entire generation, transmission on, distribution and consumers. The aim of smart grid is to make existing grid more reliable, robust and efficient by using intelligent devices and IT technologies.

A traditional electric grid with automation and advanced layers of IT and communication technologies can manage the multidirectional flow of power from generation point to end consumer or a step ahead up to appliances and can control the load on real time basis to minimize the demand supply gap.

Increase in the efficiency of power delivery, reduction in power losses with optimal power quality, self healing, smart and active participation of consumer by empowering them to manage their electricity uses and reduction in carbon emission are the main advantages of smart grid.

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3. Building Blocks of Smart Grid Technology

Smart grid technologies consist of set of new technologies spread over from generation to transmission, distribution and upto consumers.

Major intelligent technologies are listed below:

1. Advanced Sensing and Measurement Technologies like PMU's, Demand Side Management, Remote measurement and Time of Use. Intelligent Electronic Device, Smart Meters, Fault Pass Indicators.
2. Advanced Metering Infrastructure (AMI)
3. Demand Side Management (DSM) and Demand Response
4. Outage Management System

Table 3. Benefits of smart grid

To Utilities	To Consumers
Stabilized Grid	Improved quality of power supply
Better Peak Load Management	Producer and consumer enabled.
Strong Renewable Integration	Reduced electricity bills
Reduced AT&C Losses	User Friendly Interaction with the utility
Revenue Increment	Opportunities to enter and interact with the electricity market into the ne
Better Asset Utilization	Better load management through smart meters.
Self Healing	Opportunities to purchase electricity from clean energy sources user
Reduction in capital and operational cost	Reduction in load curtailments

5. Power Quality Management
6. Power Electronics Advanced
7. Renewable Integration
8. Micro grid
9. Wide Area Measurements
10. Energy Storage Systems
11. Plug- in Electric Vehicles
12. Integrated Communications Technologies
13. Cyber Security.

4. Factors for Adoption of Smart Grid in India

Electric Grid in the developing countries like India is facing new challenges of providing secure, reliable, quality and sustained energy to all. Optimal use of present bulk power generation in combination with distributed resources is the main challenges.

For different stakeholders like utilities, customers, regulators and government the main driving factors for adoption of smart grid technology are:

1. Reduction in AT&C losses and improvement in system efficiency
2. Management of supply short fall and Peak Load
3. Integration of renewable energy into the grid with the concept of green power
4. Load Forecasting
5. Customer satisfaction and financially sound utilities
6. Grid Improvement
7. Energy Advancement
8. Managing Human Element
9. Maintaining Security, Reliability and Resilience of Large Interconnected System
10. Maintaining Quality of Supply and IT Enabled Services in Distribution Sector
11. Regulatory Changes in the Electricity Sector.

5. Policy Reforms and Smart Grid Initiatives Taken by Government of India

India Smart Grid Forum and India Smart Grid Task Force have been launched in May, 2010. To accelerate implementation of Smart Grids in India in alignment with the Ministry of Power's overarching policy objectives of "Access, Availability and Affordability of power for all". Five Working groups have been constituted to take up the different task related to SMART GRID activities i.e. work group1 – Trials/Pilot on new technologies, work group2 – Loss reduction and theft, data gathering and analysis, work group3 – Power to rural areas and reliability & quality of power to urban areas, work group4 – Dist Generation & renewable, work group5 –Physical cyber security, Standards and Spectrum. To deal with following important areas ten working groups were constituted:

1. Advanced transmission
2. Advanced distribution
3. Communications for Smart Grid
4. Metering including Interoperability standards
5. Consumption & load control
6. Policy and regulations
7. Architecture & design incl. interoperability
8. Pilots and business models
9. Renewable and Microgrids
10. Cyber Security

India Smart Grid Knowledge Portal was launched in Jan 2013[7,8]. The IPv6 Roadmap version 2 was released on 26th March 2013. 14 smart grid pilot projects were approved by the India Smart Grid Task Force in 14 States in June 2013. To review functional specifications of low cost single phase smart meters a committee was constituted by Ministry of Power, under Chairperson, Central Electricity Authority and its report was released on 12th June 2013.

Launch of Roadmap for the country at the Power Ministers Conclave on Sep 10th 2013 are the major steps taken by GoI. National Action Plan on Climate Change (NAPCC) has fixed fifteen percent of total generation of the nation from Renewable Sources by 2020.National Mission for Electric Mobility (NMEM) launched by Ministry of Heavy Industries and Public Enterprises

(MHIPE), has put a target of around forty million electric vehicles (27 million two-wheelers and 5-13 million four–wheelers) in the country by 2020[6].

National Smart Grid Mission (NSGM) has been launched by Ministry of Power in May 2015 to promote smart grid development activities in the country. Power Grid Corporation of India Limited (PGCIL) will work as a resource centre for providing support to NSGM.

In June 2015 the Forum of Regulators has approved the Model Smart Grid Regulations (MSGR) to help in acceleration of smart grid initiatives in the country.

Central Electricity Regulatory Commission (CERC) is implementing Renewable Purchase Obligation (RPO) on Distribution Utilities to purchase at least ten percent of their power mix by the year 2015.

Thus in India the smart electric grid network will provide better way to control the technological advancements and electrical infrastructure up gradations on real time basis. Introduction of Electric Vehicle (EV) will again put a burden on the complexity of today's grid.

6. Smart Grid Technology Implementation Steps in Distribution

Following are the major proposed targets and programmes of Government of India (GoI):

1. Access to uninterrupted electricity to all minimum for 8 hours per day.
2. Hundred percent electrification for all households by 2017.
3. Reduction in AT&C losses upto below 10% by 2017[10].
4. Roll out of AMI for all customers in a phased manner based on connection size and business scopes for utility by 2017.
5. Formation of National Optical Fiber Network (NOFN), with a target to connect 2,25,000 village panchayats through optical fiber cable[10].
6. Microgrids, storage technologies, solar photovoltaic to grid (PV2G), buildings to grid (B2G) technologies are being appreciated to manage peak load demand.
7. Adoption of standard for smart grid.
8. Active participation of experts from different utilities.

Restructured Accelerated Power Development Programme (R-APDRP) in 2008 was launched with the aim of reducing AT&C losses and making the utilities IT enabled. It is divided into two parts: part A and part B.

Under part A installation of meters at distribution transformers and feeders and IT enabled billing system for efficiency improvement are being established. Work has been completed in 953 out of 1412 towns sanctioned across 31 states of the country under part A[11]. Part B aims to upgradation and strengthening of distribution network. Work has been completed in 265 out of 1259 towns sectioned across 27 states under part B[11].

To strengthen the sub transmission and distribution network in urban areas, recently launched Integrated Power Development Scheme (IPDS) has now merged R-APDRP in November 2014[9,10].

IPDS comprises three components:

1. Sub transmission and distribution network Strengthening in urban and semi-urban areas.
2. Improving metering in urban and semi urban areas.
3. Enabling IT in the distribution segment.

Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) aims to undertake regulated power supply to agricultural consumers and continuous power supply to non agricultural consumer in rural areas through feeder separation for agricultural and non agricultural consumers.

DDUGJY consists of three parts:

1. Separation of agricultural and non agricultural feeders.
2. Strengthening and augmentation of sub-transmission and distribution system in rural areas.
3. Rural Electrification.

Ujwal Discom Assurance Yojana (UDAY) is launched by GoI to make majority of Discoms profitable. The major initiatives under this scheme are:

a. Improvement in operational efficiency of Discoms.
b. Reduction in their power cost
c. Reduction in interest cost.
d. Enforcing financial discipline through alignment with state finances.

7. Smart Grid Technology Initiatives in Transmission

Initiatives are being taken for the development of a reliable, secure and resilient grid supported by a strong communication infrastructure that enables greater visibility and control of efficient power flow between all sources of production and consumption by 2027[3].

1. To meet bulk power evacuation requirement of different Independent Power Producers (IPPs), 11 numbers of High Capacity Power Transmission Corridors (HCPTCs) have been finalized and these are essentially coming up in resource

rich and coastal States such as Odisha, Madhya Pradesh, Chhattisgarh, Sikkim, Jharkhand, Andhra Pradesh and Tamil Nadu.

2. About 2,000km long -+800kV, 6000 MW HVDC Bi-pole connecting Biswanath Chariali (Assam) to Agra (UP) is under implementation. This line shall be amongst the longest such lines in the world.
3. 1200 kV Ultra High Voltage AC (UHVAC) Single Circuit (S/c) and Double Circuit (D/c) test lines (highest voltage level in the world) were successfully test charged along with one 1200 kV Bay at 1200kV UHVAC National Test Station at Bina, Madhya Pradesh and field tests are currently undergoing.
4. To identify transmission infrastructure for Renewable capacity addition in 12th Plan, MNRE and CERC have entrusted POWERGRID. Studies include: – Identification of transmission infrastructure for Renewable Capacity addition in 7 states: Tamil Nadu, Karnataka, A.P, Maharashtra, Gujarat, Himachal Pradesh and Rajasthan – Estimation of requirement – Strategy framework for funding and speedy renewable power development .

8. SMART Grid Technologies in Transmission Sector

Implementation of Wide Area Measurement System (WAMS) is going on throughout the country. At the first instance 62 such units have been deployed (Northern: 14, Western: 16, Southern: 12, eastern: 12, & North-Eastern: 08)[3]. Without the risk of causing overloads, utilization of existing transmission assets can be optimized with the help of Dynamic Line Rating (DLR) that uses sensors to identify the current carrying capability of a section of network in real time.

High-Temperature Superconductors (HTS) can considerably reduce transmission losses and enable economical fault-current limiting with higher performance, though there is a debate over the market speediness of the technology.

At different transmission and distribution substations implementation of FACT, STATCOM, SCADA, Remote Communication, Substation Automation are the major initiatives towards smart grid realization in the country.

9. IS 16444:2015 National Standard for Smart Meters

On the basis of technical specifications and functional requirements published in report by CEA in June 2013, *Bureau* of Indian Standard (BIS) has released the national standard for Smart Meters, IS 16444:2015, in August 2015. This standard is applicable for a.c. static direct connected Wh smart meter of class 1 and 2. It specifies requirements of smart meters only. Requirements of DCU, HES, HHU and IHD are not being covered in this standard.

As Smart Meter is a composite unit consists of metrology elements, control, elements, module and two way communications features, it works as measurement and computational unit in addition of controlling, event capturing, storing and communicating entity with HES. Real time data obtained from Smart Meter is useful in various smart grid applications. Standard IS 15959:2011covres the requirements of Data Exchange from Smart Meter.

The standard is revised in two parts:

1. IS15959(Part 1):2011
   'Data Exchange for electricity meter reading, tariff and load control: Part1 Comparison Specification"
2. IS15959(Part 2):2011
   "Data Exchange for electricity meter reading, tariff and load control: Part1 Comparison Specification for Smart Meters".

The standard considers smart meter as single unit consisting of metering, load switching, metering protocol, and communication modules as four different functional zones. On the basis of communication modules used to communicate with DCU or HES the standard proposes two different variants:

1. Variant 1 provides communication connectivity with DCU using NAN module.
2. Variant 2 provides communication connectivity with HES using WAN module.

Standard defines metering, general constructional, mechanical, electrical, load switching and communication requirements for smart meters.

Tests for Metrology, Tests for Load Switching, Test for Data Exchange Protocol, Test for smart meter communicability, and smart meter functional requirements like smart meter disconnection mechanism, Reconnection mechanisms and Communications and recording of each tampering data, instantaneous parameters and first power ON and first power OFF detection and communication are also included in the standard to check.

The formation of this most awaited standard is an important step towards the smart grid initiation programme. It will definitely work as a guideline for the meter manufactures and utilities to improve these technology and infrastructure.

Jharkhand Bijali Vitaran Nigam Limited Ranchi has opened tender for procurement of two Lacs A.C. Single phase Two Wire Smart Energy Meters of class 1.0 with two way communications facilities suitable for Advanced Metering Infrastructure (AMI), Peak Load Management (PLM), and Demand Response. The same board has

also opened another tender for procurement of fifteen thousand Three Phase Four Wire Whole Current Static Smart Meters of class 1.0 with two way communications facilities suitable for Advanced Metering Infrastructure (AMI), Peak Load Management (PLM), and Demand Response.

10. Smart Grid Pilot Updates across India

On the recommendation of India Smart Grid Task Force (ISGTF), Ministry of Power had approved 14 pilot smart grid projects in India in October 2012[15].

These projects deployed advanced technologies like: AMI for residential, commercial and industrial consumers along with Peak Load Management and Outage Management System. Estimated cost of these projects is around Rs 4 billion, out of which half of the money will be funded by MoP and the remaining amount is to be arranged by the state utilities. Of the 14 projects initiated, only seven are in various stages of execution and three have been cancelled, while there are four in tendering stage. State wise smart grid pilot projects and their current status as upto December 2015 are discussed below[11]:

1. Utility: Assam Power Distribution Company Limited
   Project area: Guwahati Distribution Region. Consultant-MEDHAJ
   Consumer base: 15,000 Nos.
   Functinalities: AMI R,AMI I,PLM,OMS,PQM,DG.
   Project Status: Project awarded to M/s Phoenix IT Solutions Work has been approved and preparation of design and documents has been sent to MoP. Smart meters prototype testing is under progress.
2. Utility: Uttar Gujrat Vij Company Limited Gujrat
   Project Area: Naroda of Sabarmati circle and Deesa-II of Palanpur circle. Consultant-GERMI

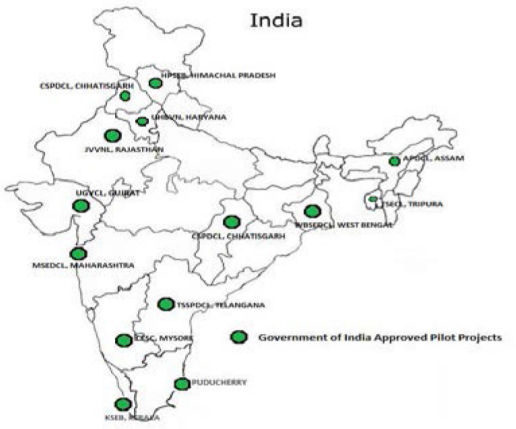

Figure 2. Smart grid pilot projects spread all over India.

   Consumer Base: 39,442Nos.
   Functionalities: AMI I,AMI R,OMS,PLM,PQ
   Project Status: UGVCL vide letter dtd 5th November 2015 stated that scope of pilot area confined to Naroda only.
3. Utility: Uttar Haryana Bijli Vitran Nigam Limited Haryana.
   Project area: Panipat City Sub Division.
   Consumer Numbers: 31,914 reviced to 11,000.
   Functionalities: AMI I, AMI R, OMS, SCADA/DMS
   Project Status: The project is funded by Japan's New Energy and Industrial Technology Development Organization (NEDO).
   On Dec4, 2014 contract of detailed engineering and work implementation was awarded to Japan's Fuji Electric Works.
4. Utility: Himachal Pradesh State Electricity Board Ltd, Himachal Pradesh. Consultant-POWERGRID
   Project Area: KalaAmb Industrial Area
   Consumer Nos.: 1500
   Functionalities: AMI I,PLM,OMS,PQM
   Project Status: Project awarded to Alstom T&D India for a total cost of 31.41 crores on Feburary 28, 2015. Work has been started.
   1100 Smart Meters installed, data from 300 meters being monitored.
5. Utility: Chamundeshwari Electricity Supply Corporation Limited, Mysore. Consultant-POWERGRID
   Project Area: Additional City Area Division Mysore.
   Consumer Base: 21, 824.
   Functionalities: AMI I,AMI R ,PLM,OMS,PQM, DG/MG.
   Project Status: On April 30, 2014 the project was awarded to a consortium led by Enzen Global Solutions Pvt Ltd. Cyan Technology, UK.
   Installation of 500 single phase meters has been completed, 14DCU and 81 Modems installed. Softwares in Smart Grid Control Centre also installed SCADA application.
6. Utility: Kerala State Electricity Board, Kerala
   Project Area: Restructured to 8 numbers of the R-APDRP towns.
   Consumer Base: 25,078
   Functionalities: AMI I,AMI R,OMS
   Project Status: Documentation on retendering is completed. Pre bid meeting was scheduled on 18.12.2015.
7. Utility: Maharashtra State Electricity Distribution Company Limited.
   Project Area: Baramati Town
   Consumer Base: 29,997
   Functionalities: AMI I,AMI R,OMS
   Project Status: Project has been cancelled.

8. Utility: Electricity Department of Government of Puducherry.
   Project Area: Division 1 of Puducherry, Consultant-POWERGRID
   Consumer Base: 34,000
   Functionalities: AMI I,AMI R
   Project Status: Tender notice issued. Bid(5 nos.) opened on 29.10.2015.
9. Utility: Punjab State Power Corporation Limited Punjab.
   Project Area: Industrial Division of City Circle Amritsar. Consultant-POWERGRID
   Consumer Base: 2734.
   Functionalities: AMI I AMI R,PLM
   Project Status: Contract awarded to M/s Kalkitech. Site survey and design documents are in progress.
10. Utility: Jaipur Vidhyut Vitaran Nigam Ltd. Rajasthan
    Project Area: Vishwakarma Industrial Area Jaipur
    Consumer Base: 34,752.
    Functionalities: AMI I,AMI R,PLM,OMS
    Project Status: Regulatory commission's update is still awaited.
11. Utility: Telangana Southern Power Disturibution Company Limited (TSPDCL)
    Project Area: Jeedimetla Industrial Area, Consultant-CPRI
    Consumer Base: 11,904
    Functionalities: AMI I,AMI R,PLM,OMS,PQM
    Project Status: Lol was issued to M/s ECIL, Hyderabad on 28.10.2015.
12 Utility: Tripura State Electricity Corporation, Tripura
    Project Area: Electrical Division No. 1 of Agartala town
    Consultant-POWERGRID
    Consumer Base: 42,676.
    Functionalities: AMI I,AMI R,PLM.
    Project Status: Project was awarded to M/s Wipro and the cost is under revision.
13. Utility: West Bengal State Electricity Distribution Company Limited
    Project Area: Siliguri Town in Darjeeling District. Consultant-POWERGRID
    Consumer Base: 5275
    Functionalities: AMI I,AMI R,PLM.
    Project Status: Contract awarded to M/s Chemtrols Engineering Ltd. in June 2015 and work is expected to begin soon.
14. Utility: CSPDCL Chhattisgarh
    Project Area: Siltara-DDU Nagar of Raipur District. Consultant-POWERGRID
    Consumer Base: 1987
    Functionalities: AMI I, PLM.
    Project Status: Project is cancelled.

11. Other Smart GRID Projects in India

11.1 Smart Grid Testing Laboratory, CPRI Bangalore

Apart from the 14 sectioned smart grid pilot projects Ministry of Power has also approved the "Smart Grid Research Laboratory" project at CPRI Bangalore with the outlay of 11.05 Crores. Purpose behind the establishment of this laboratory is to develop it as a Smart Grid Technology Centre (SGTC) and Interoperability Laboratory CPRI also providing consultancy in building smart grid systems and testing of subsystems of Smart Grid components. SCADA consultancy services for seven towns of Andhra Pradesh DISCOM, Project Management Service for Bangalore City DAS project for BESCOM are some important consultancy services provided by CPRI. Other Smart Grid Laboratories are under developmental condition and soon will start working, the main projects are:

- Itron Inc at Noida, has established the Smart Metering Lab and Knowledge Center
- Smart Grid Research Laboratory at Indian Institute of Technology, Jodhpur Rajasthan and Indian Institute of Technology, Guwahati.
- TERI's Smart Controller Laboratory (SCLab) in New Delhi, India.
- HCL's Center of Excellence (CoE) Smart Grid Lab in Noida, India.

11.2 TATA Powers Mumbai, AMI Project

The project consists of deployment of Advanced Metering Infrastructure. The first phase of the project covers 5,000 smart meters. The technology partners of the project are Cyan, L&T and Neosilica. Cyan is providing Wireless technology and Neosilica is providing Meter Data Acquisition System interface from Cyan's Head End Server into Tata's Meter Data Management System for billing and fault management.

11.3 BESCOM, Bangalore Indiranagar Smart Grid Pilot Project

BESCOM Bangalore is conducting a smart grid pilot project at its Indira Nagar area with the consumer coverage of 63,058. Major functionalities used are Advance Metering Infrastructure; Peak Load Management and Solar Rooftop PV Systems (RTPV).

11.4 Odisha Smart Grid Project

Disaster Resilient Power Strengthening System has been announced by Odisha government by using a Smart Grid power network, for the cyclone prone Ganjam district in Orissa.

Implementation of latest Power System technologies which can withstand very high-speed cyclones through underground and over ground cables and gas insulated sub-stations with full automation and control. Consumers will be informed about the power cuts through SMS.

11.5 Chhatrapur Smart Grid Pilot Project

Odisha Government has also taken up a small Smart Grid pilot project covering 5800+ consumers and installing one MW solar power plant.

11.6 Calcutta Electric Supply Corporation Limited (CESC)

Under USTDA grant Tetra Tech and ESTA International, Inc are preparing Smart Grid Roadmap for the Calcutta Electric Supply Corporation Limited (CESC). The planned functionalities are being prepared by under a USTDA grant. SCADA/DMS/EMS the CESC made recommendations for the functionalities being planned to use. Smart metering, AMI, Improved power qualities, improved communication infrastructures are the major technologies planned to implement.

12. Pilot Projects

12.1 Puducherry Smart Grid Pilot Project

The town area of Puducherry is the first smart grid trial which is being implemented by Puducherry Electricity Department and the Power Grid Corporation of India. It has covered with 87031 smart meters of different makes using different communication technology implementations in collaboration with 60 service providers[14]. It has been based on narrow and broadband power line communication at 865MHz and 2.4GHz. This project includes Distribution Transformer Monitoring Solution (DTMS), fault passage indicators, smart street lighting system, and integration of renewable through net. Metering, smart home, solar charging based electric vehicle & micro grid.

Pudducherry electricity board has started billing of consumers on the basis of online metering data from smart meters. Tamper cases are being detected, DT wise energy accounting, auditing, unbalancing in transformer loading identified. Up to 57% saving in consumption is achieved by automation of street lighting, improvement in voltage profile, reduction in losses, improved supply quality, integration of roof top solar PV with net metering, reduction of power bills and electric vehicle with solar charging are the main achievements of this project.

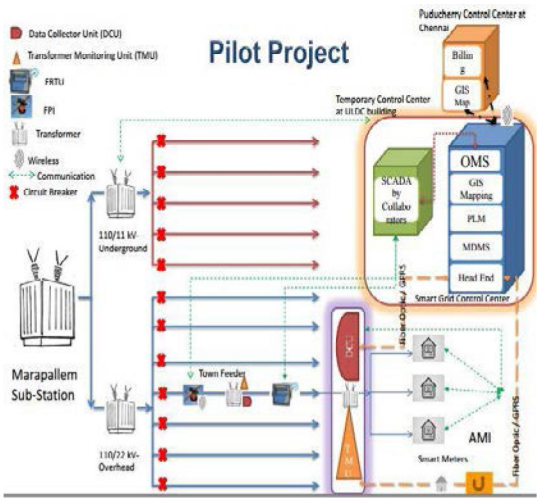

Figure 3. Pudducherry smart grid pilot project.
Source: www.ieee-pec.org/presentations/gm2015/PESGM

12.2 Jeedimetla Smart Grid Pilot Project

Jeedimetla Smart Grid Pilot Project is proposed to implement power management in power distribution sector by using intelligent smart grid technologies. The plan under this project is to deploy about 12000 smart meters among 43000 domestic and industrial consumers contributing in higher power consumption[12,13]. Focus is on HT and LT network automation, strengthening the distribution network and introducing the IT and Communication technologies in distribution. Project Manager designated by TSSPDCL will coordinate all project activities in association with CPRI will lead the Smart Grid effort. Functionalities used in the project include AMI for residential, AMI for Industrial, Peak Management, Outage Management and Power Quality.

13. Conclusion

Smart Grid technology needs better electricity delivery infrastructure. Unfortunately in our country still there are several regions without access to electricity or facing frequent electricity outages. Smart grid implementation needs strong computer software and hardware network, sensor and high speed communication technology network and customer supporting services to help them to communicate directly with the utilities. In other word it is an information exchanging network with combination of electrical infrastructure and information technology. Adoption of smart grid technology is helpful in reduction in electricity theft, AT&C losses and improvement in distribution reliability. Integration of renewable energy sources needs new standards for interconnection. Installation of PMU, interconnection of Energy storage devices, HVDC interconnection in transmission has greatly increased the way of making existing grid smart. Apart

from all these efforts discussed in the paper still there is a need of strong and dedicated institutional framework to implement the targeted goals as mentioned in the India Smart Grid Vision and Roadmap reports.

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