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# PACE-D Technical Assistance Program
# SMART GRIDS ELECTRIC SYSTEM – INCEPTION REPORT

**November 2012**
This publication was produced for review by the United States Agency for International Development. It was prepared by Nexant, Inc. under Contract No. AID-386-C-12-00001.

PARTNERSHIP TO ADVANCE CLEAN ENERGY DEPLOYMENT (PACE-D)

Technical Assistance Program

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## Abbreviations

| | |
|---|---|
| AMI | Advanced Metering Infrastructure |
| AT&C | Aggregate Technical and Commercial |
| BEE | Bureau of Energy Efficiency |
| BESCOM | Bangalore Electricity Supply Company |
| BIS | Bureau Of Indian Standards |
| CEA | Central Electricity Authority |
| CERC | Central Electricity Regulatory Commission |
| CPRI | Central Power Research Institute |
| Rs. Cr. | Rupees Crore (1 crore approximates to 0.2 million dollars) |
| DGPS | Differential Global Positioning System |
| DR | Demand Response |
| DSM | Demand Side Management |
| DT | Direct Transformer |
| EA | Electricity Act |
| EV | Electric Vehicle |
| GHG | Green House Gas |
| GoI | Government of India |
| HSIL | High Surge Impedance Loading |
| HTLS | High Temperature Low Sag |
| IS | Indian Standards |
| ISGF | India Smart Grid Forum |
| ISGTF | India Smart Grid Task Force |
| IT | Information Technology |
| ITIA | IT Implementation Agency |
| KEPC | Kerala Electric Power Corporation |
| LNG | Liquid Natural Gas |
| MoP | Ministry of Power |
| NBEM | National Board For Electric Mobility |
| NCEM | National Council For Electric Mobility |

| | |
|---|---|
| NDPL | North Delhi Power Limited |
| NMEEE | National Mission For Enhanced Energy Efficiency |
| NTPC | National Thermal Power Corporation |
| OMS | Outage Management System |
| PACE-D | Partnership To Advance Clean Energy – Deployment |
| PFC | Power Finance Corporation |
| PGCIL | Power Grid Corporation of India Limited |
| PLM | Peak Load Management |
| PMU | Phasor Measurement Unit |
| PPP | Public Private Participation |
| PQ | Power Quality |
| R-APDRP | Restructured - Accelerated Power Development Program |
| RE | Renewable Energy |
| REC | Rural Electrification Corporation |
| SCADA | Supervisory Control And Data Acquisition |
| SDA | State Development Agencies |
| SERC | State Electricity Regulatory Commission |
| TERI | The Energy And Resources Institute |
| TPPDL | Tata Power Delhi Distribution Ltd |
| WAMS | Wide Area Measurement Systems |
| WBEDCL | West Bengal Electricity Distribution Company Ltd |

# 1 BACKGROUND AND OBJECTIVES OF THE ASSIGNMENT

## 1.1 BACKGROUND

With the effects of Green House Gases (GHG) becoming more pronounced, all nations in the world decided upon reducing their respective carbon emissions by shifting to Clean Technologies including Renewable Energy and Energy Efficiency. In this context, a Memorandum of Understanding (MoU) was signed between USA and India. The major objective of this MoU is to enhance the co-operation on energy security, energy efficiency, and climate change through development, deployment, and transfer of innovative technologies from USA to India.

Thus, the PACE-D program was formulated to take this partnership ahead. It has been designed to be a key instrument in carrying forward the Indo-US partnership in clean energy, and to support and strengthen the elements of energy technology innovation in India. USAID, having four decades of prior experience in India, in consultation with the Government of India (GoI) has selected NEXANT to lead the design, project planning, and preparation and implementation phases of PACE-D.

India's installed capacity currently stands at 209 gigawatt (GW) (as on October 31, 2012), compared to just 1.3 GW during independence. However, it still lags far behind the demand. The country's per capita consumption is one of the lowest in the world at 778 kilowatt hour (kWh) which is significantly lower than the world average of 2,429 kWh. A majority of the Indian population still does not have access to even basic power supply. Only nine states have been declared completely electrified and only 67 percent of India has access to electricity. This supply is again not reliable and is not available 24x7. This is despite the fact that the power sector has been growing at seven percent every year. It has been seen that there is a perennial problem in the systems delivery process.

India's Transmission and Distribution (T&D) losses have escalated from 22 percent in 1995/96 to nearly 25-32 percent at present. Aging infrastructure and high levels of power theft are the major reasons behind the mounting loss levels. Most of the state utilities are at the brink of bankruptcy and cannot afford even regular repair and maintenance (R&M) of their assets.

The country has significant scope for improving energy efficiency across the energy supply chain from generation to end consumption. To achieve this, India needs to create an appropriate enabling environment and build innovative technological capabilities. The PACE-D aims to further the initiatives already underway in India, and create a facilitative environment for taking these to the next level.

It also intends to meet USAIDs clean energy directive, and contribute towards India's most pressing priorities. It aims to reduce the GHG emission per unit of electricity generated by deploying new technologies for clean energy and energy efficiency. It also aims to assist in preparing India's low-carbon strategy for inclusive growth, promoting the carbon market readiness, and carbon market mechanism.

In line with the above, the key expected outcomes from the PACE-D[1] are as follows.

- **Improved end-use energy efficiency through scaling up and deployment of energy efficiency technologies:** India's economic growth has been rapid and accompanied by a corresponding growth in the demand for energy services. Meeting the energy demand just by increasing the supply without managing the demand side is an expensive solution and will lead to increase in GHG emissions. An effective way of managing the increase in demand is by improving end use energy efficiency. Technology, both hardware and software, is essential for implementing energy efficiency programs. USAID/India through PACE-D, aims to accelerate clean energy development and its integration through technical assistance, financial mechanism, technical policy, and promotion of knowledge about clean energy in India.

- **Increased supply of renewable energy by scaling up renewable energy technologies:** With concerns of limited fossil fuel supply and energy security renewable energy (RE) assumes even more importance. Though India has deployed around 24 GW of RE (solar, wind, biomass, etc), vast amount of RE potential remains untapped. PACE-D will assist the GoI in implementing its goal of promoting grid-interactive RE and rural electrification through micro-grids and off-grid applications such as those for fossil fuel replacement, lighting applications, and rooftop installations. This will be done by engaging various state governments in strengthening state-level policy and regulatory framework. The program will also address avenues to increase access to finance, develop sustainable business model, and build capacity at the local, state, and national levels.

- **Adoption and accelerated deployment of cleaner fossil technologies and management practices to achieve supply-side efficiency from existing fossil power generation:** Coal is the major source of energy for the Indian power sector and accounts for nearly 70 percent of the total power generation. Increase in the use of coal increases the carbon dioxide ($CO_2$) emission drastically. The power sector is the highest GHG emitter in the country. Some developed and developing countries have moved to efficient coal-based power generation technologies like supercritical pulverized-coal system. India has now developed a roadmap to move to advanced clean coal technologies and is investing in the required manufacturing capabilities. There are many barriers in deploying cleaner fossil fuels or clean coal technologies. The few challenges are inferior coal quality in India, higher capital costs, limited

[1]As defined in the Request for Proposal No. SOL-386-11-000002

access to technological capacity, and lack of incentives to maintain or improve efficiency. USAID/India will assist in implementing GoI's program on cleaner coal and create an enabling environment to deploy cleaner fossil technology. PACE-D will contribute meaningfully to the implementation of the GoIs National Perspective Plan for cleaner fuels through technical assistance, training, and know-how.

In order to achieve the objectives specified above, various tasks have been outlined in the **RfP (Request for Proposal)** covering a wide range of topics in order to map the objectives and expected outputs of PACE-D. The module related to the Smart Grids Electric System is part of Task 1 (Market Driven Energy Efficiency Technology Deployment) under the CLIN 001 (Development Result 1): Improved end-use energy efficiency through scaling up and deployment of energy efficiency technologies.

The focus of this report is on the module related to Smart Grids Electric System (SGES). Wherever applicable, the linkages to the other modules have been mentioned in the road map of interventions proposed under the program.

## 1.2 OBJECTIVE OF THE ASSIGNMENT

The PACE-D program is expected to support and strengthen the Smart Grid initiatives planned in India by creating a facilitative environment that promotes technology exchange and access, knowledge sharing, training and capacity building, and channels of financing. As this report identifies, there are several initiatives on the Smart Grid front that are already underway in the country. These need to be nurtured and supported. There are also several other areas that would require interventions through Smart Grids, and where the present level of awareness and activity is limited. There is a need to increase the visibility of these areas and initiate programs to ensure that the potential of Smart Grids on such aspects is unleashed. The PACE–D program is expected to play a catalysing role, leveraging upon the institutional knowledge, understanding, and capabilities brought in from the Indian, and international experience.

The efforts under PACE–D will seek to address these aspects and make way for scale-up by leveraging the inputs provided through the program for Smart Grids to proliferate at a faster pace and on a larger scale. Specifically, the Smart Grid module under the program aims at achieving the following objectives.

- Design an action plan, developed in partnership with the Ministry of Power (MoP), GoI, to roll out Smart Grids tailored to India's unique needs and requirements
- Develop a white paper on common inter-operability standards for the Indian power sector to support a national Smart Grid road map
- Prepare a document on the status of Smart Grid pilots in the US, including the communication technologies adopted, lessons learnt from these pilots, and recommendations for the Indian power sector

- Design and monitor the implementation of at least two Smart Grid pilot projects in India
- Conduct an international seminar to improve capacity of various stakeholders including utilities, consumers, technology providers, and regulators to implement Smart Grid projects and programs
- Technical assistance to state government agencies and regulators to effectively implement Smart Grid technologies in close coordination with state utilities

The PACE-D team will work closely with GoI counterparts, as well as other functional areas identified as priorities in this report, and in-effect will play an important integrating role in bringing various interventions together.

# 2 PURPOSE OF INCEPTION REPORT

In order to plan out various activities required to meet the objectives of the Smart Grids module and also the overall objectives of the PACE-D, it is essential to undertake an 'As-Is' analysis of the current set-up, activities already underway in India, the status of the same, success and failures, and the lessons emerging. This will then form the basis for planning the activities of the assignment and the tasks proposed as part of this module.

Thus, the purpose of this report is as follows.

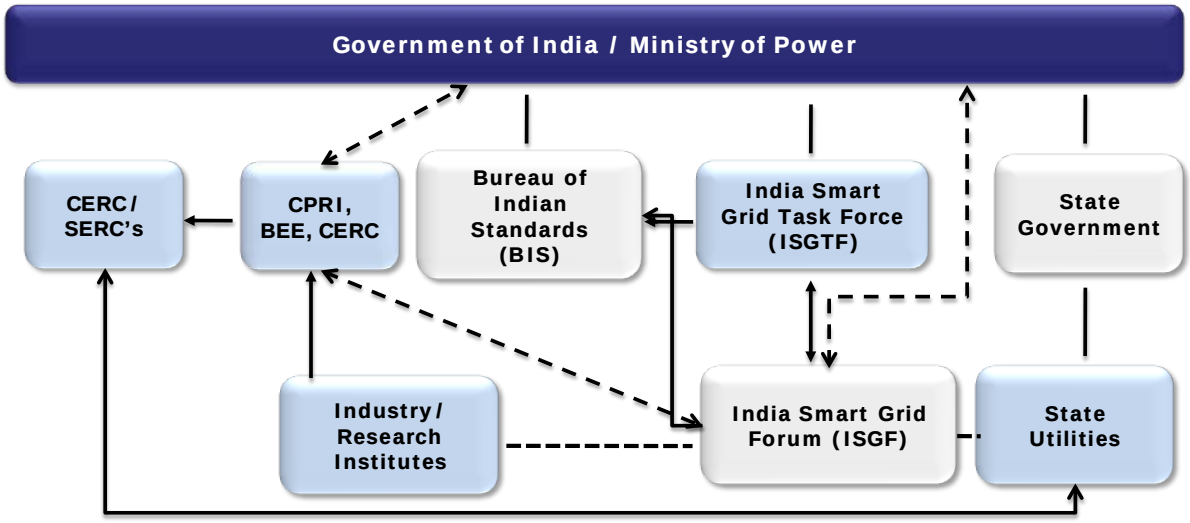
- Assess the institutional set up for Smart Grid implementation in India
    - This covers the role of MoP, India Smart Grid Task Force (ISGTF), India Smart Grid Forum (ISGF), the Bureau of Indian Standards (BIS), Central Power Research Institute (CPRI), Bureau of Energy Efficiency (BEE), Central Electricity Authority (CEA), and so on .
- Identify overall Smart Grid vision for India as envisioned by the GoI: – a brief introduction to the Smart Grid vision as laid out by the ISGTF and ISGF
- Assess the institutional set up for Smart Grid implementation in the India
- Review the Smart Grid programs, activities, and pilots in the country.
    - This covers the following programs - the Restructured Accelerated Power Development and Reforms Program (R-APDRP) and the Electric Vehicles Program of the Ministry of Heavy Industries.
    - Prior to the announcement of Smart Grid Pilot program by the GoI, a few utilities had already initiated pilots in their respective utilities. These include the Bangalore Electricity Supply Company (BESCOM), West Bengal Electricity Distribution Company Ltd (WBEDCL), Tata Power Delhi Distribution Ltd (TPPDL), and the Electricity Department of Puducherry. Many other small pilots that were announced were later abandoned. This section covers the description of these pilots, their business model, proposed functionality, current status, and our assessment on the overall approach and plan of the pilot programs.
    - In addition, 14 pilots of the GoI, their coverage, cost-benefit analysis, and deployment schedule are also described as part of this report
- Define an overall roadmap for a Smart Grids enabled India.
- Identify priority areas for PACE-D.
- Define the deliverables and the work plan for the assignment

The draft inception report along with the work plan and the deliverables will be finalized in consultation with the key stakeholders/counterpart entities, particularly the ISGTF.

# 3 INSTITUTIONAL SET-UP FOR SMART GRID IMPLEMENTATION IN INDIA

Figure 3.1 describes the institutional set-up for Smart Grid implementation in India.

**Figure 3.1: Institutional Set-up for Smart Grid Implementation in India**




| | |
|---|---|
| ——— | Indicates direct interaction among the entities |
| - - - | Indirect interaction among the entities |

As observed, the ISGTF has been created under the MoP to provide policy direction to the Smart Grid initiatives in the country. The ISGTF is supported by ISGF, a PPP initiative of MoP. ISGF has a more operational role and is responsible for helping the stakeholders in the deployment of Smart Grid technologies and undertaking research work for promotion of such technologies. The BIS is the statutory body of GoI responsible for formulation of standards including those for Smart Grid equipment and related applications. Other entities like CEA, CPRI, and BEE are also responsible for contributing towards development of Smart Grid technologies and standards. SERCs are the regulatory bodies responsible for approval of Smart Grid investments, and gradually for framing regulations governing implementation of Smart Grid initiatives in the country.

## 3.1 INDIA SMART GRID TASK FORCE

The ISGTF was formed in 2010 to draw a roadmap for developing a technical and institutional framework for the implementation of Smart Grids pilot projects in India. Dr. Sam Pitroda, Adviser to the Prime Minister on Public Information Infrastructure and Innovation is the Chairperson of ISGTF.

### *3.1.1 KEY ROLES AND RESPONSIBILITIES [C-level]*

The ISGTF is an inter-ministerial group and will serve as the government focal point for activities related to the Smart Grid. Members of ISGTF have been selected from the concerned ministries (power, home, defence, communications and IT, new and renewable energy, environment and forest, and finance) and organizations (Planning Commission, Department of Science and Technology, CEA, CPRI, BEE, NTPC, PGCIL, BIS, PFC, and REC).

The main functions of ISGTF pertaining to Smart Grids are as follows.

- Awareness, coordination, and integration of diverse activities related to Smart Grid technologies
- Practices and services for research and development of Smart Grid
- Coordination, and integration of other relevant inter-governmental activities
- Collaboration on interoperability framework
- Review and validate recommendations from ISGF etc.

Five Working Groups have been constituted to take up the different tasks related to Smart Grid activities. Listed below are the working groups constituted under the ISGTF. A more detailed description of the functions of the ISGTF is provided in Annexure 1.

1. Working Group 1: Trials/Pilot on new technologies
2. Working Group 2: Loss reduction and theft, data gathering, and analysis
3. Working Group 3: Power to rural areas and reliability and quality of power to urban areas
4. Working Group 4: Distributed generation and renewable
5. Working Group 5: Physical and cyber security, Standards and Spectrum

### *3.1.2 KEY ACTIVITIES AND CURRENT STATUS*

The ISGTF, entrusted with the sole responsibility of ushering in a new wave of reforms in the Indian power sector, is skillfully supported by ISGF; various government entities like PFC, REC, CPRI, and BIS; and various other competent national and global companies operating in the Smart Grid space. The ISGTF has undertaken feasibility studies to understand the market environment for Smart Grids in India. Various white papers have also been published. Based on the initial set of research carried out by the ISGTF, the following recommendations were made to the GoI to further the Smart Grid initiatives in the country.

- Implementation of eight Smart Grid pilot projects in India. These projects were proposed to be funded by agencies of the GoI in part. The aim of these pilot projects is to establish a proof of concept for Smart Grid projects in India. These pilots are proposed to be implemented in various states encompassing different categories of utilities, thereby reflecting a holistic

approach for scaling up the Smart Grid interventions in the country. The number of pilot projects was subsequently increased to 14 (from the initial eight.)

- Hundred percent metering of all consumers was proposed under all distribution utilities through deployment of low-cost smart meters. Business model to recover the cost of the smart meter by the distribution company is to be developed in a manner that reduces immediate burden on the consumers.
- Several utilities have implemented IT-based applications. However, there is no uniformity in the format in which such applications have been designed and implemented. When a national plan is rolled out, it causes hindrance due to non-compatibility. Hence, the BIS was asked to step in to create necessary technical Smart Grid standards to ensure complete inter-operability across various systems.
- The R-APDRP program needs to be extended to cover more towns, thereby ensuring deployment of Supervisory Control and Data Acquisition (SCADA) system.
- Since Smart Grids work on complex networks where communication is carried out through the internet, necessary cyber security measures need to be put in place to counter the numerous cyber security threats that can prove fatal to the entire operation of the grid.
- Demand management must be made an integral part of the Smart Grid program. Regulatory commissions need to implement time-of-day tariff to encourage consumers to participate in demand side management thereby addressing how to take care of peak load demand.
- PGCIL has initiated the implementation of Wide Area Measurement Systems (WAMS) with Phasor Measurement Unit (PMU) on the extra high voltage transmission system.

Of all the recommendations made by the ISGTF, top priority has been accorded to the pilots and the smart meter installation. The ISGTF along with the ISGF has worked actively to set up a framework for these two areas.

- It has issued model specification and guidelines to the utilities for choosing the pilots and technology partners. Under the program, 50 percent of the project cost is proposed to be funded by GoI (under R-APDRP program) and the rest would be borne by the utility fully or shared between the utility and the technology partner. Seventeen utilities submitted detailed project reports (DPRs) in December 2011/ January 2012. Of this, 14 pilots have been selected, with the average size of the investment being Rs. 50 crore. Further, details on the selected pilots, their coverage and plans are discussed in the subsequent sections of this report.

It is expected that the outputs and learning from the above activities will enable development of a robust framework for driving the Smart Grids in India, customized to the Indian needs. The PACE-D team will be interfacing with the ISGTF and the working groups to identify areas where PACE-D can facilitate and support the activities of ISGTF. Hence, one of the initial activities will be to get in touch with the ISGTF Secretariat to initiate this process.

## 3.2 INDIA SMART GRID FORUM

The ISGF was launched in 2010 as a non-profit voluntary consortium of public and private stakeholders, research institutes, and selected utilities with the prime objective of accelerating development of Smart Grid technologies in the Indian power sector.

### *3.2.1 KEY ROLES AND RESPONSIBILITIES*

The objectives of ISGF are as follows.

- To help the Indian power sector in deploying Smart Grid technologies in an efficient, cost effective, innovative, and scalable manner by bringing together all key stakeholders and enabling technologies.
- To bring together stakeholders specializing in regulation, policy, and business case for Smart Grid.
- To undertake research work and other efforts such as scoping the capabilities of Smart Grids in the Indian context through case studies, cost-benefit framework, technical advancements in the renewable energy sources, and other ancillary activities.

ISGF advices the government, regulators, and utilities in the form of reports, white papers, and technical seminars.

The ISGF is divided into 10 different working groups. These working groups have been classified as follows. A detailed summary of the functions of each of the working groups is provided in Annexure 2.

1. Working Group 1: Advanced Transmission
2. Working Group 2: Advanced Distribution System
3. Working Group 3: Communications for Smart Grids
4. Working Group 4: Metering
5. Working Group 5: Consumption and Load Control
6. Working Group 6: Policy and Regulations (including Tariffs and Finance )
7. Working Group 7: Architecture and Design
8. Working Group 8: Pilots and Business Model including planning and implementation, and capacity building
9. Working Group 9: Renewables and Micro-grids
10. Working Group 10: Cyber-Security

### *3.2.2 KEY ACTIVITIES AND CURRENT STATUS*

The ISGF functions as an advisory body to the ISGTF. It is responsible for accelerated development of Smart Grid technologies in the Indian power sector. The ISGF has links with various global agencies thereby building in requisite international expertise in the Smart Grid roadmap. The organization has also collaborated with a wide array of technical and academic institutes and has strong capabilities to guide other entities on issues related to Smart Grid technologies. The ISGF also conducts technology sessions at regular intervals for capacity building of all the personnel associated with the ISGF.

The ISGF, keeping in line with its role of an advisor, has brought out the Smart Grid Vision for the Indian power sector (discussed in the following section).

- Smart Grid priorities defined by the ISGF for India are as follows.
    - No power cuts, and therefore, empowerment of both producers and consumers
    - Reduce transmission and distribution (T&D) losses, improve quality of supply, and optimize revenue cycle
    - Manage peak power, demand response, and electric vehicle proliferation
    - Integrate renewables/distributed generation efficiently

The working groups are currently in the process of formulating their inception reports, which would list out their respective work plan including deliverables and time schedule.

## 3.3 CENTRAL ELECTRICITY AUTHORITY INITIATIVES [B-level]

A committee was constituted by the MoP during April 2011 under the Chairmanship of Chief Engineer (DP&D), Central Electricity Authority) CEA, comprising 17 members, from utilities, meters, and chip manufacturers, to finalize the functional requirement specifications for cost-effective single-phase smart meters.

The key mandate provided to the Committee was as follows.

- Finalization of functional requirement/Specifications for cost-effective single-phase electricity meters;
- Suggest changes in applicable Indian Standards (IS);
- Review of CEAs regulations on installation and operation of meters.

The Committee finalized the functional requirement specifications for cost-effective single-phase meters during March 2012. These are provided in Annexure 3. Currently, the MoP is in process of engaging an entity for designing of a “chip” as per the functional requirement finalized by the group. The chip design once finalized will be available to the industry players for incorporation in their single-phase smart meter designs.

## 3.4 BUREAU OF INDIAN STANDARDS

The Bureau of Indian Standards (BIS), the national standards body is one of the core members of the ISGTF, and is also part of the working group on "Physical cyber security, Standards and Spectrum". Considering that IT architecture is an important constituent of power system control and automation to facilitate Smart Grid deployment, a Panel on Digital Architecture has been constituted by BIS under Power System Control and Associated Communications Sectional Committee LITD 10 to formulate standards on IT architecture with a view to harmonize the interface and integration of various IT solutions.

The LITD 10 constituted of seven panels to work and develop draft reports on the following attributes. These are as listed below.

1. Panel 1: Interoperability (Guidelines on Standards for Interoperability in Power System Communications)
2. Panel 2: Security (Security Standard for Power Control Systems)
3. Panel 3: Common information model (Common Information Model (CIM) for Information Exchange in the context of Electrical Utilities – Companion Specification)
4. Panel 4: Phasor Measurement Unit (Standard for Phasor Measuremet Units [PMU], Phasor Data concentrator (PDC), and Testing & Certification requirements)
5. Panel 5: Distribution Management System (Distribution Management System specification in the context of electrical utilities)
6. Panel 6: Digital Architecture Framework (Digital architecture framework for the power sector – a blueprint for electric utilities in India)
7. Panel 7: Advance Metering Infrastructure (Guideline document for advanced metering infrastructure)

As per the recent update, the draft reports after incorporating the comments from various members of other Panels of LITD 10 are likely to be finalized by November 2012.

## 3.5 CENTRAL POWER RESEARCH INSTITUTE

The Central Power Research Institute (CPRI) serves as an independent authority for testing and certification of power equipments. It has set up laboratories under its purview which carry out the following activities:

- **Metering Protocol Laboratory:** This lab is involved with setting meter standards and management of intelligent meters. CPRI advocated the use of open standards in meters. It has also set up "Conformance Test Laboratory" for verifying if the provisions of Device Language Message Specification (DLMS) protocol are implemented correctly in the metering device.

- **Substation Automation System Laboratory:** The laboratory develops tests, and certifies protocol-related substation communication as per the national and international standards like IEC 61850, IEC 62056, and BIS Indian companion specification. This national laboratory has played a very critical role in certifying the protocols for the communication between different substations in Smart Grid pilot projects.

CPRI also conducts various workshops/ training programs for making personnel familiar with Smart Grid technologies. These workshops cover the following aspects.

- Application of Information Technology to Power Systems
- International Electricity Metering Protocols (IEC 62056)
- Distribution Automation
- Cyber and System Security of Power sector

A proposal to set up Smart Grid test bed at CPRI Bangalore is under active consideration by the MoP. This may be taken up through partnership with private entities through a PPP model along with the participation of ISGF. Currently, the DPR for the same is under preparation.

## 3.6 BUREAU OF ENERGY EFFICIENCY

BEE is an active member of the ISGF. It is responsible for formulation of standards for appliances that are Smart Grid ready. At the Sub-Ministerial meeting for International Smart Grid Action Network (ISGAN) held in Republic of Korea in 2011, the participating countries gave their consent for the following deliverables.

1. Global Smart Grid Inventory
2. Smart Grid Case Studies
3. Cost/Benefit Study
4. Insight for Policy Makers

Of the four deliverables, BEE intended to work on two deliverables i.e. Cost/Benefit Study and Insight for policy makers. Consequently, the BEE partnered with IBM to undertake the cost benefit analysis for Smart Grid activities. This was taken up as part of the NMEEE (National Mission for Enhanced Energy Efficiency**).** NMEEE is one of the eight national missions that promote innovative policy and regulatory regimes, financing mechanisms, and business models that help sustain the market for energy efficiency.
IBM was responsible to create the requisite tool kit to help calculate the return on investment for all Smart Grid projects being rolled out in the country. The report was finalized during May 2011.

As observed from the above, several entities are involved in Smart Grid initiatives through various channels covering wide array of activities. Effective coordination to harmonize the work

performed by these entities is critical to ensure coherent development of the Smart Grid program in India. The tasks under the PACE-D have been designed by considering these aspects.

# 4 POLICY FRAMEWORK AND VISION FOR SMART GRIDS IN INDIA

The following section describes the policy framework and the vision evolved by ISGF for Smart Grid implementation in the country.

## 4.1 NATIONAL ELECTRICITY POLICY

The National Electricity Policy (NEP) aims at accelerated development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders keeping in view efficiency improvement in power utilities; improve service quality; promote time of day tariffs for peak load management; demand side management etc.,
The policy highlights the following.

- Section 5.1.2 (b) of NEP lays emphasis on providing decentralized distributed generation facilities together with local distribution network to households where providing electricity access through conventional supply chain is not feasible
- Section 5.4.10 of NEP emphasizes on use of modern IT systems, to facilitate creation of network information and customer data base which will help in management of load, improvement in quality, detection of theft and tampering, consumer indexing and mapping, customer information and prompt and correct billing and collection
- Section 5.6.1 of NEP emphasizes on the adoption of state of the art technologies for demand side management.
- Section 5.9.1 also accords high priority to energy conservation and demand side management

Smart Grid acts as a key enabler in achieving the policy objectives listed above.

## 4.2 NATIONAL SMART GRID VISION

The ISGF has recently brought out the Smart Grid vision for the Indian power sector. The vision formulated is as follows.
*"Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem by 2027 that provides reliable and quality energy for all with active participation of stakeholders"*.
In line with the above, the following National Smart Grid Mission has been adopted.
*"Quality Power on Demand for All by 2027"*
Further, the following road map has been recommended by the ISGF, which also reflects the targets proposed to be achieved in various plan periods.

**Table 4.1: Smart Grid Vision for India**

| 12th Plan (2012-2017) | 13th Plan (2017-2022) | 14th plan (2022-2027) |
|---|---|---|
| Access to " Electricity for all" | Reduction of transmission losses to below two percent | Reduction of AT&C losses to below 10 percent in all utilities |
| Reduction of transmission losses to below 3 percent | Reduction of AT&C losses to below 12 percent in all utilities | Financially viable utilities |
| Reduction of all AT&C losses in all distribution utilities to below 15 percent | Improvement in Power Quality | Stable 24x7 power supply to all categories of consumers across the country |
| Reduction in Power Cuts | End of power cuts and electrification of all houses by 2020 | Renewable integration of 120 GW; 10 percent EV penetration |
| Renewable integration of 30 GW and EV trials | Nationwide smart meter roll out | Smart cities and smarter infrastructure |
| Improvement in Power Quality and reliability | Renewable integration of 70 GW; five percent EV penetration | Export of Smart Grid products , solutions and services to overseas |
| Time of use tariff | Standards development for smart infrastructure | Research and development , training and capacity building |
| Energy efficiency programs | UHV and EHV strengthening | Active participation of "Prosumers" |
| Standards development for Smart Grid including EVs | Research and development , training and capacity building | Sustainability Initiatives and Public safety |
| Strengthening of EHV systems | Export of Smart Grid products, solutions and services to overseas | |
| Efficient power exchanges | Customer outreach and participation | |
| Research and development , training and capacity building | Sustainability Initiatives and Public safety | |
| Customer outreach and participation | | |
| Sustainability initiatives | | |
| Smart Grid pilots and Smart Grid roll out in major cities | | |

The total outlay for the 12th plan period has been computed at Rs. 31,419 crores (approximately 5.7 billion dollars).

The above vision and the implementation targets are under discussion with various stakeholders and are yet to be finalized.

As observed from the above, the roadmap proposed for various plan periods includes wide range of activities. Adequate clarity on the role of various entities and implementation wherewithal will be critical to achieve the proposed targets. This will also require institutional strengthening and defining responsibility and accountability structure for ensuring coordinated development. An administrative wing within MoP has also been in discussion for coordinating various Smart Grid related activities.

All of the above will have an important bearing on the plan of activities proposed under the PACE-D, wherein the aim will be to support and facilitate such developments.

# 5 SMART GRID ACTIVITIES IN INDIA

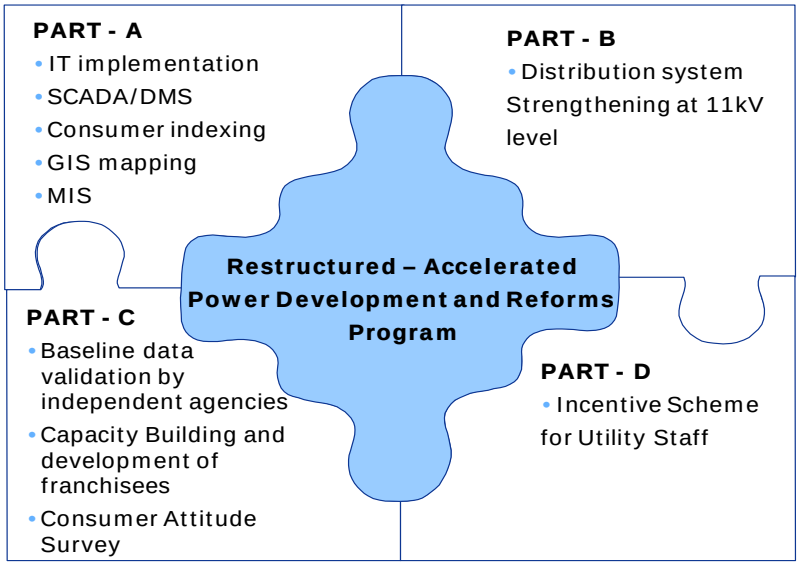
## 5.1 RESTRUCTURED – ACCELERATED POWER DEVELOPMENT AND REFORMS PROGRAM

### *5.1.1 SCOPE OF THE PROGRAM*

The Restructured – Accelerated Power Development and Reforms Program (R-APDRP) is the GoIs flagship reforms program initiated to strengthen infrastructural handicaps in the distribution sector to bring down AT&C losses. The program has a sanctioned budget of Rs.51,577 crore with PFC playing the role of nodal agency. This program was formulated by tweaking the earlier APDRP and the APDP prior to that, due to several shortcomings identified by the review committees constituted to review the progress of the program. The R-APDRP was heralded as a serious reforms program since it had an outcome driven agenda. The focus of the program was on actual, demonstrable performance in terms of sustained loss reduction. Establishment of reliable and automated systems for sustained collection of accurate base line data, and the adoption of Information Technology in the areas of energy accounting were necessary pre-conditions for the sanction of a project. This was to enable objective evaluation of the performance of utilities before and after implementation of the program, and enforce internal accountability leading to better performance.

The R-APDRP was designed to have a four pronged approach. The details of each part are provided below.

**Figure 5.1: Schemes under R-APDRP**



### *5.1.2 R-APDRP IMPLEMENTATION STATUS*

Part-A of the R-APDRP program is directly linked to the readiness of the utilities in establishing the base infrastructure for taking up Smart Grid and other IT initiatives; hence this section provides the status of the power utilities in various states in implementing schemes/initiatives envisaged under Part-A of the R-APDRP program.

Part-A projects worth Rs. 5, 196 crore covering all the eligible towns (1402 Nos.) in the country have already been sanctioned. Additionally, 63 Supervisory Control and Data Acquisition (SCADA) projects worth Rs.1443.48 crore have also been sanctioned for 15 states (Maharashtra, Uttar Pradesh, Gujarat, Rajasthan, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Kerala, Bihar, Punjab, West Bengal, Assam, J&K, Chhattisgarh, and Uttarakhand) under Part-A.

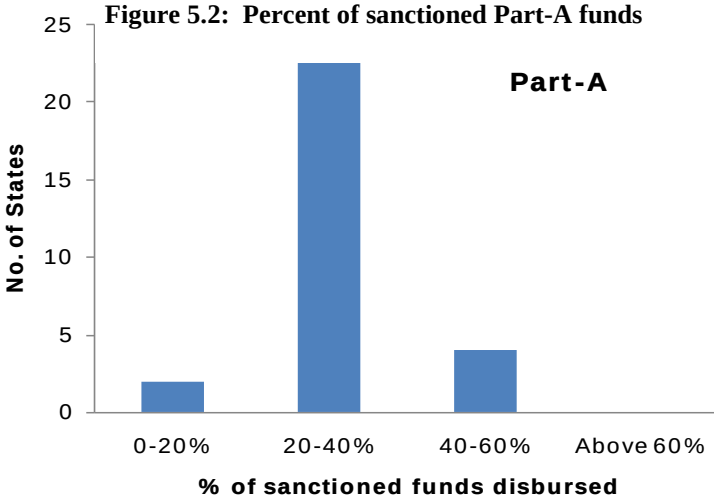
Summary of loan disbursement and percentage completion of the sanctioned projects under Part-A and SCADA has been provided in Annexure 4.

### *5.1.3 ASSESSMENT OF THE PROGRESS OF R-APDRP*

The following observations can be made from the above.

- The order on R-APDRP was released on September 19, 2008 and the guidelines were released on December 22, 2008. According to official reports, the earliest date any state utility went in for appointing an IT Implementing Agency (ITIA) was at the end of 2009. There was significant delay in the process of appointing an ITIA. This can be attributed to the lack of experience and understanding of the requirements of the program by the distribution utilities.
- Many of the utilities have started appointing ITIAs in the recent past only. For example, North-eastern states, Goa, J&K started the process only in 2011 which is almost three years after the R-APDRP scheme was announced. Similarly, states like Chhattisgarh, Maharashtra, Himachal Pradesh, and Tamil Nadu appointed the consultant only in the later part of 2010.

**Figure 5.2: Percent of sanctioned Part-A funds**

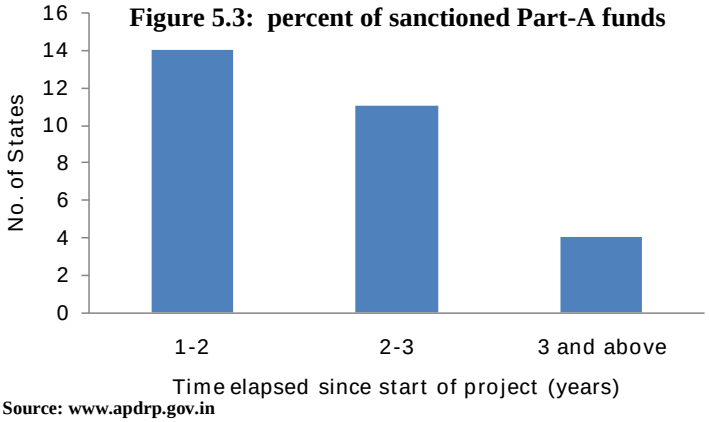



Source: www.apdrp.gov.in

- The disbursement of funds has also been very slow. Nearly 80 percent of the states have received only 30 percent of the sanctioned amount of funds under the scheme. This could be due to the laggardly pace at which the states are consolidating baseline data and progressing on the implementation of IT applications as of the utilities lack qualified personnel versed in operating a computer.

- As per guidelines of the R-APDRP, for the funds sanctioned under Part-A to be converted into grant, the scheme needs to be implemented within three years from the date of start of the project. As per official reports, a few utilities have already gone past the three year period and many are approaching the deadline. But none of these have a disbursement of more than 60 percent which shows there has been very less progress in implementing R-APDRP throughout India.

**Figure 5.3: percent of sanctioned Part-A funds**




**Source: www.apdrp.gov.in**

- As the related entities did not have much experience, RfP were not designed properly and bidders did not know how much to quote. This resulted in bids higher than the allocated budget. Many utilities like Punjab State Power Corporation Limited (PSPCL) went in for re-tendering thereby slowing down the entire process.
- Also in due course, the prices discovered for undertaking the work became extremely low owing to the competitive response from large number of players who entered the market eyeing a pie of the large fund that was committed for IT implementation. This raised several questions on the ability of the players to deliver good quality products and services, in a time bound manner.
- Many utilities failed to finalize their DPRs, thereby making it difficult for the MoP to expedite the process and release the funds.
- The R-APDRP was formulated in such a way that, initially Part-A would be implemented followed by system strengthening under Part-B. However, in practice both schemes were being implemented in parallel. Due to this, there were compatibility issues between the ITIA (Part-A) and the Project Management Consultant (Part-B) regarding various hardware and software technologies.
- Delays in follow-up measures like preparation of RfP or tender documents, finalization, and award of contracts to successful bidders, non-availability of project-specific manpower to monitor and execute the projects, and the inability of state utilities to handle high-value contracts have hindered the process of implementation of the scheme. Though utilities in Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh are at various stages of implementation, utilities in Bihar, J&K, Kerala, and Uttar Pradesh are lagging behind.
- Further, though most of the eligible utilities appointed SCADA consultants in 2010, only three states i.e. Tamil Nadu, Maharashtra, and Madhya Pradesh have gone ahead with selecting a SCADA implementation agency.

- Loan disbursement for SCADA implementation has also very slow. Of the 15 states that were eligible for funds, five are yet to get any funds and the rest have received only 30 percent of the sanctioned amount.

### *5.1.4 ISSUES IN IMPLEMENTATION OF R-APDRP*

The key issues being faced in implementation of R-APDRP (Part-A) are as follows.

- **Lack of adequate capacity**: A study on review of R-APDRP program by ISGF states that the utilities, consultants and the implementing agencies under the program were not ready for large IT implementation program roll-out in terms of manpower capacity and domain knowledge. In addition, the utilities lacked IT knowledge and IT savvy manpower. Most ITIAs and ITCs had very poor knowledge of power distribution business. Hence, lack of adequate capacity at all levels has been one of the major concerns in implementing the envisaged scheme.
- **Lack of standardization:** At the time of commencement of the R-APDRP program most of the utilities were running standalone applications with limited or no integration. Lack of uniformity in standards across utilities is a key issue in maintaining consistency at the national level. The R-APDRP program was designed for implementation at the national level; however standardization was not introduced from the start. The PFC has subsequently issued technical guidelines and standard model documents that enable the utilities to introduce standards based approach to implementing enterprise-wide automation solutions.
- **Timeframe for implementation:** Considering the actual loan disbursed as a proxy of the progress made by the states, meeting the proposed timelines has been a significant issue. The states were given a timeline of 18 months to complete the collection of baseline data from the date of sanction of the project. However, all states have crossed the stipulated deadline. There are several reasons for such non-achievement - (i) timelines for all states have been uniform which is unrealistic. For instance, states like UP, Maharashtra, AP and Tamil Nadu with large number of towns have timelines similar to small states like Goa, Puducherry, HP, Mizoram, Meghalaya etc.; (ii) procurement of satellite imagery which is to be acquired from National Remote Sensing Centre (NRSC) is a time consuming exercise. The IT implementing agency is required to obtain mandatory authorization from the State Government authorities and submit the same to NRSC which is a time consuming process; (iii) in cases where satellite imagery is not available, new scans is even more time consuming exercise.

  A study on review of R-APDRP program by ISGF states that Part-A under R-APDRP is first of a kind nation-wide IT implementation project in the world that covers 63 electricity distribution utilities to be implemented in 18 months and all packed in one contract per state. Most of the utilities around the world with much smaller systems and consumer base have taken much longer time in implementation of such initiatives. The timeline drawn for Part-A

was highly ambitious and was drawn without adequate appreciation of issues faced in such complex transformation projects. Consequently, the ISGF has recommended extension of the timeframe for implementation and pass through of appropriate cost escalations.

- **Electrical Boundary Ring Fencing**: Without ring fencing of electrical network (HT feeders), it is impossible to define the boundaries for GIS-based network mapping and energy accounting. Most of the utilities have not installed boundary meters on HT feeders which help in determining feeder-wise electricity flow.
- **Inadequate Metering**: 100 per cent metering of consumers, substation feeders, and Distribution Transformers (DT) is a pre-requisite for total energy accounting. The energy audit modules have to be integrated with the metering, billing and collection processes of the utility through IT interventions. Many utilities are lagging behind in ensuring 100 per cent metering of DTs, which prevents DT-wise accounting of energy losses.
- **Weak Data Regimes and Records for Network related data:** There are several network analysis tools available today that use sophisticated algorithms to compute phase imbalances, identifying low-voltage or overloaded sections, calculating section-wise loss levels and taking decisions on system optimization through network reconfiguration, capacitor placements and system improvement measures. Use of such tools requires real time data for every substation, feeders, DTs, circuit breakers, sectionalizers, auto-reclosures, capacitor placements etc. Due to lack of adequate and skilled manpower and absence of systems to capture such data on regular basis, a number of utilities struggle to furnish such data and decide on the way forward for maintaining such data. This results in consequent delay in the timely implementation of the schemes under the R-APDRP program.
- **Complexities in data collection for GIS based indexing and mapping:** GIS-based consumer indexing and network mapping requires Differential Global Positioning System (DGPS) survey for collecting geospatial data of distribution network and door to-door survey of consumers for mapping their unique electrical identity. The process has several challenges. Ground truth verification and post-processing of geospatial data sometimes require multiple visits to the site and data recollection. Often the legacy data on electrical network like the single-line diagram and asset attributes are not easily available with the utility because of the absence of proper field documentation.
- **Data Migration:** Migration of legacy data from the existing system to the new system is another challenge of R-APDRP. The historical data has to be understood, extracted in the required form, verified and tested, reconciled before it is fed to the IT systems. This is a significant change from the historical practices at most of the utilities.

In addition to the above, there have been several issues encountered in bidding for selection of suppliers for IT implementation which owing to the competition among the market players led to levels that are difficult to sustain raising questions on doability and quality of implementation. These issues collectively have resulted in the slow progress of the program. Nevertheless, the

program as conceived is much needed to revive the power sector in the country and is expected to pave way for better data measurement and handling, standardization in procedures, and implementing IT and related Smart Grid initiatives.

### *5.1.5 LINKAGE OF R-APDRP TO THE SMART GRID INITIATIVES IN THE COUNTRY*

All the interventions planned as part of the R-APDRP program are necessary first steps for introducing any IT intervention in a distribution utility. Table 5.1 details out the elements of the Part-A of the R-APDRP program and establishes its linkages with the implementation of Smart Grid initiatives.

**Table 5.1: Part-A of R-APDRP and its linkage to Smart Grid Implementation**

| S. No. | Part-A (under R-APDRP) | Linkage to Smart Grid Implementation |
|---|---|---|
| 1 | Preparation of Base-line data for the project area covering Consumer Indexing, GIS Mapping | • One of the major issues among the Indian utilities is the lack of information on asset classification and records, customer database etc. This acts as a huge constraint in planning for any systems based intervention. GIS based approach proposed as part of R-APDRP provides a strong platform for this to happen. It provides the utility with:<br>o Centralized repository for all electrical and non-electrical assets<br>o Provides platform for quick identification of assets<br>o Serves as a basis for technological interventions<br>o Integration asset management for creation, movement and retirement of assets<br>o Applications to support commercial, operational and network functions.<br>While the above may require further strengthening when Smart Grid initiatives are introduced and scaled up at the utility level, nevertheless as an initial step the above is of immense value. |
| 2 | Metering of Distribution Transformers and Feeders, and Automatic Data Logging for all Distribution Transformers | • R-APDRP program aims to move towards a standards based approach to metering and meter data management. This is aimed to be achieved through specification of guidelines, and technical specifications such as specifications for 3 phase 4 |

| S. No. | Part-A (under R-APDRP) | Linkage to Smart Grid Implementation |
|---|---|---|
| | and Feeders | wire CT/PT operated fully static AMR compatible tri-vector energy meter for area ring fencing, sub-station feeders, distribution transformers and HT consumers; functional requirement for meter reading instrument etc.<br>• The above enables development of a much needed platform to migrate from the legacy system to standards based infrastructure necessary for implementation of Smart Grid initiatives.<br>• In addition, aiming to move towards 100 percent metering is also necessary for implementation of Smart Grid initiatives going forward. |
| 3 | SCADA / DMS system (only in project areas having a population over 4 lakhs and annual input energy of 350 MU). It would include Asset Mapping of the entire distribution network at and below the level of 11 kV transformers and shall include the Distribution Transformers and Feeders, Low Tension lines, poles and other distribution network equipment | Introduction of SCADA will enable centralized control and monitoring of grid substations, reduce chances of manual error, enable improvement in reliability indices (SAIFI, SAIDI, CAIDI) and permit faster restoration of supply.<br>Similarly, DMS enables the utilities to monitor the distribution network centrally, and hence enable faster fault detection and rectification.<br>Both the above systems can further be expanded to introduce several Smart Grid based interventions. These include outage management system, peak load management system, demand response etc. |
| 4 | Adoption of IT applications for meter reading, billing, and collection; energy accounting and auditing | • Under the Part-A of R-APDRP an IT enabling platform has already been conceived with different levels of communication to and from the major components of the distribution network and operations. This also covers the key revenue management process including the metering, billing, and collection process.<br>• Automation of these processes is necessary as any future Smart Grid application will have to interface with these processes. |

| S. No. | Part-A (under R-APDRP) | Linkage to Smart Grid Implementation |
|---|---|---|
| 5 | MIS; redressal of consumer grievances, and establishment of IT enabled consumer service centers | • Automated customer service centres are being developed under the R-APDRP. Establishment of these centres will permit the utilities to integrate (i) customer information/records; (ii) record, manage and address customer queries and complaints; (iii) provide information about office locations, consumers touch points etc.; (iv) provide billing information, bill payment centers, modes; (v) provide connection status, service levels, planned outages; and (vi) information on efficiency programs, among others aspects.<br>• The above mentioned inputs will help utilities in providing better customer service and quality, and hence improvement overall customer satisfaction. Alongside, it will also help in creation of awareness and provide platforms for designing and introducing participatory energy conservation and demand response models (some of the smart applications) |

In summary, a number of distribution companies in India have very limited experience and exposure to the basic IT infrastructure and applications. Consequently, the orientation, skills and capabilities to manage IT and Smart Grid related interventions have been weak. Also, most of the commercial process (metering, billing and collections) have been characterized by lack of transparency, inadequate information and conflicts in reconciliation. Incorporation of R-APDRP has been successful in overcoming this initial barrier and has introduced the utilities to information and communications technology based processes and system. It has also led to development of basic IT infrastructure, systems, and standards that can be leveraged and expanded further to design meaningful Smart Grid interventions

## 5.2 ELECTRIC VEHICLE (EV) PROGRAM BY THE MINISTRY OF HEAVY INDUSTRIES

The GoI has set up a National Council for Electric Mobility (NCEM) to promote electric mobility and manufacturing of electric vehicles in India. It will be aided by the National Board for Electric Mobility (NBEM) formed by the Ministry of Heavy Industries.

The NCEM has formulated the National Electric Mobility Mission Plan 2020 (NEMMP 2020), which is the mission document for National Mission for Electric Mobility (NMEM). The NEMMP 2020 has set a target of six-seven million units of new vehicle sales of full range of electrified vehicles, along with resultant savings of liquid fuel of 2.2 – 2.5 million tonnes to be achieved in

2020. This will also result in substantial lowering of vehicular emissions and a decrease in carbon dioxide emissions by 1.3 percent to 1.5 percent. The program has a budget of Rs. 23,000 Cr. of which around Rs. 1,800 Cr. has been allocated for R&D in this field. GoIs support would be to the tune of Rs. 12,250 - 13,850 Cr. over the next five-six years. The NEMMP 2020 document detailing out the finalization and roll out of comprehensive array of interventions, schemes, policies, and projects will be unveiled to the public in a few months.

The program though has been launched with ambitious targets; there are several challenges that will need to be addressed taking the program forward. Some of the key challenges include: (i) limited players in the India market. While many players have expressed interest, actual commitment and actions of these players will depend on the policy announcements that come post the program launch; (ii) charging infrastructure in India is absent and will require significant upgradation; (iii) the electricity requirement for charging seven million vehicles would be huge. In a significant shortage energy shortage scenario and increasing cost of generation, this might pose a challenge; and (iv) none of these entities have included the state discoms which would play a key role in planning the power supply requirements for the seven million vehicles as mentioned in the previous point.

## 5.3 SMART GRID PILOTS TAKEN UP IN THE PAST

This section assesses the Smart Grid pilot projects undertaken in the past, their coverage, the implementation model and the current status of the same. A detailed assessment of these projects is provided in Annexure 5. Also, Smart Grid programs initiated by various funding institutions have been briefly listed in Annexure 6.

### *5.3.1 SMART GRID PILOT IN THE GARIA DIVISION OF WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED (WBSEDCL)*

The Smart Grid pilot proposed by the WBSEDCL involved the Utility working along with a System Integrator (or Smart Grid Operator), to implement a variety of software and hardware measures within a defined area of the electricity distribution network. This will facilitate real-time monitoring of power flows and operating parameters of major equipment in the electrical network. This would provide information critical to efficient operation, optimized asset utilization and reduction in network T&D losses leading to potential savings. Table below describes the broad details of the Smart Grid pilot .

**Table 5.2: Summary of Smart Grid Pilot Project (WBSEDCL)**

| Particulars | Description |
|---|---|
| Utility | WBSEDCL |
| Area Proposed and Coverage | Garia division located south of Kolkata in the South 24 Paraganas District of West Bengal. Within the Garia division, a sub-area covering three sub-stations, 11 feeders, 518 transformers, 10,000 poles, 57,000 customers over |

| Particulars | Description |
|---|---|
| | 270 km of MV and LV lines (largely urban) was selected for the pilot. |
| Operating Model | Pilot included deployment of smart meters (for consumers, feeders and distribution transformers) and sensors (on critical equipment) with two-way communication systems; and analytical software in the network operation center (NOC) that will trigger alarms for a wide variety of anomalies in the electricity network. Harvest Power Technology (HPT) will communicate these alerts/opportunities to WBSEDCL on a real / near-real time basis, which if acted upon can generate huge savings.<br>Once savings opportunities have been communicated by the Smart Grid Operator and after the passage of a mutually agreed period of time allowing for intervention by WBSEDCL, the Operator will start calculating "deemed savings" or savings that would have been generated had Operator's alert been acted upon by WBSEDCL. |
| Estimated Cost | 16 million dollars, with investments largely contributed by the Smart Grid Operator. |
| Envisaged Savings | Projected deemed savings pegged at 140.8 million dollars over a period of 15 years. These benefits were proposed to be shared between the WBSEDCL and the Smart Grid Operator. |
| Remarks | The overall pilot had several positives such as: (i) the pilot was one of the first few pilots proposed in the country; (ii) the area selection was good with high load growth area and urban area chosen for implementation; and (iii) the overall offering was low cost. In addition, there were several other value added services that were planned to be implemented at later stages of the pilot. These included assisting WBSEDCL in achieving actual savings (instead of deemed savings) i.e. loss reduction, support in reducing the peak load etc.<br><br>The pilot as per original plan was to be launched and implemented in early 2011. However, due to various shortcomings the pilot could not take off. One of the biggest drawback was that the deemed savings framework that assumed that the alerts provided to the utility were acted upon and benefits realized, even though in reality no action was performed. Thus, in the absence of actual assistance to the utility in implementation of measures for realizing the savings (defined as value added services in the model), the model appeared to be inadequate. Further, the savings projected also were heavily front-loaded as opposed to more balanced and gradual achievement curve.<br><br>These issues led continuous deferment of the contract signing between the WBSEDCL and the Smart Grid Company. As per the recent understanding, the plan due to various shortcomings could not be taken forward and was |

| Particulars | Description |
|---|---|
| | subsequently abandoned. |

### 5.3.2 *SMART GRID PILOT IN THE ELECTRONICS CITY AREA OF BANGALORE ELECTRICITY SUPPLY COMPANY (BESCOM)*

BESCOM was one of the first utilities to go in for Smart Grids in India. BESCOM through funds received under the Distribution Reform Upgrades and Management (DRUM) program had implemented Distribution Management System and SCADA system in its territory. The presence of these systems proved to be a key enabler for setting up a Smart Grid. Also the presence of local IT companies, actively involved in Smart Grid technologies was also one of the driving forces behind BESCOMs Smart Grid strategy.

The initial feasibility study was funded by United States Trade and Development Agency (USTDA). The plan was to install smart meters in the pilot area to bring down metering losses. BESCOM had also planned to monitor electricity usage by consumers on a real time basis. The future plans were to scale this up to introduce Demand Response process thereby shifting loads during periods of peak demand. Table below describes the broad details of the Smart Grid pilot.

**Table 5.3: Summary of Smart Grid Pilot Project (BESCOM)**

| Particulars | Description |
|---|---|
| Utility | BESCOM |
| Area Proposed and Coverage | Electronics City; Total coverage area - 332 Acres. The major consumers present in the area are IT & ITES companies. Total number of consumers served in the area amount to 19,441 with an energy consumption of 278 MU (as of March 31, 2011) |
| Operating Model | The Smart Grid pilot targets improvements in all areas of the electric system from transmission to distribution to local generation. The pilot includes, on-line condition monitoring for switchgears and transformers; dynamic rating for transmission network; digital S/s; self-healing distribution network at 11kV level; Scheduling and control Integration of distributed local generation with EMS, and DMS; Smart meters and two-way communication network; Integration of demand side management with EMS and DMS; robust fibre optic network and wireless or power line solutions for seamless communication and enterprise level data integration. BESCOM appointed KEMA to draw up a technological roadmap for the implementation of Smart Grid.<br>As per the plan, Smart meters would be installed and cost would be borne by the consumer. The consumer would be given an option to pay 50 percent of the cost of the meter upfront and rest could be paid in installments. The Consumer User Interface is bound to be effective as the consumer will be |

| Particulars | Description |
|---|---|
| | aware of his consumption and reduce unwanted consumption. |
| Estimated Cost | 20.7 million dollars, investment to come from USAID, BESCOM, MoP and in part by contributions of equipment and expertise by suppliers who want to demonstrate their technologies. |
| Envisaged Benefits 5.1.1 | The Smart Grid would result in first and foremost AT&C loss reduction. Through effective implementation of Demand Response, there would be no power cuts and it will aid in better management of peak load. It will improve load management and better asset optimization. |
| Remarks | The planned pilot project for BESCOM was seen as a pioneering effort in the Indian Power sector. The pilot area i.e. Electronic City was an ideal area to implement Smart Grid technologies due to the presence of adequate infrastructure and high collection efficiency. The R-APDRP program had provided BESCOM with SCADA/DMS and GIS systems, and hence ensured reasonable level of basic infrastructure to already be in place.<br><br>BESCOM initiated the process of distributing prepaid and postpaid smart meters to the consumers. SysconHefcom Smart Solutions Pvt Ltd, a city-based company was entrusted with the task of installing smart meters. The plan was to install around 17,000 smart meters. BESCOM had also initiated the process of providing a Consumer Interface Unit (CIU), which could be effectively used by the consumer to monitor each one of the appliances for power consumption. The CIU displays power consumed in real time.<br><br>However, the process of implementation has been slow and characterized by several implementation issues. As per the latest update, a review consultant has been appointed by BESCOM to review the initial DPR prepared. Details of the further plan of activities and the timelines are not available. |

### *5.3.3 SMART GRID PILOT IN THE AREAS OF TATA POWER DELHI DISTRIBUTION LTD (TPDDL)*

TPDDL, erstwhile North Delhi Power Ltd. (NDPL), is a joint venture between Tata Power Company and the Government of NCT of Delhi with the majority stake being held by Tata Power. It distributes electricity in North and North West parts of Delhi. TPPDL is one of the three private distribution companies in Delhi. It has been successful in bringing down distribution losses by significant level in very less time through innovative approaches.

The following two Smart Grid projects are being implemented by TPDDL: (i) Project 1: Smart Grid Pilot project with Auto Demand Response at a capital cost of Rs. 12.5 Cr and (ii) Project 2:

Feasibility Study for development of Smart Grid technology road map. Table below describes the broad details of the Smart Grid pilot

**Table 5.4: Description of Smart Grid Pilot (TPDDL)**

| Particulars | Description |
|---|---|
| Utility | TPDDL |
| Operating Model | Project 1: The plan for implementation of this project has already been approved by the Delhi Electricity Regulatory Commission (DERC).<br>Project 2: The feasibility study awarded to Quanta Technology includes the development of requirements and specifications for a Smart Grid roadmap for TPDDL and is expected to address various improvements and investments including integration of smart meters, automated meter reading, distributed generators, and other Smart Grid applications. |
| Estimated Cost | Project 1 - Rs. 12.5 Cr., Smart grid pilot project with Automatic Demand Response with investments largely contributed by the TPDDL and IBM. |
| | Project 2 - Developing a Smart Grid technology road map funded by USTDA grant of 0.7 million dollars (Rs. 3.5 Cr). |
| Remarks | TPDDL has already completed first phase of Smart Grid pilot implementation. Technologies such as AMR, GIS, SCADA, DMS, DA and OMS already in place. Alongside, a Smart Grid team has also been formed at TPDDL and related work is in progress. |

## 5.4 SMART GRID PILOTS PROPOSED FOR SUPPORT BY GOI

The GoI announced its intention to fund Smart Grid programs across the country. It received proposals from all the states. After evaluation of all the proposals it was decided to implement 14 pilot projects across different cities in India. The total budget for the program was set at Rs. 400 Cr. with cost of individual project being pegged at Rs. 50-60 Cr. Of the entire investment plan, the GoI will be contributing 50 percent while the rest is to be complemented by the state utility. The Smart Grid pilot project would cover wide area of technological interventions such as AMI, Peak Load Management, Outage Management, Micro-grid etc.,

**Table 5.5: Summary of the 14 Smart Grid pilot projects**

| Utility, State | Target Consumer Base | Estimated Cost of the project (Rs. Cr) | Proposed Area for Pilot project | Functionalities to be implemented | Total number of feeders | Total DTs | Estimated time of completion (months) |
|---|---|---|---|---|---|---|---|
| UHBVNL, Haryana | 30544 | 29.41 | Panipat | ◦AMI for Residential /Industrial<br>◦Peak Load Management<br>◦Demand side management<br>◦Power Quality<br>◦Demand response using AMI | N.A | 531 | 18 |
| CESC, Mysore | 21824 | 41.93 | Mysore Additional City Area Division | ◦AMI for all customers<br>◦Condition Based Asset Monitoring<br>◦Peak Load Management<br>◦Mobile work force management<br>◦Outage Management<br>◦Consumer Portal<br>◦Integration of Renewable and Distributed Generation | 14 | 473 | 12 |
| TSECL, | 46071 | 25.83 | Electrical | ◦AMI for Residential /Industrial | 3 | 58 | 15 |

| Utility, State | Target Consumer Base | Estimated Cost of the project (Rs. Cr) | Proposed Area for Pilot project | Functionalities to be implemented | Total number of feeders | Total DTs | Estimated time of completion (months) |
|---|---|---|---|---|---|---|---|
| | | | | ◦Peak Load Management<br>◦Demand side management<br>◦Power Quality<br>◦Demand response using AMI | | | |
| KSEB, Kerela | 25078 | 32.31 | Geographical area of Kerala state | ◦AMI<br>◦Demand Response<br>◦Schedule based automatic billing<br>◦Load Survey<br>◦Consumer portal<br>◦Real time reporting of outage | N.A | N.A | N.A |
| Electricity Department, Puducherry | 87031 | 52.45 | Division 1 | ◦Common Meter Data Management System<br>◦AMI system | N.A | N.A | 19 |
| UGVCL, Gujarat | 20524(Naroda)<br>18898(Deesa) | 55.06 | Naroda of Sabarmati circle and Deesa of Palanpur circle | ◦AMI<br>◦Peak Load Management<br>◦Power Quality<br>◦Outage Management<br>◦Theft Management/Tamper Detection<br>◦Demand Side Management and Demand Response | 36 | 957 | 12-18 |

| Utility, State | Target Consumer Base | Estimated Cost of the project (Rs. Cr) | Proposed Area for Pilot project | Functionalities to be implemented | Total number of feeders | Total DTs | Estimated time of completion (months) |
|---|---|---|---|---|---|---|---|
| | | | | ◦DTR health Management<br>◦Consumer Portal<br>◦Asset management<br>◦Renewable energy integration | | | |
| AP CPDCL, Andhra Pradesh | 11904 | 43.4 | Jeedimetla Industrial Area | ◦AMI for Residential / Industrial<br>◦Outage Management<br>◦Peak Load Management<br>◦Power Quality | 28 | 1107 | 18 |
| APDCL, Assam | 15000 | 43.09 | Guwahati distribution region | ◦AMI for Residential / Industrial<br>◦Outage Management<br>◦Peak Load Management<br>◦Power Quality Monitoring<br>◦Demand Response and Demand Side Management | 93 | 27272 | 18 |
| MSEDCL, Maharashtra | 25629 | 26.72 | Baramati | ◦AMI for Residential /Industrial<br>◦Crew management<br>◦Outage Management<br>◦Operations dispatch<br>◦Switching order development<br>◦Demand Forecasting | 1 | 168 | 24 |
| CSPDCL, Chhattisgarh | N.A. | 5.89 | Siltara , Raipur district | ◦AMI<br>◦Peak Load Management<br>◦Demand Response and Demand Side Management | N.A | 83 | 24 |

| Utility, State | Target Consumer Base | Estimated Cost of the project (Rs. Cr) | Proposed Area for Pilot project | Functionalities to be implemented | Total number of feeders | Total DTs | Estimated time of completion (months) |
|---|---|---|---|---|---|---|---|
| HPSEB, Himachal Pradesh | 650 | 18.11 | Kala Amb | AMI for industrial consumers<br>Substation Automation<br>Distribution Automation<br>Power Quality Management<br>◦Outage Management<br>◦Demand Response and Demand Side Management | 21 | 82 | 24 |
| PSPCL, Punjab | 85746 | 13.15 | City Circle Area, Amritsar | ◦Outage Management<br>◦Distribution system<br>◦AMI | 91 | 2188 | N.A |
| WBSEDCL, West Bengal | 4404 | 8.06 | Siliguri | ◦AMI for Residential / Industrial<br>◦Peak Load Management | 36 | 1315 | 12 |
| JVVNL, Rajasthan | 2646 | 18.11 | Jaipur (VKIA* Smart Grid Project) | ◦AMI for Residential / Industrial<br>◦Peak Load Management | 36 | 760 | N.A |

A detailed description of each of the proposed Smart Grid pilot projects has been provided in Annexure 6. Additionally, the annexure also provides description of the Smart Grid pilot in Puducherry and Baramati, Maharashtra as activities in respect of the said pilot have commenced with initial control centre already operational.

**As is observed from the above, a considerable focus of the ISGF and the ISGTF now will be to take forward the implementation of the above pilots. While the utilities shall be the main implementers, necessary knowledge support shall be provided by ISGTF, ISGF and other institutions. However, it will be critical to support areas which remain uncovered (or only partially covered) in the above pilots/initiatives and appear to be key priorities for the Indian power sector.**

**A preliminary review of various pilots indicates that most of them are not backed by strong commercial and regulatory mechanisms, which are necessary for long-term sustainability and scaling up of the pilot programs. The following deliverables under this program will undertake a detailed review of the above pilots and identify pilot(s) where PACE-D could participate and support the pilot program. Alongside, possibility of alternative pilots will also be assessed to cover areas that do not find coverage in the above pilots.**

## 5.5 OTHER SMART GRID INITIATIVES

- **AZURE POWER**

Azure Power has been awarded a USD 476,670 grant from the USTDA for a feasibility study on two 500-kW micro-grid solar photo-voltaic power generation pilot projects in Gujarat and Chhattisgarh.

Following the study, Azure aims to set up over 100 micro-grid solar systems, with each system covering an average of two-three acres of rural land which would generate sufficient power to provide electricity to approximately 800-1,000 villages with little or no connectivity to existing electrical grids. The study is expected to be completed by 2014.

- **GRAM POWER (GP)**

The Gram Power micro-grid system has a simple operating model. Gram Power's Smart Prepaid Meter is installed at each of the consumer's premises. Thus, power is paid in advance before consumption. The proprietary grid communication monitors and collects data from all meters. The grid can be managed remotely. There is a configurable load limit on every meter and consumers are charged as per hours of consumption. Overload detection and self-recovery on meters are available. Gram Power set up India's first smart micro-grid in rural Rajasthan in May 2012.

- **MAHARASHTRA STATE ELECTRICITY DISTRIBUTION COMPANY LTD. (MSEDCL)**

It is understood that, MSEDCL has planned to appoint Telvent along with Larsen & Toubro Ltd to implement Smart Grid solution covering baseline data and Information Technology (IT) applications for energy accounting, auditing and IT based consumer service centers for 95 towns in its area. However, the plan was later abandoned. In addition to the above, recently, MSEDCL has taken up another initiative involving implementation of RF/ZigBee communicable meters with the first tender for one Million meters already released and 90,000 meters deployed. It is also implementing DCU and Communication Head-end for automatic reading of these meters, in addition to reading through RF Hand-held meters. This once implemented will be one of the first large scale metering project in India.

Further, MSEDCL has initiated the process of implementing a Demand Response (DR) project in Mumbai to curtail power consumption during peak load periods. The project envisages a saving of 2.5 MU. This program has been approved by the MERC and has been allocated a budget of INR 45 Million. According to the mechanism followed, a service provider who is essentially a demand response aggregator (DRA) will install necessary instrumentation at consumers' end for interaction, to effectively participate in DR Program. During periods of "need" the utility will trigger a DR event at least one hour prior to start of the DR event. The event will last a maximum of two hours. The DR participants will respond to the DR event. At the end of the month the service provider/DRA calculates load reduction by the DR participants in kWh. The utility pays

Rs 5.50/kWh for saved energy to the DRA who in turn pays INR 2.50/kWh to the DR participant. The payment is based on the assumption that during peak periods, the utility purchases power at more than INR 8/kWh.

- **SOLAR ENERGY CENTRE – MODEL MICRO-GRID**

The Solar Energy Centre is a dedicated campus of the Ministry of New and Renewable Energy (MNRE) for testing of various Solar Energy technologies in India. It has around 60 kW of renewable energy sources consisting of solar PV, Solar thermal, and planned biomass. To handle all these sources effectively, there was a need for establishing a smart micro grid in the campus. A Smart Micro grid infrastructure (E-Grid) of both IT hardware and software was implemented on the existing electrical outlay to efficiently manage the generation sources, and the block loads, leading to maximization of renewable energy harvest, and budgeting of dirty power consumed by demand side management efforts. The E-Grid implemented by Ecolibrium Energy provides the following functionality:

**Table 5.6: E-Grid Functionalities**

| Functionality | Benefit |
|---|---|
| Real time generation and consumption tracking | • Improved solar panel tracking and maintenance<br>• Ability to perform self-budgeting for consumption (customized alerts)<br>• Showcase ability to do AMR, net metering , Time of day tariff management |
| Status Tracking and Control | • Improved maintenance and tracking of devices and DG sets.<br>• Identify energy inefficient devices for replacement during next procurement<br>• Track any ghost appliances running during nonworking hours |
| Battery Management | • Showcase ability to perform Smart Grid management by battery storage and discharge at non-peak and peak hours respectively<br>• Limit battery storage at peak hours, thus increasing savings from grid power buy |
| Demand side management and response | • Massive savings due to limiting grid power purchase during peak hours by performing selective non-essential load shedding from server<br>• Diesel savings due to demand management during grid failure |

The project is in its final stage of implementation and is expected to be in its demonstration phase by end of November 2012

- **KERALA ELECTRIC POWER CORPORATION (KEPC)**

Kerala Electric Power Corporation had also announced implementation of Smart Grid pilot in its area. The program had a budget of USD 10 billion for improvement of power infrastructure and deployment of Smart Grids. It is understood that Korea Electric Power Corporation (KEPCO), along-with Consortium of Companies including POSCO ICT was selected as the implementing agency. However, this pilot was also later abandoned.

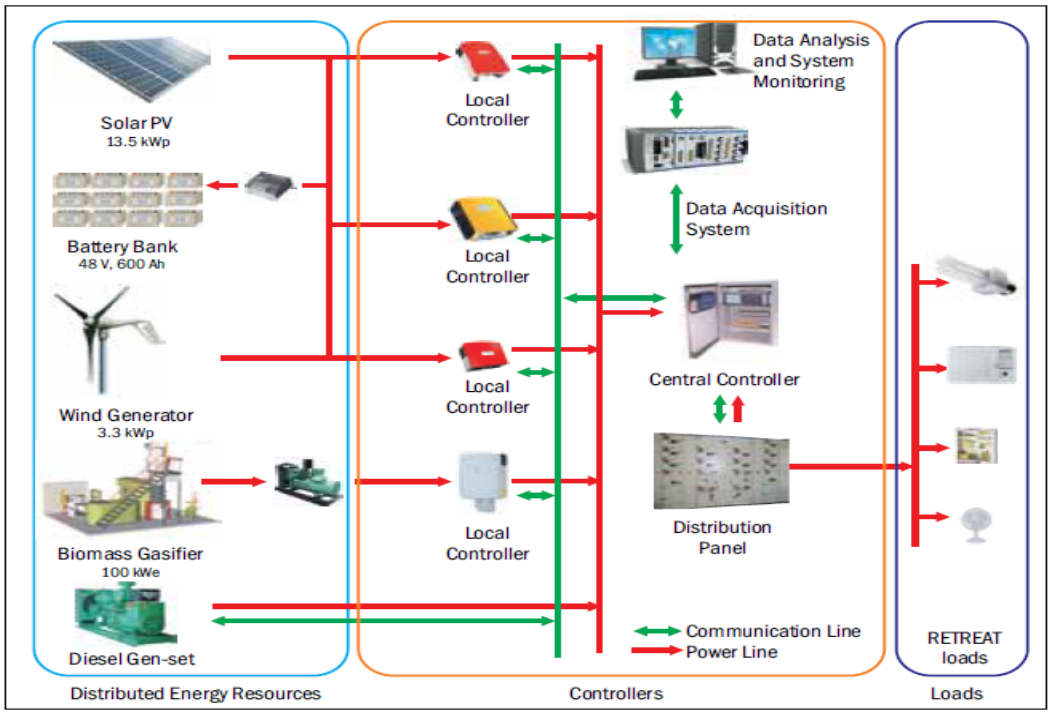
- **TAMIL NADU GENERATION AND DISTRIBUTION COMPANY (TANGEDCO)**

Tamil Nadu is in process of preparing for implementing a pilot Demand Response program in Udumalpet area. The area is one of the major textile production hubs of Tamil Nadu and has a lot of wind power generating plants. Shakti Sustainable Energy Foundation (SSEF), part of ClimateWorks Foundation (USA), has funded a study to determine the potential of demand response program in Tamil Nadu.

- **THE ENERGY AND RESOURCES INSTITUTE (TERI)**

TERI has implemented a pilot micro-grid for demonstration purpose on its Retreat campus. The system makes use of RE sources like Solar, Wind, Biomass and also diesel. The system is also supported by a battery bank which stores the energy generated. This energy is used to run the local loads on the campus. Shown below is a schematic of the smart micro grid installed by TERI.

**Fig 5.6: Schematic Representation of the Micro-grid at TERI Gram**




**Source: TERI**

The main features of the micro-grid implemented by TERI at its Retreat campus are:

- Use of multiple generation sources such as solar, wind, diesel and biomass. This ensures maximum utilization of RE sources. Nowadays, solar and wind hybrids are finding favour with Indian RE developers.
- Through the monitoring systems, there is better forecasting, control and load profiling. The system uses an integrated, high-speed, FPGA-based digital communication on LabVIEW platform
- There is Real-time data acquisition and monitoring of thousands of electrical and physical signals
- Outages are minimized to a great extent and there is quick response to network disturbances through automatic connect/disconnect of system components.

As observed from the preceding discussion, the results of the proposed pilots have been mixed. This indicates the need for greater focus on pilot preparation and need for robust planning. PACE-D shall aim to create framework to ensure better planning and implementation of Smart Grid initiatives.

# 6 ROADMAP FOR ACHIEVING THE GOALS OF A SMART GRIDS ENABLED INDIA

As the preceding sections have identified, there is already a nascent vision for Smart Grids in India. There are also a large number of programs that qualify under the banner of Smart Grids. Indeed, the Indian power sector presents a story of rapid evolution and development, having come a long way since the introduction of second wave of reforms heralded by the Electricity Act of 2003 (EA 03). The EA 03 gave a major fillip to the power sector by creating conducive environment for enhanced private sector participation. Alongside, focus of the EA 03 has also been to usher in reforms that aim at providing affordable, good quality and reliable power to the consumers, making the segments of the electricity sector commercially viable and promoting efficiency improvement across the electricity supply chain. There is great amount of focus on renewable energy to complement conventional fossil fuel generation. Similarly, in the gas sector, an independent regulatory framework holds promise of ushering advancement. On the consumption side, India is witnessing great momentum in its energy efficiency initiatives in industrial and commercial applications. New environmental markets are being created to signals to renewable energy and energy efficiencies. These markets are set to complement the vibrant power markets that have emerged in the past decade.

However, in the backdrop of these encouraging developments, new challenges are emerging. India's energy realities are now unfolding in a manner that is causing considerable concern. An acute shortage of fuel has resulting in partial or full stranding of more than 30 GW of fossil fuel based generation capacity. Renewables have started filling the void, but presents technological and cost challenges that the utilities have found difficult to address. At the other end, a weak electricity distribution system loses more than 25 percent of the energy input into the grid. The aging infrastructure needs a quick revamp. The current grid failure, which brought more than half the country to a standstill, has raised serious concerns about the reliability of the entire power system. Grid modernization needs to be taken up on a priority basis primarily to bring in stringent norms for grid discipline.

The financial, fiscal and environmental impact of these problems is tremendous and pose enormous burdens for India's developing economy and seriously hampering its competitiveness. Indeed it has been variously observed that India's energy costs are by far the highest among comparable economies. This, coupled with poor quality of service, will have serious consequences for consumers, markets and the economy unless the issues are addressed in a very deliberate and coordinated manner.

In practice the relationship between conventional energy, renewable energy, energy efficiency, etc. is intricate and features deep inter-linkages. For example, renewable energy serves to address the issues faced on development, environment and fuel resources encountered in conventional energy, while conventional energy can in turn help the system manage the variability issues in renewable energy. The two thus have a symbiotic relationship and not necessarily conflicting

positions in power system development and operations, but only if the transmission and distribution networks as well as the consumption end is efficiently and effectively managed.

Smart Grids, while not being a panacea for such problems, have the potential for providing the integrated and coordinated solutions to these problems. The array of technologies and applications under the banner of Smart Grids have the ability to offer India some of the most modern and effective solutions that can take the Indian energy sector and the economy forward, rapidly modernizing the operations on the way and bringing them to world standards in a relatively short period of time. The opportunity is tremendous since the size of the Indian economy its talent pool and the nature of its issues provide an opportunity space for rapid innovation on a scale that can be truly transformative. The following table provides an account of the areas where Smart Grid interventions could be of benefit, and a summary of issues for the following application areas as an illustration:

- Electricity Distribution
- Electricity Markets
- Environmental Markets
- Renewable Energy
- Energy Storage
- Transport
- Industrial Energy Efficiency
- Building Energy Efficiency

The areas identified are but examples of the applications that can be fostered through Smart Grids. As Smart Grids attain maturity, the potential for expansion of applications is enormous. However, at the first instance it is important to identify the issues and applications at hand and priorities among them in an objective and coherent manner. While a more detailed assessment will come subsequently during the course of our project, the table provides a flavor of the issues that Smart Grids could effectively address, along with an indication of the challenges.

**Table 6.1: Smart Grid Application Areas and Potential Development Issues**

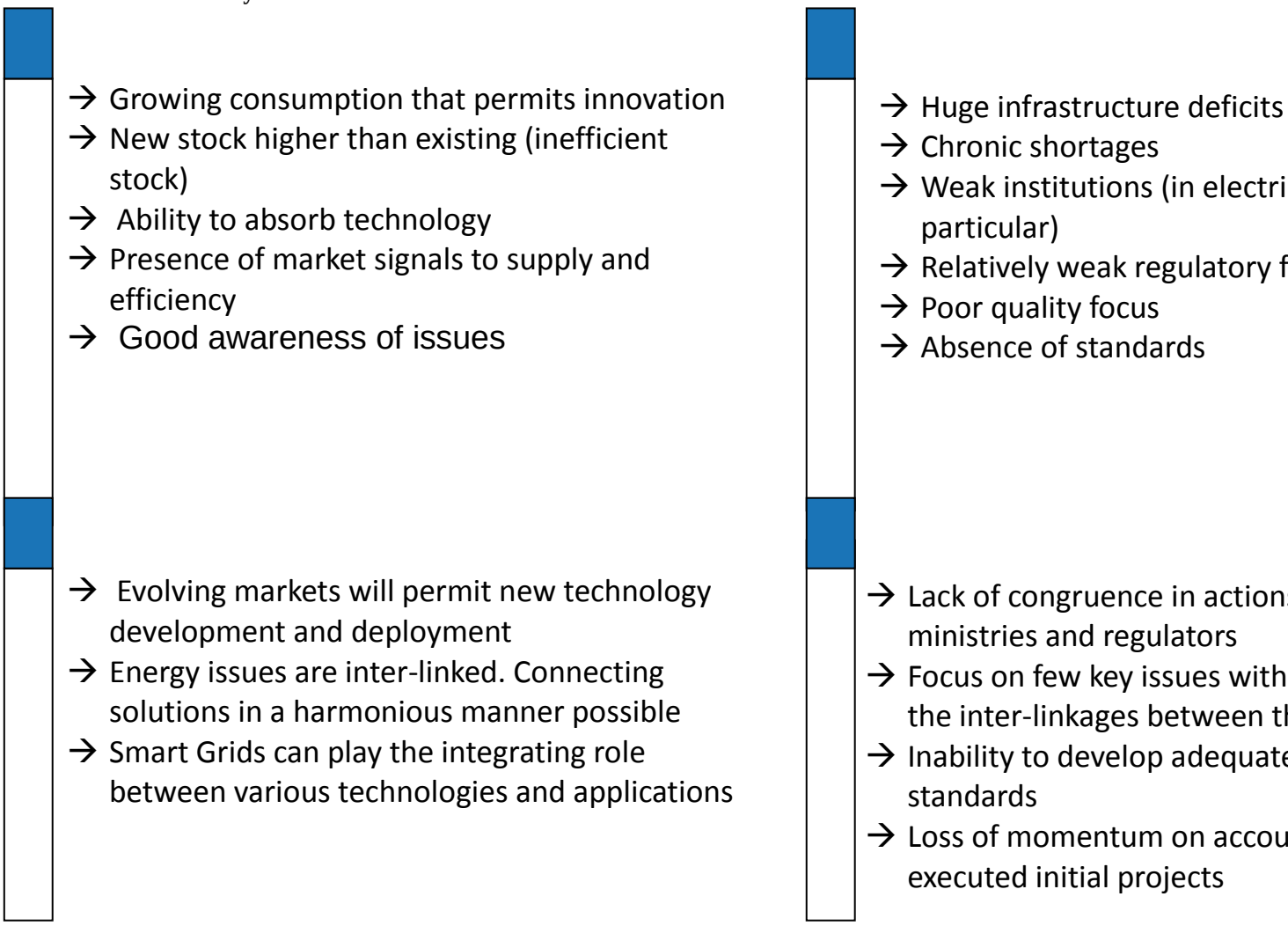
| | | Development Potential and Issues | | | |
|---|---|---|---|---|---|
| | **Aspect/Area** | **Current Status** | **Key Business Issues** | **Importance/Potential for Smart Grids** | **Issues for Smart Grid Development** |
| **Application Area** | **Electricity Distribution** | • Extremely inefficient<br>• Huge theft<br>• Poor customer service | • Lack of measurement and controls<br>• Antiquated technologies/ Manual operations<br>• Poor business orientation | Very High (can bring about rapid technological upgradation. Will support loss reduction and Demand Response) | • Poor business and technology orientation<br>• Scale of issues/poor preparedness<br>• Regulatory development<br>• Standards that permit inexpensive deployment |
| | **Electricity Markets** | • More than 10 percent of overall electricity sale<br>• Has brought about tremendous efficiency gains<br>• Sends price signals to consumption (distribution) | • Poor networks. Problems in open access<br>• Inadequate Business Processes, Measurement and control<br>• Poor cost signaling/ understanding | High (Open access and controls can be very effectively supported) | • Political economy and regulatory issues<br>• Network and control design that permits innovation<br>• Utility capability to manage transformation |
| | **Environmental Markets (REC, PAT)** | • Nascent, developing fast<br>• Closely linked to energy efficiency and renewables | • Very nascent now. Does not provide confidence to investments<br>• Baseline definition issues in (PAT) and monitoring<br>• Trading systems need refinement | High (SG can provide a strong information and controls base and also enable response to price signals) | • SG system design and regulations<br>• Standards that are universal and assist inexpensive deployment |

| | | | | | |
|---|---|---|---|---|---|
| | **Renewable Energy** | • Very fast developing<br>• Fills India's energy void | • Variability management and storage<br>• Transmission networks and controls | Very High (SG can assist in grid integration, forecasting, balancing and storage) | • SG system design and regulations<br>• Standards that permit inexpensive deployment<br>• Control center management |
| | **Energy Storage** | • Nascent in India<br>• Closely linked to RE and EE | • Expensive<br>• Technological upgradation<br>• Space requirements | High (SG can integrate energy storage with grid and use during energy deficit; can be used as balancing; can be used to island the area in case of blackout) | • Access to technology and standards that permit inexpensive deployment<br>• Utility capability to manage transformation |
| | **Transport** | • Largest energy sub-sector after electricity<br>• Largely fossil fuel dependent<br>• Pollution a significant issue<br>• Only hybrid vehicles (fossil fuel + EV) available<br>• Current focus only on mobility and associated environmental issues | • EVs are expensive<br>• Inadequate infrastructure for EV deployment and proliferation<br>• EV charging may coincide with peak time since consumers will charge in the evening | High (SG can integrate with grid and reduce short term power purchase; use as balancing resource; SG can also optimize the charging periods i.e. can automatically start charging during non-peak periods in the night) | • Policy for EV deployment at National level<br>• Deployment of inexpensive technology<br>• Regulatory issues |
| | **Industrial Energy Efficiency** | • Improving rapidly<br>• Signaled by environmental markets | • Lack of awareness | High (SG enables better load management through DSM and DR | • Poor business and technology orientation<br>• Scale of issues/poor preparedness |

| | | | | | |
|---|---|---|---|---|---|
| | | • Contending with energy shortages | | interventions) | |
| | **Building Energy Efficiency** | • Fastest growing energy consuming sector<br>• Widely varying energy efficiency levels | • Lack of awareness among builders and consumers<br>• High initial cost of EE appliances | High. Smart Grid can help consumer govern usage in real time thereby reduce unwanted wastage of electricity. Consumer User Interface is an example | • Regulatory development particularly ToU/ToD tariff<br>• Low level of awareness<br>• Poor business and technology orientation among developers and consumers |

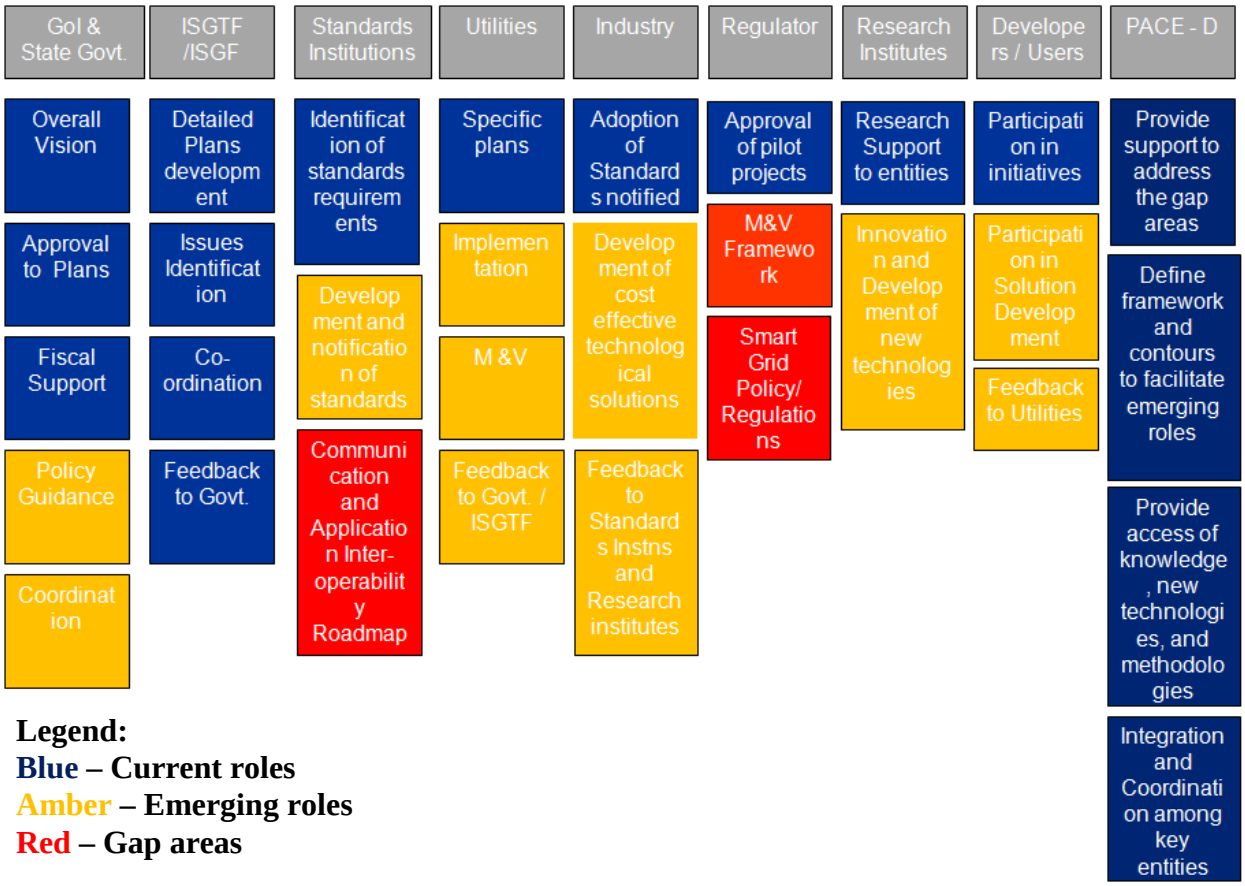
The benefits of Smart Grids are apparently enormous and so are the challenges. The strategy of a country must thus be tailored to its needs and aligned to its strengths and weaknesses. In the Indian context, given the federal structure, legacy issues on poorly managed operations, weak institutions and a fragile state of finances, assessing the strengths and weaknesses is of considerable importance, and must drive the strategy the country takes towards implementation of the Smart Grids program. The following table summarizes these in the form of a SWOT analysis.

**Chart 6.1: SWOT Analysis of Smart Grids Initiatives in India**




To progress effectively in deployment of Smart Grids, India needs to seize the large opportunity space and, cognizant of the deep seated weaknesses, address the threats that the deployment of Smart Grids will face in a very deliberate manner. These must be translated into an effective action program within the PACE – D program, but also beyond in all initiatives on Smart Grid enablement. The following chart provides an assessment of the aspects that would need to be addressed in this regard by the principal actors in the deployment of Smart Grids.

**Chart 6.2: Definition of Actors and Roles in India's Smart Grids Deployment Program.**




**Legend:**
**Blue – Current roles**
**Amber – Emerging roles**
**Red – Gap areas**

Review of the various current and potential tasks clearly indicate that there are very large gap areas between what is required for a holistic implementation and what the identified responsibilities are currently. Even when one considers the 14 pilot programs under implementation, the gaps are significant. This is not unusual since the overall program for Smart Grids is in very nascent stage. The initiatives under the PACE – D program will play a very critical role in furthering the Smart Grids initiatives in a comprehensive manner.

It is also apparent that considering the large number of application areas and the range of issues involved (and their complexity), there has to be a set of priorities drawn out for India's Smart Grids actions. Based on the account of the activities involved, as articulated in the previous section, a systematic set of priorities need to be evolved and attended to. Actions also need to be defined for each aspect for the Short Term, Medium Term and Long Term in an overall 10 year time frame.

The following table provides a list of actions along with suggested timelines, which will serve as a basis for discussion for the PACE – D Smart Grids team with the ISGTF and GoI.

**Chart 6.3: Actions Identified for India's Smart Grids Program**

| Implementation Plan Aspect | Short Tem (2012-14) | Medium Term (2015-17) | Long Term (2018-22) |
|---|---|---|---|
| **Regulatory/Technical Development for Smart Grids** | | | |
| Communication and Application Interoperability roadmap | | | |
| Adoption and deployment of roadmap | | | |
| Metering specification for three-phase meters | | | |
| Smart Grid regulations (interfacing with FoR) | | | |
| Time of Usage/Time of Day tariff mechanism (interfacing with FoR) | | | |
| EV integration pilot trial runs | | | |
| EV commercialization | | | |
| M&E framework development for planned pilot programmes | | | |
| RE control centres for RE integration | | | |
| Scaling up of RE control centres | | | |
| Demonstration of DR programs | | | |
| Scaling up of DR programs | | | |
| Pilots to demonstrate new/emerging energy storage technologies | | | |
| Commercialization energy storage solutions | | | |
| **Policy/Institution Development** | | | |
| Administrative cell within MoP to coordinate Smart Grid initiatives in the country | | | |
| Smart Grid cell in utilities with dedicated officers to handle IT and communication related activities | | | |
| Policy for EV deployment | | | |
| State level Smart Grid policy and roadmap | | | |

| Implementation Plan Aspect | Short Tem (2012-14) | Medium Term (2015-17) | Long Term (2018-22) |
|---|---|---|---|
| **Capacity Building** | | | |
| Pilot conceptualization and planning | | | |
| M&E aspects | | | |
| Awareness creation and capacity building among utilities and regulatory agencies | | | |
| Strengthening of State Development Agencies | | | |
| Capacity building of 14 pilot projects | | | |
| Capacity building on emerging SG technologies | | | |

By extension the finalized priorities for Smart Grids in India will guide the actions under the PACE – D program as well. Even as they are thus subject to finalization of the overall Smart Grids action plan, the following section discusses these priorities for the PACE – D program, as perceived at this juncture.

# 7 PRIORITY AREAS IDENTIFIED FOR PACE-D

The preceding section points out several gaps that need to addressed for holistic implementation of Smart Grids in the country. The focus of this section is to define the immediate issues and priorities for PACE-D, which then form the basis for activities proposed during the initial years of the program.

These are defined below:

a. **Absence of a comprehensive vision and road map**: As stated in the preceding sections, the ISGF has recently brought out a draft vision statement and the corresponding roadmap/targets to be adopted for the country. Several programs, activities and pilots (including the recently approved GoI pilots) have been initiated much before the formulation of the National Smart Grid Vision, and hence lack coherence with the overall policy goals, the standards to be adopted and the technologies to be considered. Further, the vision as finalized in its current form will need strong buy-in and acceptability at the state level. The states further may need to evolve their own road map that is consistent with the national road map. Thus, finalization of the vision and the road map at the national level should be an immediate priority.

b. **Lack of Adequate Institutional Capacity** – Several entities/stakeholders are involved in the Smart Grid activities in various forms covering wide range of activities from development of a national vision to Smart Grid pilot planning to formulation of standards. Due to absence of a harmonious framework, the roles and responsibilities of the institutions involved are diffused. Also, institutions involved lack adequate capacity and skills required for Smart Grid implementation. The utilities, the key implementers of the programs lack IT knowledge and IT savvy manpower to take the initiatives forward. Similarly, there is lack of appreciation among the state electricity regulatory commissions of IT as an enabler of change. Thus, adequate capacity development and handholding of all stakeholders involved is critical for success of programs initiated for Smart Grid implementation.

c. **Weak Commercial and Regulatory Framework** – Need for a clear regulatory regime is critical for promoting the Smart Grid pilots in the country. With the lack of clarity on the approval of investments for proposed pilots and the regulations/guidelines governing the same, the utilities are apprehensive of implementing such initiatives. The pilot programs also need to conceptualize and develop robust commercial mechanisms that enable sustainability of the proposed initiatives in the long-run. The current cost benefit analysis undertaken for many of the pilots does not reflect this. Support in development of robust business models is hence an area that needs to be strengthened.

d. **Lack of Uniform Standards**[2] **-** One of the critical requirements for large scale adoption of Smart Grid initiatives would be to define the communication and application Inter-Operability Roadmap for India. The current framework lacks consistency among the stakeholders in adoption of standards for various Smart Grid technologies and equipment. One of the problems that India faced with implementation of APDRP was the issue of ability to read proprietary meters and lack of standardization in metering. In R-APDRP, while the issue was addressed to some extent by the adoption of IEC 62056 / Indian Companion Standard by BIS, this was limited to DT and Boundary meters and hence there still remains the issue of Inter-operability standards for other meters. Further, the application integration of various modules implemented under R-APDRP and existing modules has not been standardized and hence is a major impediment to implementation and future maintenance and upkeep. Thus any intervention in India's Power Sector must essentially have a roadmap defined that covers the inter-operability aspects well.

e. **Consistency of Pilot Objectives with Policy Goals and Emerging Sector Requirement** – In line with the emerging sector dynamics and the policy goals of the country, the following key priorities emerge for Smart Grid implementation – (i) Technical and Commercial loss Reduction; (ii) Peak Load Management and Demand Response; (iii) Integration of Renewable Energy Technologies/Distributed Generation; (iv) Facilitation of retail choice through incorporation of necessary metering and communication infrastructure that promotes retail completion, transparent supplier switching, automated billing and smart collection mechanism; and (v) adoption of micro grids for urban areas for reliable power supply and in rural areas for ensuring electricity access. The pilots current planned for implementation do not comprehensively address these priorities and hence need to be assessed in this light. This is important as the incremental hardware and software requirement in a number of cases may not be high, even as the enhancements can provide important additional functionality to such pilots.

f. **Sustainability of Pilots** – Prior to the announcement of the Smart Grid pilots by the GoI, several utilities had taken up Smart Grid pilots in their areas albeit at a lower technological level such as implementation of AMI. These pilots however, either have failed to take off or have been abandoned by the respective stakeholders due to various reasons. It is essential to understand the reasons for failure of such projects and design pilot that address gaps in such pilots. Thus, need for demonstration of a successful pilot backed by strong commercial and

[2] The Inter-Operability Roadmap should cover the following distinct aspects: (i) Meter Standards – Define standard meter specifications, in terms of functionality and applications and Communication Module Integration, which enables better interface to Communication Providers and technologies; (ii) Communication Standards covering – a. Meter Communication Standards – AMI / Two way meter communication protocol standards applicable for the Indian conditions should be defined, based on the BIS Indian Companion Standard for Smart Meters; b. Application Interoperability based on CIM XML to be defined based on SGIP recommendations; c. DR/DSM Communication Standards – Define Use Case Standards and Communication Protocol Standards for the Implementation of DR/DSM through the AMI Infrastructure / otherwise; and SCADA/DMS Communication Standards – Define the communication standards for SCADA/DMS applications in Smart Grid; (iii) Last Mile Communication Technology Definition – With various last mile communication technologies available, standardization of technology standards to be adopted for the last mile in distribution is critical. Both for Metering / AMI / and SCADA/DMS Applications; and (iv) Define the issues related to Spectrum Availability for Power System Communications

regulatory mechanism is critical for fast paced implementation of Smart Grid initiatives. Such pilot should act as a model for replication and for scaling up the existing pilot programs.

We believe that the priority areas identified above are critical for achieving the goals of a Smart Grids enabled India. The efforts under PACE-D will aim to address these aspects and create ground for scale-up of various initiatives.

# 8 WORK PLAN

In line with the key priorities presented in the preceding section and the terms of reference of the project, this section describes the key interventions proposed as part of the Smart Grid module. The PACE-D team shall comprise of experts from the USA and India. The team shall work closely with the ISGTF to start with and subsequently with other stakeholders directly. All tasks proposed below are indicative and will be finalized in discussions with the ISGTF.

The work plan for the next five years has been captured broadly in the following table.

| Year One | Year Two | Year Three | Year Four | Year Five |
|---|---|---|---|---|
| In Year one, the PACE-D team will undertake the following activities[3]:<br>a. Provide support in implementation of ISGTF Smart Grid Action Plan<br>b. Provide assistance in selection of Smart Grid Pilot Projects<br>c. Provide technical and implementation assistance for the identified/selected | In Year two, the PACE-D team will undertake the following activities:<br>a. Provide support to the ISGTF and the Administrative cell developed in Year one under the MoP<br>b. Technical assistance and handholding support to agencies implementing Smart Grid initiatives in the | In Year three, activities of the PACE-D team will be as follows:<br>a. Provide support to the ISGTF and the Administrative cell developed in Year one under the MoP<br>b. Provide assistance in the development of Smart Grid regulations at the national level while interfacing with FoR<br>c. Technical assistance and handholding | In Year four, activities of the PACE-D team will be as follows:<br>a. Provide support to the ISGTF and the Administrative cell developed in Year one under the MoP (focus on outreach)<br>b. Support in creation of Smart Grid cell in utilities<br>c. Conduct demonstration workshops for educating | In Year five, activities of the PACE-D team will be as follows:<br>a. Provide support to the ISGTF and the Administrative cell developed in Year one under the MoP (focus on outreach)<br>b. Assistance in developing policy framework for commercialization of EV<br>c. Continuation of Capacity building |

[3] Explained in detail in the following section

| | | | | |
|---|---|---|---|---|
| pilot projects<br>d. Provide assistance formulating capacity building plan for Smart Grid initiatives<br>e. Provide inputs in development of Smart Grid interoperability standards:<br>f. Develop criteria to select two State Development Agencies/ SERC's and provide technical assistance<br>g. Develop an action plan for promotion of Smart Grid | country<br>c. Provide assistance in the implementation/adoption of the interoperability roadmap<br>d. Provide technical inputs in the development of specific standards<br>e. Provide assistance in implementation of action plan developed for the promotion of Smart Grid<br>f. Technical assistance to State Development Agencies/ SERCs | support to agencies implementing Smart Grid initiatives in the country<br>d. Assistance to FoR in designing national level ToU/ToD tariff pricing mechanism<br>e. Designing and carrying out awareness programs on Smart Grid technologies among utilities and regulatory agencies<br>f. Conduct workshops and dissemination seminar on new technologies in the Smart Grid space<br>g. Technical assistance to State Development Agencies / SERCs | stakeholders on new technologies in energy storage<br>d. Continuation of technical assistance and handholding support to agencies implementing Smart Grid initiatives in the country<br>e. Conducting awareness and capacity building programs for respective stakeholders | workshop for utilities.<br>d. Conducting awareness/outreach programs |

The work plan for the Year One has been detailed out in the following section:

## 8.1 PLAN FOR YEAR ONE[4]

PACE-D proposes the following four areas of work to support the implementation of tasks under Smart Grids during Year One:-

### 8.1.1 ISGTF Smart Grid Action Plan Implementation Support

The ISGTF has developed a draft vision document and action plan for Smart Grids implementation in India. Based on the discussions of the PACE-D team with the ISGTF, it is understood that no midcourse correction or revision is envisaged in the document. Hence, the PACE-D team will focus on facilitating the finalization and implementation of the ISGTF vision and roadmap. Activities will include a comprehensive review of the Smart Grid Vision document, taking stock of current implementation capacity of utilities and other stakeholders, commercial and regulatory mechanisms at the state and central level, identifying gaps (if any) and a prioritized step by step approach for implementation of Smart Grid programs in India. The team will provide assistance in the formation of an Administrate Cell under the MoP to coordinate Smart Grid initiatives in the country. The team will also facilitate a process of regular update of the document and work towards preparation of a performance evaluation plan to track the implementation success. The international best practices and lessons learnt during Smart Grid technology implementation in the U.S. will be leveraged while suggesting modifications in the roadmap. If required, possible interventions to improve effectiveness of program implementation will also be developed by PACE-D in Year-Two.

**Deliverables (Date of Completion)**

1. Report covering review of ISGTF vision including the existing gaps and plan for strengthening the road map developed – February 2013

2. ISGTF Implementation performance evaluation criteria and project management plan – May 2013

### 8.1.2 Smart Grid Pilot Projects

The PACE-D team will work closely with the ISGTF and other stakeholders to develop selection criteria for selecting viable Smart Grid pilots for the project. These pilots could be selected from the 14 ISGTF pilot projects or could be identified through dialogue with other private utility and distribution companies. The pilots will be chosen based on the priority addressed (of the state, utilities and consumers), acceptability of the entities involved, energy saving potential, greenhouse

[4] Up to May 2013.

gases avoided, replicability and scalability potential etc. The pilot assistance will include technical assistance, capacity building, transfer of best practices, project management, performance evaluation, improvement in existing DPRs (if any), provision of tools/resources etc.

PACE-D will also develop market based business model (aligned to the regulatory mechanism most acceptable in the state) and establish linkages with relevant financial institutions and other stakeholders. It will also develop communication channels for transfer of lessons learnt, energy/cost savings achieved, implementation successes, barriers, etc. after successful completion of the pilot projects. The PACE-D team will continue its discussions with all stakeholders to identify other opportunities for support to Smart Grid initiatives, such as aligned activities under the R-APDRP initiative (Advanced Metering infrastructure (AMI), IT implementation, operations and maintenance etc.).

The PACE-D team will also facilitate stakeholder communications between consumers, regulators, utility companies, DISCOMS and others to identify the technical assistance needs of all stakeholders. Finally, the team will provide the needed technical assistance and work on building the capacity of the utilities and the State Development Agencies (SDAs) with an overall aim of achieving a market transformation using Smart Grid technologies.

**Deliverables (Date of Completion)**

1. Pilot project selection criteria– January 2013
2. Selection of two suitable pilot projects based on the above criteria– January 2013
3. Pilot technical assistance plan for the identified/selected pilot – April 2013
4. Pilot implementation and performance management plan – May 2013

### 8.1.3 Smart Grid Technical Capacity Building Assistance

PACE-D will actively participate in the ISGTF workshop proposed for training the utilities involved in the 14 pilots during the last quarter of year 2012. PACE-D will bring to the workshop thought leadership and industry expertise from Nexant, AF Mercados EMI and other international experts. The team will use the workshop platform to build relationships and identify at least two DISCOMS through which the project can offer focused support in implementation of Smart Grid pilot and other programs. The PACE-D team will bring to the workshop technical expertise on pilot implementation, regulatory capacity building, steps to consider before, during and after implementation, data collection and analysis tools, monitoring procedures, operability standards and consumer interface issues. The ISGTF workshop will provide an excellent platform to immediately understand the capacity building needs of stakeholders and the insights gained through participation will be used to plan and develop the PACE-D capacity building deployment activities for Year Two and beyond.

Apart from training of the 14 ISGTF pilots, the PACE-D team will engage other utilities, DISCOMS and other key stakeholders to understand their capacity building needs. After a detailed capacity building needs assessment, the PACE-D team will develop a detailed capacity building plan to deliver the necessary trainings, facilitate the transfer of technologies and best practices, and work towards building the capacity of institutions and professionals that will implement Smart Grid initiatives on ground. The training programs developed under USAIDs DRUM program might be utilized for the Smart Grid capacity building efforts. PACE-D will also work with its Resource Pool partners GE and IBM to build partnerships with private sector.

**Deliverables (Date of Completion)**

1. Workshop for 14 utilities implementing Smart Grid pilots (in country) on pilot planning and implementation – February/March 2013

2. Capacity Building Plan for ISGTF pilots, utilities and regulators and the plan to establish linkages with SDAs and public and private sector agencies/institutions - April 2013
3. Capacity building inputs to other PACE-D initiatives linked to the Smart Grid Module – April 2013
4. Inputs to capacity building team of PACE-D for regulatory capacity development – April 2013

### 8.1.4 Smart Grid Interoperability Standards

As stated in the preceding sections, one of the critical requirements for deployment of Smart Grid technologies is to define the communication and application Inter-Operability Roadmap for India. The PACE-D team will facilitate the development of a consistent standardization framework and inter-operability standards for smart metering and other Smart Grid technologies. The development of these standards will allow the use of a single, object-oriented data model that can be used over a wide range of communication media, and allow interoperability on the end device level. These standards will be critical in removing market barriers and help towards facilitating a cost-effective large scale rollout of Smart Grid technologies in India.

BIS is working on developing the standards for Smart Grid technologies. At the moment, the draft standards for 3-phase supply have been developed. Additionally, the functional specification of the single phase smart meter has also been finalized. The focus, of the PACE-D during Year One shall be to support the groups working on development of various standards by providing inputs as and when the initial drafts are prepared.

**Deliverables (Date of Completion)**

1. Development of a Inter-Operability Road Map for India – March 2013

2. Review document/technical review and gap analysis of existing Smart Grid standards as proposed by entities involved in design of such standard

### 8.1.5 Technical Assistance to State Development Agencies/ State Electricity Regulatory Commissions

The team will also work on developing criteria in consultation with MoP/BEE for identifying minimum of two State Designated Agencies (SDAs)/ State Electricity Regulatory Commissions (SERCs) for focused technical assistance activities required for the rapid deployment of Smart Grid technologies. The PACE-D team will develop a detailed technical assistance plan according to the unique assistance needs of the selected states. The technical assistance activities will focus on empowering the SDAs/SERCs to effectively formulate policies and implement Smart Grid technologies in close coordination with state utilities. PACE-Ds work on development of financial mechanisms will also be aligned towards implementation of the Smart Grid technologies and has been discussed separately.

The PACE-D team will work with the selected SDAs to promote the deployment of EE technologies such as EE Buildings, Heating, Ventilation and Air- Conditioning (HVAC), Waste Heat Utilization (WHU) and other industrial EE technologies etc., through Smart Grids. The team will help the selected SDAs develop a state level action and implementation plan for the promotion of advanced EE technologies. The team will also work with SDAs/SERCs to conduct a resource assessment and planning exercise to help them understand the financial, personnel and infrastructural resources needed for the state level advancement of EE technologies. Finally, the PACE-D team will facilitate the collaboration between SDAs/SERCs, utilities and the private sector to develop new programs and initiatives to aid the market deployment of EE technologies.

**Deliverables (Date of Completion)**

1. Selection criteria for selection of two SDAs/SERCs for focused EE in the context of Smart Grids technical assistance – January 2013
2. Action and Implementation Plan for the promotion of Smart Grid – May 2013

The framework to monitor and evaluate activities proposed under Year one of the assignment is discussed below:

a. **Assistance in evolving Policy framework** – Once the $12^{th}$ plan document is notified, the goals envisaged will need to be further detailed out and implementation plan developed. PACE-D team will work closely with ISGTF Secretariat to develop two-three year implementation plan subject to acceptance by ISGTF. This will also involve prioritization of tasks/activities envisaged under the plan.

b. **Assistance in creation of an Administrative Cell** – The PACE-D team will assist in the formation of an Administrative Cell/Unit under the MoP. This Cell/Unit will primarily coordinate Smart Grid initiatives in the country.

c. **Capacity Building/Awareness Creation** – Target of at least two workshops/100 personnel trained per year, covering at least 15 institutions, with at least 50 percent participation from regulatory bodies and utilities.

d. **Facilitation of Standards** – (i) Development of an inter-operability road map subject to acceptance by ISGTF; and (ii) Provide knowledge inputs to various bodies working on Smart Grid standards; (iii) Bring out at least one standards document per year.

e. **Demonstration of Concepts** – (i) Preparation of bankable projects subject to acceptance by ISGTF (two Nos.) which would result in an average saving of around 24 MU; and (ii) Evolving implementation plan for promotion of EE technologies through – two State Development Agencies (SDA)

f. **Monitoring Developments –** Quarterly monitoring reports on progress of Smart Grid implementation in the country.

# 9 ANNEXURE

**Annexure 1: Working Groups under ISGTF**

The table below lists the functions of each of the working groups under the ISGTF.

| No. | Working Group | Purpose |
|---|---|---|
| **1** | Trials/Pilot on new technologies | • Increase in all forms of RE based generation<br>• WAMS of transmission network<br>• Monitoring and Control of MV and LV distribution network<br>• Energy Efficiency and DSM<br>• Creation of technology evaluation platform<br>• To evolve the Smart Grid operational, management and legal requirements<br>• Creation of Smart Grid Knowledge Centre |
| **2** | Loss reduction and theft, data gathering and analysis | • Guidelines for Rationalization of Tariff<br>• Extending IT implementation under R-APDRP to all other towns<br>• Installation of AMI<br>• Demand side Management with Distribution automation |
| **3** | Power to rural areas and reliability and quality of power to urban areas | • Installation of prepaid meters in rural areas and low cost smart meters<br>• Creation of quality indexed power tariff<br>• Setting up micro-grid |
| **4** | Distributed Generation and renewable | • Finalization of regulations on Technical Standards for connectivity to the Grid for Renewables and Distributed generation at 33kV level and above<br>• Formulation of Indian Standards for Distributed Generation and Renewables<br>• Design and development of highly efficient power controllers/power conditioning<br>• Identify Scope of Pilot Projects in association with renewable |

| No. | Working Group | Purpose |
|---|---|---|
| | | energy generators |
| **5** | Physical cyber security, Standards and Spectrum | • Creation and finalization of Cyber security standards<br>• Modification in Indian Electricity Act 2003 to address Cyber Security<br>• Capacity building |

## ANNEXURE 2: FUNCTIONS OF ISGF WORKING GROUPS

### Working Group 1: Advanced Transmission

- **Chairman** – Dr. ShekharKelapure , GE Energy.
- **Co Chairman**- A.K. Misra, Power Grid Corporation of India Ltd.
- **Members** - GE Energy , Power Grid Corp. of India Ltd , Tata Power Company Ltd , Crompton Greaves Ltd., L & T, Moksha Infratech , OSI Soft , Sterlite Technologies, MSEDCL
- **Objectives**
  - This working group studies and analyzes the critical issues related to Indian transmission systems and recommends appropriate system enhancements/upgradations and technologies and standards, by creating a suitable platform within the ecosystem for the sustainable success of Smart grid deployment in India.
- **Functions**
  - Reduction of transmission losses at state level
  - Efficiency improvement: technical and behavioral.
  - Better coordination between transmission and distribution
  - Improvement in system availability, grid discipline
  - Transmission needs for enhanced renewables
  - Planning for advanced transmission systems, e.g., FACTS, and WAMS (with PMUs)
  - Transparent and improved models for transmission pricing, which capture marginal costs and incentives (e.g., LMP) and ancillary services
  - Introduction of advanced technologies such as Robotics and use of helicopters for both commissioning and operations, including live line insulator cleaning, and thermo-scanning.
  - AMI at transmission levels to enable same day settlement at power exchanges
  - Introduction of day-ahead and hour-ahead trading
  - Trials on high temperature super conductivity (HTS) systems.

### Working Group 2 – Advanced Distribution System

- **Chairman**- Ram Pillai, Tata Power Company Ltd.
- **Members** – Hitachi , HCL Technology, Sterlite Technology, MSEDCL, BESCOM, Schneider Electric, Oracle, Infosys, Moksha Infratech, TCS, Microsoft, , GE Energy,

Atos Origin, Larsen & Toubro, Moksha Infratech, NEST, OSI Soft, Oracle, Schneider Electric, Sterlite Technologies, TCS, Spanco

- **Objectives:**
  - Working Group 2 would identify and develop standards specifications for Smart Grids (advanced distribution) in India, encompassing measures to reduce losses, achieve interoperability, reliability and security in the distribution grids. The standards would be based on existing and/or emerging standards from organizations such as IEC, IEEE, NIST, CIGRE or others. Within these, Working Group 2 would select suitable and relevant standards for India pertaining to advanced distribution and provide a guide (manual) on their adoption.
- **Functions:**
  - Advanced Distribution Operations
  - Integration with R-APDRP systems
  - Advanced Asset Management
  - Self-Healing Networks
  - Integration of Distributed Energy Resources

**Working Group 3 – communications for Smart Grids**

- **Chairman**- Manjushrishah, Secure Meters(Acting)
- **Members** – Secure Meters, Power Grid Corp. of India Ltd, Reliance , AMI Tech , Analog Devices, CISCO , HP, Hitachi, KLG Systel, Sterlite Technologies, Omneagate , Orga Systems, Grid 20/20, IBM, Powertec, Mahindra Satyam, HPL Electric
- **Objectives**:
  - To study and recommend most suitable, sustainable and scalable communication technologies that can be adopted in India for all building blocks of Smart Grid in a continuum fashion. The WG focuses on analyzing various communication technologies with due consideration to the total cost of ownership (TCO) in the Indian context.
- **Functions:**
  - **Facilitation -** By conducting on ground assessment of varied communication technologies and options in the Indian context to suggest the optimal choices for the success of the envisaged SG projects
  - **Benchmarking -** Study, analyze and recommend global technologies and their feasibility in the Indian context, and identify gaps that necessitate solution updating/adaptations or even new solutions.

- Best practice creation and recommendation
- **Ecosystem Management -** Coordination with other WGs, policy advocacy groups and awareness building for the best technological aspects in the relevant arena

**Working Group 4- Metering**

- **Chairman – V. Arunachalam, CPRI**
- **Members** –CPRI, Atos Origin, MSEDCL, Analog Devices, Capgemini, CISCO, GE Energy, HPL Electric, Itron, L & T, Landis &Gyr, NEST, OSI Soft, Oracle, Phoenix IT Sol. , SAP, Secure Meters, Siemens , TCS , Omneagate, JnJPowercom Systems Ltd , Genus , Orga Systems, Powrtec Energy
- **Objectives**:
  - The Working Group 4 aims to assess the metering scenario in India, identify the goals and requirements. The WG4 can also focus on available technologies and best practices as well as identifying gaps in existing solutions from an Indian perspective. It is worth mentioning that for R-APDRP metering applications the IEC 62056 (DLMS/COSEM) is chosen as the standard metering protocol. CPRI has the test facility for carrying out conformance test for this protocol standard. The Working Group 4 can extend the additional design and standards requirements.
- **Functions**:
  - Study of country wide metering and billing practices
  - Bird's eye view of AMR projects and understanding the technology that can be used
  - Regulatory provisions in implementing AMR projects.
  - Infrastructure requirement for AMI
  - Understanding the information and the interface requirements.
  - Designing the Meter Data Management System (MDMS).
  - Understanding and implementing the new metering philosophies such as KVAH metering , cluster meters and load limiters

**Working Group 5 – Consumption and Load Control**

- **Chairman**- VikramGandotra , Siemens Co-Chair:
- **Members** – Siemens, CPRI, BESCOM, HP, HPL Electric, Hitachi , Honeywell, KLG Systel, Medhaj Techno Concept, Phoenix IT Solutions, SAP, Schneider Electric, TCS, Omneagate, JnJPowercom Systems Ltd, Genus, Ecolibrium Energy, MSEDCL
- **Objectives**:

- Working Group-5 would recommend technologies and solutions which can be adopted in India for load control and consumption to enable peak load management and overall energy management

- **Functions**:
  - To recommend technologies (appliances, storage, electric vehicles etc) and regulatory/policy options viable in Indian conditions with a focus on demand side management, demand response management and TOU/variable pricing as key processes for peak load shaving and energy efficiency.
  - To focus on energy controlling and measurement systems and devices with an objective of understanding real time energy consumption information leading to smarter energy consumption with a focus on sectors such as Industries, Commercial buildings (including data centers ), Infrastructure and residential sector.
  - To coordinate with key institutions/groups like BIS, IEC, IEEE, BEE, BIS, state designated agencies and Utilities etc. to adopt appropriate standards for DR in India.
  - To work with BEE to formulate standards for appliances that are Smart Grid ready

**Working Group 6 – Policy and Regulations (incl. Tarrifs , Finance etc )**

- **Chairman** – PankajBatra , CERC
- **Members** – CERC , PGCIL , BESCOM , CapGemini, Ericsson, HP, Moksha Infratech, TCS , Grid 20/20 , Powrtec Energy, MSEDCL
- **Objectives**:
  - To identify and recommend appropriate regulatory policy initiatives to the Government, both central and state, and to suggest regulations to facilitate implementation of Smart Grid through inter-state regulations of CERC and facilitate implementation of Smart Grid through SERCs and the intra-state system through the Forum Of Regulators (FoR), by demonstrating or otherwise conveying feasible and sustainable business cases and societal level cost-benefit analyses.
- **Functions**:
  - Suggest Innovative business and operating models in Smart Grids and overall, through discussion by engaging and considering perspective of all the stake holders
  - Identify, the parameters of Smart Grid implementation, such as, economy, design and technology options, reliability, quality , pay-back period
  - Special regulatory enablement of Smart Grid: Feed-in-tariff for renewables by generators including from individuals, technical requirements for connectivity, network planning, making regulations for integration of renewables into the grid from the point of view of system operation, differential tariff for reliable supply (retail and

bulk), transmission pricing models including LMP, pricing models for ancillary services, more granular and updated rate cases.

- Policies for advanced metering infrastructure (AMI) and demand response (DR), including virtual power plants (VPPs)

**Working Group 7- Architecture and Design**

- **Chairman**- Deepak V Konnur IBM Co. Chair: , AnanthChandramouli Infosys
- **Members** – IBM , Infosys , MSEDCL , Tata Power Company Ltd. , Reliance , Atos Origin , Analog Devices India Pvt. Ltd. , CapGemini , CISCO , Crompton Greaves Limited , HCL Technologies , Itron , KLG Systel , Landis &Gyr , Microsoft
- **Objectives**:
  - The primary objective of Working Group 7 is to define the architecture and design standards (or guidelines) to support Smart Grid applications and evolution. While there are other WGs under ISGF to cover aspects like advanced transmission, distribution, load control, metering, communication etc., the WG7 shall lay the technical and functional guidelines to support Smart Grid applications keeping in view factors like interoperability, scalability, security and, more importantly, the Indian power sector centric requirements.
- **Functions**:
  - Identify and define Smart Grid layered architecture specific to Indian power sector, and the applications involved within
  - Define the Smart Grid conceptual architecture, which consists of application integration architecture like data attributes which needs to be exposed by individual systems of Smart Grid , different interfaces types to be supported by Smart Grids applications and integration interfaces with or without the use of middleware technology . It shall also incorporate IT technologies like cloud computing
  - Identify focus areas for and define use cases for each Smart Grid application.
  - Identify and define test cases for inter Smart Grid application integration
  - Technology adoption roadmap for utilities, including plotting on Smart Grid maturity levels and covering technology lifecycle management.
  - Attempt to balance the architecture needs from perspectives of interoperability versus design/purchase freedom and stability versus innovation

**Working Group 8-Pilots and Business Model incl. planning and implementation, incl. capacity building)**

- **Chairman**- RaghupathiCavale , Infosys Co-Chair: Ajay Biswas (HCL)

- **Members** – Infosys , CERC , Power Finance Corp. Ltd. , Reliance, AMI Tech , HCL Technologies , Itron, Landis &Gyr , Medhaj Techno Concept , Microsoft, Oracle , Phoenix IT Solutions, SAP , JnJPowercom Systems Ltd , Genus , Orga Systems , Grid20/20 , EC Infosystems, IBM, Spanco, MSEDCL, Ericsson
- **Objectives**:
  - Working Group 8 will Observe and study the list of Smart Grid technology pilots that will be undertaken in India and recommend the most appropriate options and models for the distribution companies, including recommendations on appropriate timeframe for investments. It evaluates different business models for different technology pilots and recommends the most appropriate model(s). Its objective is also to identify metrics for respective pilots and assists in their validation/monitoring. It also examines end-to-end planning and models, with a focus on capacity building for the success of projects and programs. It identifies gaps in capacity building with recommendations to overcome these.
- **Functions**:
  - Study various Smart Grid pilot initiatives across the globe (developed as well as emerging economies) and list out the ones that are most relevant to Indian context.
  - Review the draft RFP circulated by ISGTF and come up with additional points / ideas on Smart Grid pilot initiatives
  - Prioritize the Smart Grid initiatives that give best returns / benefits for all stakeholders (utilities, consumers and solution providers)
  - Study various business models for different Smart Grid pilot initiatives, which shall include:
    - ✓ funding and benefits sharing options
    - ✓ comparison of various models (pros and cons)
    - ✓ recommendation of the most appropriate business model for each Smart Grid pilot initiative
  - Examine human and other resource capacity requirements for successful pilot and broader deployments.
  - Work with other ISGF WGs wherever necessary, for understanding the costs involved and technology details of executing pilots
  - Work with consumers/consumer forums and other stakeholders to articulate SG benefits
  - Work for assessing and developing training and capacity building initiatives for Smart Grids.

**Working Group 9-Renewables and Microgrids**

- **Chairman**- PrakashNayak (IET) Co-Chair: SatyanVijayvergia (Genus)
- **Members** – IET, Genus, OSISoft, CERC, PowerGrid, Siemens, Hitachi, AMI Tech, JnJPowercom Systems, Crompton Greaves Limited, Oracle, TERI, IIT Mumbai, Alstom T&D India Limited, Texas Instruments, Reliance Infra, IIT Rajasthan, IIT Kanpur, IIT Delhi.
- **Objectives**:
  - The main objective of Working Group 9 is to study and recommend appropriate solutions for improving the CUF (capacity utilization factor) of Renewable and to study tools available for forecasting and scheduling of Wind and Solar and recommend appropriate tools. It also develops set of standards, guidelines and technology recommendations for integration of renewable sources into the grid. Its objective is also to develop a methodology for carrying out cost-benefit analysis of a microgrid project in the Indian context. It also develops recommendations for tariff policy for renewables in India.
- **Functions**:
  - Study various Smart Grid pilot initiatives across the globe (developed as well as emerging economies) and list out the ones that are most relevant to Indian context.
  - Review the draft RFP circulated by ISGTF and come up with additional points / ideas on Smart Grid pilot initiatives.
  - To identify the issues, enabling technologies and economics for encouraging the deployment of Microgrids in India. To explore state-of-the-art technologies and recommend solutions associated with the deployment of microgrid technologies leading to efficient and smart microgrids. To examine the protocols for connecting microgrids at various levels, namely, discom, state and regional levels.

**Working Group 10-Cyber Security**

- **Chairman**- Abraham Samson (L&T) Co-Chair: ShailendraFuloria (ABB)
- **Members**- L&T, ABB, TCS, HP, IET, NeST, TPDDL, NXP Semiconductor, Reliance Infra, Capgemini
- **Objectives**:
  - The main objective of this Working Group is to develop Smart Grid cyber security requirements in Indian context and to propose a risk assessment framework to evaluate the risk of each Smart Grid component throughout its lifecycle. It also develops a cyber-security approach and checklist useful for utilities and proposes risk mitigation

measures, regulatory and policy measures for security, legal and information privacy issues.

- **Functions**:
  - Security aspects are all pervasive ranging from bulk generation domain to the end consumer domain. In the interoperability context, security is a cross-cutting subject, ranging from physical connectivity to regulatory and policy issues.
  - While the rest of the working groups would be working on specific well defined domains and propose their respective recommendations, WG10 would collaborate with all working groups proposing design level inputs on security.
  - WG10 would drill down on the proposed solutions of other WGs and conduct a detailed cyber security threat assessment.
  - WG10 would then, workout the measures and guidelines from security perspective for each of the technology recommendations.

## ANNEXURE 3: FUNCTIONAL REQUIREMENT SPECIFICATION FOR SINGLE PHASE SMART METER

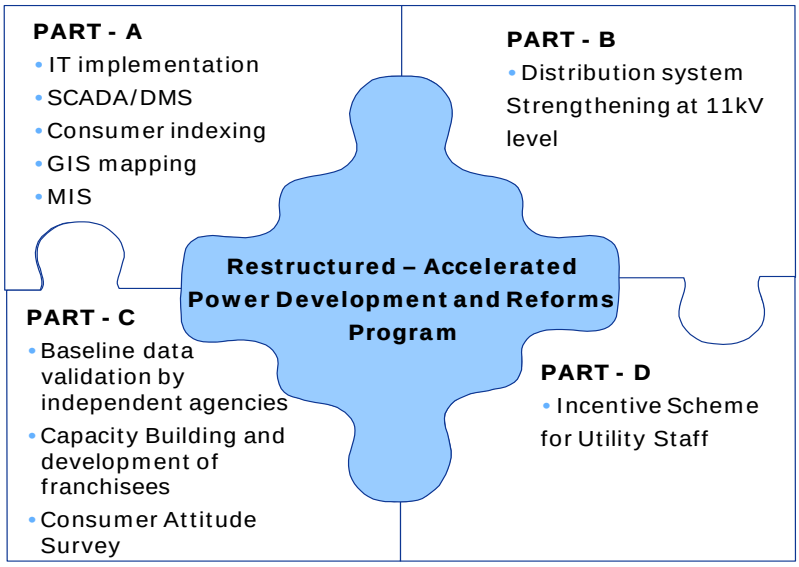
Table A3.1: Functional Requirement Specification for Single Phase Smart Meter

| Particulars | Specifications |
|---|---|
| Applicable Standards | The meters shall comply to IS 13779 for all requirements except for those parameters which have been specifically mentioned to be otherwise in this specification. |
| Reference Voltage | 240 V (-40percent to +20percent) Single Phase |
| Current Rating | 5-30 A, 10-60A |
| Starting Current | 0.2 percent of Ib |
| Accuracy | Class 1.0 as per IS 13779 for Active Energy |
| Operating Temperature range | -10 deg C to 55 deg C |
| Humidity | <= 95percent |
| Frequency | 50 Hz +/- 5percent |
| Influence Quantities | As per IS 13779 |
| Power Consumption of meter | As per IS 13779. |
| Meter Display | Min 6 digit LCD Display with legends to identify parameters on meter |
| Parameters to be measured | Instantaneous-V, I , kW, Power factor<br>Cumulative – Active Energy, Apparent Energy<br>Average power factor<br>Previous Month parameters : MD in kW, kWh, Average PF |
| Power Quality Information | Logging of quality of supply events like power on/off, over/under voltage, over current ( 50 events)<br>Setting of Under/Over Voltage and Over current shall be decided by utilit y. |
| Maximum Demand | Should have Maximum Demand register kW with integration period 30 minutes. Resets should be auto-monthly or through communication command. |
| Load Survey/IntervalData | 35 days data to be recorded with 30 minutes integration period for Active Energy, Average Voltage, Average Current.<br>In addition cumulative mid night kWh (00.00 Hrs) shall also be recorded for 35 days |
| Time of Use | Should support four tariff registers / six time zones per day. |
| LED/ LCD | LED indicator for pulse/kWh. |
| Indicators | LED / LCD Indicator for Tamper, Disconnection, Earth leakage. |
| Tamper/Event recording | A total of last 50 events considering all tampers defined must be detected and logged as tamper events on first in first out basis along with date &tim e of occurrence and restoration, total tamper counts with tamper identification. |

## ANNEXURE 4: R-APDRP SCHEME AND SUMMARY OF LOAN DISBURSEMENT UNDER R-APDRP (PART-A AND SCADA)

The R-APDRP was designed to have a four pronged approach. The details of each part are provided below:

**Fig A4.1: Schemes under R-APDRP**




***Part – A*** of the R-APDRP program with a massive budget allocation of Rs. 10,000 Cr. was inclined towards initiating the implementation of a *Smarter* distribution system. To this end, Part-A involved the use of IT to a very large extent. The major aim was to prepare an accurate baseline data of the consumers through GIS mapping and consumer indexing. It also included asset mapping of the entiredistribution network at and below the 11kV transformers and include the Distribution Transformers and Feeders, Low Tension lines, poles and other distribution network equipment.

***Part – B*** of the R-APDRP program was allocated Rs. 40,000 Cr. The funds were to be used for renovation, modernization and strengthening of 11 kV level substations, transformers/transformer centres, re- conducting of lines at 11 kV level and below, load bifurcation, feeder separation, load balancing, High Voltage Distribution Systems (HVDS), aerial bunch cabling in dense areas, replacement of electromagnetic electricity meters with tamper proof electronic meters, installation of capacitor banks and mobile service centres. In exceptional cases, where sub-transmission system is weak, strengthening of 33 kV or 66 kV levels may also be considered.

The R-APDRPs goal was to collect baseline data for total energy audit and accounting, through an integrated IT strategy across the distribution value chain. AT&C losses were to be brought down to 15percent over a course of five years, by automating and integrating various utility processes like Connections Management, Asset Management, Maintenance Management, Metering, Billing and Collection, Energy Audit, GIS-based Consumer Indexing, Network mapping, Customer care,

and MIS. A reduction of three percent every year for utilities with more than 30percentAT&C loss level and a reduction of 1.5percent for utilities with less than 30percent loss level were envisaged.

***Part-C*** of the R-APDRP program was allocated Rs. 1,177 Cr. Under this scheme validation of the baseline data by an independent agency nominated by the Ministry of Power was to be taken up. Capacity building of personnel of the distribution companies is the main aim of this scheme. Under this part, project consultants will be appointed to monitor the implementation of the R-APDRP by validating proposals submitted by distribution utilities. A consumer attitude survey will also be conducted to gauge the impact of the reforms program towards improving of services, improving the reliability and quality of power supply.

***Part-D*** of the R-APDRP program was to deal with recognizing the efforts of the staff of the distribution utility by giving them adequate incentives. For this purpose, a maximum amount equivalent to two percent of the grant for Part-B project has been allocated. This reward would be available only to those utilities which would bring down their AT&C losses to less than 15percent.

**Loan Disbursement under R-APDRP:**

The table provided below, show the amount of loan amount disbursed against the sanctioned amount. The table also highlights the time passed since the start of implementation of the program.

**Table A4.1: Summary of Loan Disbursement of Sanctioned projects under Part-A: (as on September 31, 2012)**

| S.No. | State | No. of Towns | Sanctioned Cost (Rs. Cr) | Disbursement (Rs. Cr) | Disbursement as a percent of Sanctioned Cost (percent) | Date of appointment of ITIA | Time elapsed since appointment of ITIA (years) |
|---|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 113 | 388.82 | 116.63 | 30 | 31/03/2010 | 2 |
| 2 | Arunachal Pradesh | 10 | 37.67 | 11.3 | 30 | 17/06/2011 | 1 |
| 3 | Assam | 67 | 173.76 | 52.15 | 30 | 16/06/2011 | 1 |
| 4 | Bihar | 71 | 194.58 | 58.35 | 30 | 18/01/2011 | 1 |
| 5 | Chandigarh | 1 | 33.34 | 0 | 0 | 29/04/2010 | 2 |
| 6 | Chhattisgarh | 20 | 122.45 | 36.74 | 30 | 15/11/2010 | 2 |
| 7 | Goa | 4 | 110.74 | 31.46 | 28 | 08/07/2011 | 1 |
| 8 | Gujarat | 84 | 230.72 | 67.65 | 29 | 08/10/2009 | 3 |
| 9 | Haryana | 36 | 165.6 | 49.7 | 30 | N.A. | N.A. |

| S.No. | State | No. of Towns | Sanctioned Cost (Rs. Cr) | Disbursement (Rs. Cr) | Disbursement as a percent of Sanctioned Cost (percent) | Date of appointment of ITIA | Time elapsed since appointment of ITIA (years) |
|---|---|---|---|---|---|---|---|
| 10 | Himachal Pradesh | 14 | 96.4 | 28.91 | 30 | 30/08/2010 | 2 |
| 11 | Jammu & Kashmir | 30 | 151.99 | 45.63 | 30 | 20/01/2011 | 1 |
| 12 | Jharkhand | 30 | 160.61 | 48.17 | 30 | 01/03/2011 | 1 |
| 13 | Karnataka | 98 | 391.08 | 117.31 | 30 | 17/12/2009 | 3 |
| 14 | Kerala | 43 | 214.38 | 64.34 | 30 | 10 | N.A |
| 15 | Madhya Pradesh | 83 | 228.76 | 94.62 | 41 | 04/02/2010 | 2 |
| 16 | Maharashtra | 130 | 324.44 | 97.38 | 30 | 13/10/2010 | 2 |
| 17 | Manipur | 13 | 31.55 | 9.47 | 30 | 17/06/2011 | 1 |
| 18 | Meghalaya | 9 | 33.98 | 10.21 | 30 | 17/06/2011 | 1 |
| 19 | Mizoram | 9 | 35.12 | 10.55 | 30 | 17/06/2011 | 1 |
| 20 | Nagaland | 9 | 34.58 | 10.37 | 30 | 17/06/2011 | 1 |
| 21 | Puducherry | 4 | 27.53 | 4.51 | 16 | 20/08/2010 | 2 |
| 22 | Punjab | 47 | 272.83 | 141.59 | 52 | 29/04/2010 | 2 |
| 23 | Rajasthan | 87 | 315.95 | 94.82 | 30 | 23/09/2009 | 3 |
| 24 | Sikkim | 2 | 26.3 | 7.89 | 30 | 24/05/2011 | 1 |
| 25 | Tamil Nadu | 110 | 417.05 | 125.1 | 30 | 20/08/2010 | 2 |
| 26 | Tripura | 16 | 35.2 | 10.55 | 30 | 17/06/2011 | 1 |
| 27 | Uttar Pradesh | 169 | 650.91 | 250.57 | 38 | 21/01/2010 | 2 |
| 28 | Uttarakh | 31 | 125.82 | 71.35 | 57 | 11/01/2010 | 2 |

| S.No. | State | No. of Towns | Sanctioned Cost (Rs. Cr) | Disbursement (Rs. Cr) | Disbursement as a percent of Sanctioned Cost (percent) | Date of appointment of ITIA | Time elapsed since appointment of ITIA (years) |
|---|---|---|---|---|---|---|---|
| | and | | | | | | |
| 29 | West Bengal | 62 | 164.37 | 93.89 | 57 | 23/09/2009 | 3 |
| | **Total** | **1402** | **5196.53** | **1761.2** | **34** | **11** | **12** |

Source: Power Finance Corporation (PFC)

**Table A4.2: Summary of Loan Disbursement for SCADA implementation (as on September 31, 2012)**

| S.No. | State | No. of Towns | Sanctioned Cost | Disbursement | Disbursement as a percent of Sanctioned Cost (percent) | Appointment of SIA |
|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 5 | 116.81 | 35.05 | 30 | N.A |
| 2 | Assam | 1 | 21.82 | 6.55 | 30 | N.A |
| 3 | Bihar | 1 | 22.02 | 0 | 0 | N.A |
| 4 | Chhattisgarh | 2 | 41.06 | 0 | 0 | N.A |
| 5 | Gujarat | 6 | 138.51 | 41.53 | 30 | N.A |
| 6 | Jammu & Kashmir | 2 | 52.89 | 15.87 | 30 | N.A |
| 7 | Kerala | 3 | 83.15 | 24.95 | 30 | N.A |
| 8 | Madhya Pradesh | 5 | 102.94 | 30.89 | 30 | 21-Nov-11 |
| 9 | Maharashtra | 8 | 161.62 | 48.49 | 30 | 13-Dec-11 |
| 10 | Punjab | 3 | 52.36 | 0 | 0 | N.A |
| 11 | Rajasthan | 5 | 150.9 | 45.28 | 30 | N.A |
| 12 | Tamil Nadu | 7 | 182.17 | 54.65 | 30 | 24-Sep-11 |
| 13 | Uttar | 11 | 266.55 | 0 | 0 | N.A |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Pradesh | | | | | |
| 14 | Uttarakhand | 1 | 16.55 | 0 | 0 | N.A |
| 15 | West Bengal | 3 | 32.94 | 9.88 | 30 | N.A |
| | **Total** | **63** | **1442.29** | **313.14** | 22 | N.A |

Source: Power Finance Corporation (PFC)

## ANNEXURE 5: SMART GRID PILOT PROJECTS IMPLEMENTED IN THE PAST

## A5.1 SMART GRID PILOT IN THE GARIA DIVISION OF WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

### *A5.1.1 DESCRIPTION OF PILOT PROJECT*

The Smart Grid pilot proposed by the WBSECL involved the Utility working along with a System Integrator (or Smart Grid Operator), that will implement a variety of software and hardware measures within a defined area of the electricity distribution network of WBSEDCL that will facilitate real-time monitoring of power flows and operating parameters of major equipment in the electrical network and provide information critical to efficient operation, optimized asset utilization and reduction in network (T&D) losses leading to potential savings. Table below describes the broad details of the Smart Grid pilot proposed to be initiatives by the WBSEDL during 2011.

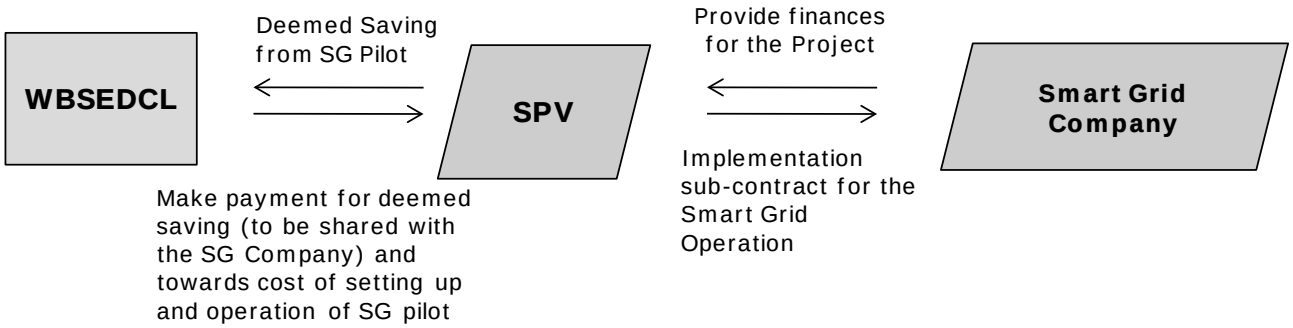
**Table A5.1: Summary of Smart Grid Pilot Project (WBSEDCL)**

| Particulars | Description |
|---|---|
| Utility | WBSEDCL |
| Area Proposed and Coverage | Garia division located south of Kolkata in the South 24 Paraganas District of West Bengal. Within the Garia division, a sub-area covering three sub-stations, 11 feeders, 518 transformers, 10,000 poles, 57,000 customers over 270 km of MV and LV lines (largely urban) was selected for the pilot. |
| Operating Model | Pilot included deployment of smart meters (for consumers, feeders and distribution transformers) and sensors (on critical equipment) with two-way communication systems; and analytical software in the network operation center (NOC) that will trigger alarms for a wide variety of anomalies in the electricity network. Harvest Power Technology (HPT) will communicate these alerts/opportunities to WBSEDCL on a real / near-real time basis, which if acted upon can generate huge savings.<br>Once savings opportunities have been communicated by the Smart Grid Operator and after the passage of a mutually agreed period of time allowing for intervention by WBSEDCL, the Operator will start calculating “deemed savings” or savings that would have been generated had Operator’s alert been acted upon by WBSEDCL. |
| Estimated Cost | 16 million dollars, with investments largely contributed by the Smart Grid Operator. |
| Envisaged Savings | Projected deemed savings pegged at 140.8 million dollars over a period of 15 years. These benefits were proposed to be shared between the WBSEDCL and the Smart Grid Operator. |

### *A5.1.2 BUSINESS MODEL AND ROLES OF VARIOUS ENTITIES INVOLVED*

The overall business model of the project is demonstrated below:

**Fig A5.1: Business Model**




The implementation of a Smart Grid was to allow WBSEDCL to access accurate information on a range of measures and consequently take corrective and pre-emptive actions that will enable a range of savings. Once the SPV alerts WBSEDCL to potential savings, these savings are categorized as Deemed Savings. The savings were estimated on account of AT&C loss reduction; (ii) Peak load power management; (iii) Reduction in feeder interruption; (iv) labour savings in O&M; (v) Additional revenue earned by imposing penalties on unsanctioned load; (vi) Additional revenue from improved power quality; (viii) Reduction in transformer failures; (ix) Savings in transmission charges; and (x) Savings from avoided capital expenditure.

Deemed savings, accumulated over the concession period of 15 years, serve as a revenue driver because WBSEDCL will be contracted to make payments to the SPV based on defined percentages of the value represented by these deemed savings. Deemed savings can only be generated with reference to a baseline. For the purposes of the Smart Grid Pilot, the baseline was to be initially provided by DPR1. Upon contract signing, DPR2 was to be initiated. When completed, DPR2 was to serve as the final baseline. In summary, WBSEDCL was to perform the following functions:

- Act on alerts provided by the SPV/Smart Grid Company in order to achieve deemed savings
- Facilitates SPVs access to Area of Interest
- Responsible for customer management
- Make payments to SPV as per the provisions of the contract
- Electrical network management and upgradation

Further to the above, the Smart Grid Company was to act as a systems integrator by implementing Smart Grid solution. Some of the products and solutions proposed to be deployed in the pilot were designed and developed by the Smart Grid Company itself, while others were designed and

developed by its sub-contractors. As a systems integrator, the Smart Grid Company was the primary point of contact for WBSEDCL and will lead the assessment of its needs, provide project management services and generally ensure the installation and operation of Smart Grid Pilot. In summary, the SPV/the Smart Grid were responsible for the following:

- The SPV serves as the primary counter party responsible for the delivery of products and services to WBSEDCL and subcontracts implementation to the Smart Grid Company
- SG Company installs the hardware and software necessary to identify deemed savings
- SG Company will manage the alert mechanism of deemed savings and co-ordinate the activities of all sub-contractors
- SG company provides various solutions by aggregating products and solutions from select sub-contractors

### *A5.1.3 OUR ASSESSMENT*

The overall pilot had several positives such as: (i) the pilot was one of the first few pilots proposed in the country; (ii) the area selection was good with high load growth area and urban area chose for implementation; and (iii) the overall offering was low cost. In addition, there were several other value added services that were planned to be implemented at later stages of the pilot. These included assisting WBSEDCL in achieving actual savings (instead of deemed savings) i.e. loss reduction, support in reducing the peak load etc.

However, due to various shortcomings the pilot could not take off. One of the biggest drawback was that the deemed savings framework that assumed that the alerts provided to the utility were acted upon and benefits realized, even though in reality no action was performed. Thus, in the absence of actual assistance to the utility in implementation of measures for realizing the savings (defined as value added services in the model), the model appeared to be inadequate. Further, the savings projected also were heavily front-loaded as opposed to more balanced and gradual achievement curve.

The pilot as per original plan was to be launched and implemented in early 2011. However, there were several issues that led to continuous deferment of the contract signing between the WBSEDCL and the Smart Grid Company. As per the recent understanding, the plan due to various shortcomings could not be taken forward and was subsequently abandoned.

## A5.2 SMART GRID PILOT IN THE ELECTRONICS CITY AREA OF BANGALORE ELECTRICITY SUPPLY COMPANY (BESCOM)

### *A5.2.1 DESCRIPTION OF PILOT PROJECT*

The Bangalore Electricity Supply Company was one of the first utilities to go in for Smart Grids in its area. BESCOM through funds received under the Distribution Reform Upgrades and Management (DRUM) program had implemented Distribution Management System and SCADA system in its territory. The presence of these systems proved to be a key enabler for setting up a Smart Grid. Also the presence of local IT companies, actively involved in Smart Grid technologies was one of the driving forces behind BESCOMs Smart Grid strategy.

BESCOM requested the USTDA to fund the feasibility study for a Smart Grid pilot project. The plan was to install smart meters in the pilot area to bring down metering losses. BESCOM had also planned to monitor electricity usage by consumers on a real time basis. In the future BESCOM has plans to initiate Demand Response process thereby shifting loads during periods of peak demand.

**Table A5.2: Summary of Smart Grid Pilot Project (BESCOM)**

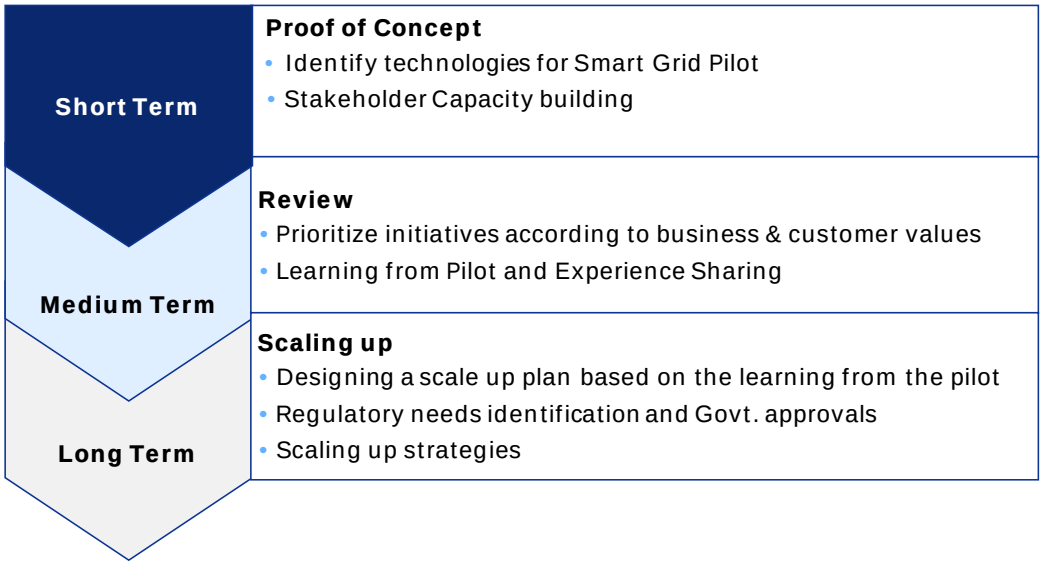
| Particulars | Description |
|---|---|
| Utility | BESCOM |
| Area Proposed and Coverage | Electronics City; Total coverage area - 332 Acres. The major consumers present in the area are IT & ITES companies. Total number of consumers served in the area amount to 19,441 with an energy consumption of 278 MU (as of March 31, 2011) |
| Operating Model | The Smart Grid pilot targets improvements in all areas of the electric system from transmission to distribution to local generation. The pilot includes, on-line condition monitoring for switchgears and transformers; dynamic rating for transmission network; digital S/s; self-healing distribution network at 11kV level; Scheduling and control Integration of distributed local generation with EMS, and DMS; Smart meters and two-way communication network; Integration of demand side management with EMS and DMS; robust fibre optic network and wireless or power line solutions for seamless communication and enterprise level data integration. BESCOM appointed KEMA to draw up a technological roadmap for the implementation of Smart Grid.<br>As per the plan, Smart meters would be installed and cost would be borne by the consumer. The consumer would be given an option to pay 50 percent of the cost of the meter upfront and rest could be paid in installments. The Consumer User Interface is bound to be effective as the consumer will be aware of his consumption and reduce unwanted consumption. |

| | |
|---|---|
| Estimated Cost | 20.7 million dollars, investment to come from USAID, BESCOM, MoP and in part by contributions of equipment and expertise by suppliers who want to demonstrate their technologies. |
| Envisaged Benefits 12.1.1 | The Smart Grid would result in first and foremost AT&C loss reduction. Through effective implementation of Demand Response, there would be no power cuts and it will aid in better management of peak load. It will improve load management and better asset optimization. |

### *A5.2.2 IMPLEMENTATION PLAN*

Figure below indicates the overall implementation of the BESCOM Smart Grid initiatives and the scale-up plan proposed during the initial stages.

**Fig A5.2: Implementation Plan**




The key activities of various phases of the program are described below:

- **Short Term:**
  - In the first phase of the project, appropriate and proven Smart Grid technologies were proposed to be selected for implementation in BESCOM area.
  - Training and Development of the relevant stakeholders involved in the project. Familiarization with the technologies and overall implementation strategies were envisaged to play a critical role in the success of the pilot project.

- **Medium Term:**
  - Once the relevant Smart Grid Technologies have been chosen, a technology roadmap will be developed prioritizing initiatives according to business and customer values
  - After implementing the pilot project in Electronic City, it will be constantly monitored and feedback collected

- The outcomes and experience related to the Smart Grid Pilot project implementation will be shared with all the stakeholders

- **Long Term:**
  - After successful implementation of the Smart Grid pilot project, a scale-up plan will be designed, which would lay down a guiding framework for the implementation of Smart Grid technology in rest of the BESCOM area.
  - This will take into account the learning and improve upon the initial pilot project
  - To scale up, necessary regulatory approvals would be required. The SERC will be approached by the BESCOM to initiate regulatory process approvals to scale up the Smart Grid initiative in an efficient and effective manner.

Various scaling up strategies will also be formulated so that, in case one fails, another can be rolled out without delay.

### *A5.2.3 PHASES OF PROJECT IMPLEMENTATION*

BESCOM plans to implement the Smart Grid pilot project in two phases:

1. **Planning phase**

2. **Project phase**

The **Planning phase** will involve the following activities:

- Development of Strategy and Roadmap for BESCOM: A roadmap will be developed to form a guiding framework and also strategies need to be formulated according to the condition prevalent in BESCOM for faster and effective adoption of Smart Grid technologies

- Site Selection: Though Electronics city has been selected for the implementation of the pilot Smart Grid project, further studies will be undertaken to find if it is a suitable site or should BESCOM select another site.

- Issuance of Request for Information: The pilot project would need state of the art Smart Grid technologies, both hardware and software. BESCOM would issue RFIs seeking information from prospective bidders on services, functionality and pricing of such technologies for selecting the most viable option.

The **Project phase** will involve the following activities:

- Creation of DPR: Once the strategy roadmap is finalized, a DPR of the pilot project will be created.

- Consumer outreach campaign: Consumer acceptance would form the major attribute of implementing any new program. Through the outreach campaigns, BESCOM would educate consumers on the Smart Grid technologies to be implemented and associated benefits.

- Finalizing the business model: BESCOM is looking at a 50-50 PPP model.

- Issuance of RfP: Bids will be called from prospective entities which can provide complete implementation packages.

- Implementation: After the qualified vendor has been selected, he would undertake the following activities initially:

    - AMI field test and deployment: Initially the smart meters will be installed only in a smaller area for testing. Learning from this test deployment will guide in scaling up the implementation of AMI in the entire pilot area.

    - Smart Pricing and Load Control: Once smart meters are installed in the pilot area, smart pricing options can be brought into place through regulatory approval.

    - Self-healing and integration of Renewables: Integration on Renewables is necessary for a Smart Grid to be complete. Micro-grids based on solar and wind will provide a buffer in times of high energy deficit.

- Post implementation: The pilot project will provide all information related to energy consumption. This data can be analyzed to formulate technical guidelines for further implementation of Smart grids in the state.

### *A5.2.4 BUSINESS MODEL AND ROLES OF VARIOUS ENTITIES INVOLVED*

The overall business model of the project is demonstrated below:

**Fig A5.3: Business Model**

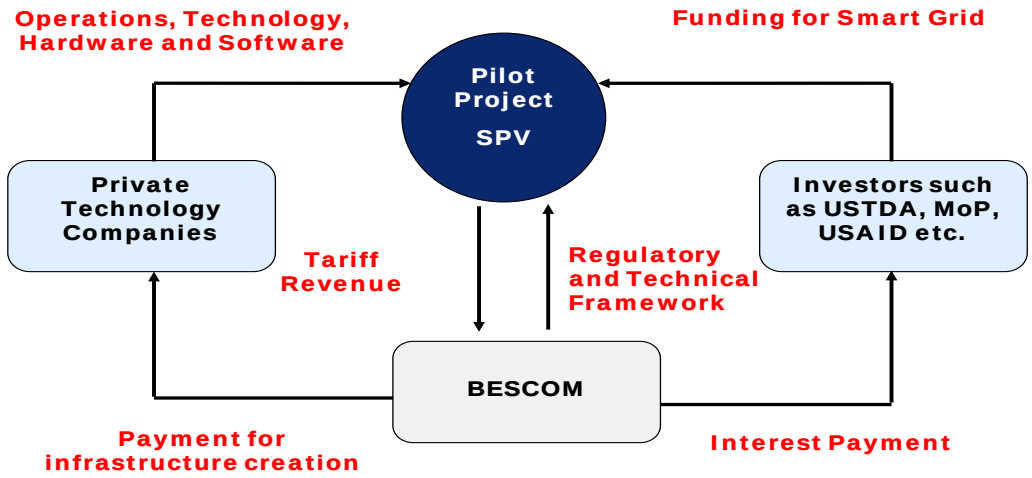


Figure above indicates the business model and working arrangement proposed for the Smart Grid pilot project to be implemented in BESCOM. An SPV was proposed to be created for the pilot Smart Grid project. The main goal of the project was to help BESCOM bring down peak demand by making the consumer aware of his consumption on real time basis. Also though BESCOM had high collection efficiency, there were some metering related issues to be addressed through the pilot project. Pre-paid and post-paid smart meters were seen as a solution to these problems. The Smart Grid pilot project was to be funded partly by BESCOM, USTDA, Japan Bank for International Cooperation etc.,

The private entities providing required technologies and operational guidance were also proposed to be invited to fund the initiative by supplying their hardware and software. This was done to provide a platform for such technology majors to showcase their competency and be recognized in India.

### *A5.2.5 OUR ASSESSMENT*

The planned pilot project for BESCOM was seen as a pioneering effort in the India Power sector. This project was assured to be successful due to the utilities competent capability. BESCOM has been an efficient distribution company in the recent past and the pilot area i.e. Electronic City was an ideal area to implement Smart Grid technologies due to the presence of adequate infrastructure and high collection efficiency. The R-APDRP program had provided BESCOM with SCADA/DMS and GIS systems, and hence ensured reasonable level of basic infrastructure to already be in place.

BESCOM started the process of distributing prepaid and postpaid smart meters to the consumers. SysconHefcom Smart Solutions Pvt Ltd, a city-based company was entrusted with the task of installing smart meters. The process was to install around 17,000 smart meters. BESCOM had also initiated the process of providing a Consumer Interface Unit (CIU), which could be effectively used by the consumer to monitor each one of the appliances for power consumption. The CIU displays power consumed in real time.

On the whole the process of implementation has been slow and characterized by several implementation issues. As per the latest update, a review consultant has been appointed by BESCOM to review the initial DPR prepared. Details of the further plan of activities and the timelines are not available.

## ANNEXURE 6: SUMMARY OF GOI SMART GRID PILOT PROJECTS

The 14 pilots proposed by GoI intend to implement the following functionalities:

**Table A6.1: Functionalities proposed to be implemented in GoIs pilot projects**

| | Functionalities to be implimented | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utility, State | AMI for industrial | AMI for residential | Peak Load Management | Demand Side Mangement | Power Quality | Demand Response using AMI | Condition based asset monitoring | Mobile Work Force Management | Outage Management | Consumer Portal | Integration of RE | Automatic Billing | Load Survey | Common metre data management system | Theft management/tamper detection | DTR Health Management | Asset Management | Crew Management | Operations Dispatch | Switching Oreder Devlopment | Demand Forecasting | Substation Automation | Distribution Automation | Distribution System |
| UHBVNL , Haryana | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | |
| CESC, Mysore | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | |
| TSECL, Agartala, Tripura | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | |
| KSEB,Kerela | ✓ | ✓ | | | | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | |
| Electricity Department, Puducherry | ✓ | ✓ | | | | | | | | | | | ✓ | | | | | | | | | | | |
| UGVCL, Gujarat | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | | |
| AP, CPDCL, Andhra Pradesh | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | | | | | | | | | | | | | | | |
| APDCL , Assam | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | | | |
| MSEDCL, Maharashtra | ✓ | ✓ | | | | | | | ✓ | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | | |
| CSPDCL , Chattisgarh | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | | | | |
| HPSEB, Himachal Pradesh | ✓ | ✓ | | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | ✓ | ✓ | |
| PSPCL , Punjab | ✓ | ✓ | | | | | | | ✓ | | | | | | | | | | | | | | | ✓ |
| WBSEDCL, West Bengal | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| JVVNL , Rajasthan | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |

## A6.1 UHBVN, Haryana

UHBVN, Haryana has proposed a Smart Grid pilot in the panipat city subdivision covering 30,544 consumers and distribution system of 531 DTs. The area has around 131.8MU input energy consumption. The proposed project area is also covered under R-APDRP scheme of IT implementation and system strengthening which is likely to be completed by 2013. Peak Load Management is proposed by implementing Automated Metering Infrastructure for residential and industrial consumers.

The proposed project cost is Rs. 29.41 Cr. Of this around Rs. 21.4 Cr has been allocated for intelligent metres at DT and consumer premises. Meter data acquisition, data management, and data management/peak load management software's account for approximately Rs. 4.6 Cr. The approximate charges for GPRS connection charges account for nearly Rs. 2.17 Cr. The proposed timeline for the project completion is approximately 18 months.

It was observed that at some locations like DTs and some industrial consumers AMR metres are envisaged under R-APDRP and accordingly such locations should be excluded from the scope of the pilot. Also if the smart metres are installed in these locations before implementation under R-APDRP then the scope of R-APDRP should be reduced accordingly.

### COST BENEFIT ANALYSIS

The proposed cost benefit analysis for the pilot is based on the assumption of reducing distribution losses from 30.10percent to 16.50percent, reducing peak load consumption by up to 9,000 units by shifting of peak load demand to non-peak time and thereby saving differential UI charges for peak and non-peak which is about Rs 5 per unit for the utility and the cost of billing will be reduced by up to approximately 20percent. Based on this the payback has been calculated by utility in four years. This payback period is expected to decrease further after considering the moderated project cost.

### METHODOLOGY

The project proposes Peak Load Management through Demand Side Management and Demand Response using AMI for capturing consumer metring data remotely. Data Acquisition Centre is also proposed that will remotely control the metres.

Demand management is proposed to be done by remotely shutting down only non-essential electrical loads during peak hours and thereby saving on high UI charges. For this the Peak Management Function is proposed to take input from power controller. The input consists of power availability, volume of shortage and also pre-defined consumer priority. The approach of the utility is to avoid tripping of the feeders for load shedding and manage peak load by partial load curtailment. The communication between smart meter and meter head and is proposed through either Power Line communication or Low Power Radio, and from Meter Head End to Control station is through GPRS. The provision also includes measuring of energy input from DT and energy consumed by the consumers to detect any pilferage in the system.

**NEW TECHNOLOGY AND INNOVATION**

The pilot proposes a model of "time of use tariff incentives and disincentive and net metring for renewable energy "and process of Demand Response and Demand Management for Peak Load Management.

### A6.2 CESC,Mysore, Karnataka

CESC Mysore has proposed the pilot project in additional city area division ( ACAD) , Mysore involving 21,824 consumers with a mix of residential , commercial , industrial and agricultural consumers including 512 irrigation pumps covering 14 feeders and 473 DTs and accounting for input energy of 151.89 MU. The functionalities of Peak Load Management, Outage Management are proposed by implementing AMI for residential and industrial customers. Micro Grid integration was also proposed. Additional functionalities agriculture DSM with community portal, consumer portal to support DSM/DR, Employee portal for knowledge sharing and benefit realization were also proposed.

The initial estimated project cost initially mentioned by the utility was Rs. 50.94 Cr and this has been reduced by utility in terms of directions of committee. The revised cost is Rs. 41.93 Cr which mainly includes cost for smart metre at domestic, commercial and industrial consumer, metre data acquisition, data management software costs, transformer monitoring system cost of license for various softwares for OMS and PLM, operators training simulators and condition based monitoring.

The committee also observed that SCADA/DMS up to feeder level is mentioned as already existing but all functionalities are not used and this is proposed to be extended up-to consumer or DT level. The proposed timeline for project is 12 month from the date of award of technology partner.

**COST BENEFIT ANALYSIS**

Return of Investment is proposed to be realized through benefits on account of reduction in AT&C losses from 10.6 percent to 5.7 percent in three years, shifting of load of up to 80 percent in industrial feeders and up to 20 percent in domestic consumer during peak hours, reduction in number of transformer failure, meter reading costs, reduction in unforeseen outages and also recovery time in unforeseen outages by 20 percent and 50 percent. Based on project saving the payback period is calculated to be less than three years as per the initial project cost. The payback period is expected to decrease further after considering moderated project costs.

**METHODOLOGY**

The project proposes to use AMI for all consumers, transformer monitoring system and enhanced existing SCADA/DMS system for reduction in AT&C losses, outage management for increase in power supply to rural areas. Peak Load management would be done with Smart Load shedding and voluntary consumer participation. Integration of micro grid generating electricity using

renewable sources was also proposed. It is also proposed to implement consumer portal to support DSM/DR to support decision making and also to monitor the benefits of pilot and employee portal. The provision also included to replace old pump sets with energy efficient pump set and hence encourage energy saving.

**NEW TECHNOLOGY AND INITIATIVES**

The pilot project proposes real time pricing signal by interfacing at SLDC level to get UI prices subject to regulatory consent. Implementations of Fault Location Isolation and System Restoration (FLISR) at feeders where alternate feeding arrangements are available are also proposed. Distributed Energy Sources integration is proposed using already available technologies for the same.

### A6.3 TSECL, Tripura

TSECL has proposed a pilot project in electrical division of Agartala town covering 46,071 no of consumers. The proposed are is also covered under the R-APDRP scheme for IT implementation and system strengthening which is likely to be completed by 2013. The functionality of Peak Load Management is proposed by implementing AMI for residential and industrial consumers.

The estimated project cost initially mentioned by utility was Rs. 39.02 Cr and this was revised to Rs. 25.83 Cr by utility in terms of directions of committee. The cost mainly includes cost of smart meter at domestic, commercial and industrial consumer premises. The cost also included meter data management software costs and data concentrator costs. It was also noted that at some locations AMR metres were also included under R-APDRP and accordingly such locations should be excluded from the scope of the pilot. The committee also proposed to replace already installed AMR metres with smart metres. It was also suggested to explore the possibility of leveraging the software to be used for meter data acquisition and management to be installed under R-APDRP. It was also noted that if the data acquisition system under R-APDRP was compatible with the smart metres then it would not be required to deploy a separate data acquisition system in the proposed pilot.

**COST BENEFIT ANALYSIS**

The cost benefit of the pilot was based on the assumption of reducing distribution losses resulting in the saving of up to 10.95 MU of energy. Peak Load consumption was also expected to be reduced by up to 2604 units by shifting the peak load to non-peak time and thereby saving differential UI charges which is about Rs 5/unit for the utility and hence reducing cost of billing by up to 50 percent. Based on this the payback has been calculated by the utility as less than five years eightmonths as per initial project costs. This is expected to decrease further after considering moderated project costs.

**METHODOLOGY**

The project proposed Peak Load Management through demand side management and Demand Response using AMI for capturing the consumer data meter remotely at a data acquisition centre and remotely controlling the metres. Demand Management is proposed to be done by remotely shutting down only non-essential electrical loads during peak hours and thereby saving on high UI charges of up to Rs. 12/unit in peak time. For this the peak management function is proposed to take inputs from Power controller for power availability, volume of shortage and also predefined constraints and priorities defined by consumers. The main approach of the utility is to avoid tripping of feeders and manage peak load by partial load curtailment. The communication between smart meter to meter head end is proposed through either Power Line Communication (PLC) or Low Power Radio (LPR) and from meter head end to master control centre through GPRS connection. The utility has also made provisions to measure energy input to the DT and the total energy consumed by the consumers to measure any losses in the system.

**NEW TECHNOLOGY AND INNOVATION**

The pilot project proposes developing a mature model of "time of use tariff and net metering".

### A6.4 KSEB, Kerala

KSEB has proposed a Smart Grid pilot for 25,078 LT industrial consumers spread over the geographical area of Kerala state. The input energy for the total area is mentioned to be 2,108 MUs and for the LT industrial customers it is 376 MUs. The part of the area under the pilot is also covered under R-APDRP scheme. AMI is proposed which would help in providing quality service, prevent tampering and unauthorized usage of loads and accurate and timely metring and billing. It would also help in reducing supply restoration time, peak load management through load restriction for remote Disconnection/Reconnection and time of day tariff. The pilot also proposed installation of two metres one three phase LT meter and other single phase meter for light load.

The estimated project cost was Rs. 51.53 Cr. This cost was reduced to Rs. 32.31 Cr. in terms of directions of committee. The cost mainly includes cost for smart metres and modem and other hardware, data centre cost and hardware and software costs of implementation. The proposed timeline of the project is yet not decided. It is decided that only one meter at the consumer premises shall be allowed. It is also decided that one time cost for communication that includes the cost for SIM cards shall not be considered as the part of the project cost.

**COST BENEFIT ANALYSIS**

Return of investments would be realized through benefits due to reduction of AT&C losses of about 1.17 percent. There will also be reduction in losses due to manual errors, tampers, thefts, saving of employee travel cost for meter reading and introducing incremental tariff for peak hours.

Based on the above saving factors the payback period is expected to be 2.53 years as per the initial project cost. This payback period will decrease after considering moderated project costs.

**METHODOLOGY**

The main communication which has been proposed to be used is the GPRS communication technique. AMI will facilitate two way communications. Other proposals include Demand Response, tamper logging and real time reporting, schedule based automatic billing, real time reporting of outage, MD reset and remote disconnection and reconnection facility to the utility. Consumer portal is also proposed to enable consumer to participate in energy management of the utility.

### A6.5 Electricity Department, Government of Puducherry (PED)

Electricity Department, Government of Puducherry (PED) has proposed a Smart Grid Pilot in Division 1 of Puducherry covering 87031 no. of consumers with dominant being domestic consumers (79 percent). The area has around 367 MU input energy consumption. The proposed project area is also covered under R-APDRP scheme of IT implementation and system strengthening which is likely to be completed by 2013. Consumer issues like event management and prioritizing, billing cycle review and revenue collection efficiency for Energy auditing and AT&C loss reductions are proposed to me implemented using AMI for Residential Consumers and Industrial Consumers.

The estimated project cost initially quoted by the utility was Rs 77.02 Cr and then later it was revised to Rs. 52.45 Cr. The cost mainly includes cost of smart meters at domestic, Commercial and Industrial consumer premises amounting to Rs. 23.9 Cr, AMR meters at premises of low consumption consumers amounting to Rs. 11.31 Cr, Meter data acquisition/Meter data management software costs amounting to Rs. 1.1 Cr, Data Concentrator Unit cost amounting to Rs. 15.67 Cr. In Home Display, Fiber optic Communication equipment cost and Cost of Public awareness campaign were not allowed as part of project cost though GPRS Modern cost as per rates mentioned in TSECL DPR may be allowed DPR of Puducherry for alternate communication from DCU instead Of Fiber Optics. The moderated project cost allowed by the committee is Rs. Rs. 46.11 Cr including 5percent project management charges and Consultation Deployment charges. The proposed timeline for the completion of project was given as 563 days which is approximately 19 months.

It was observed that at some locations like DTs and some industrial consumers AMR metres are envisaged under R-APDRP and accordingly such locations should be excluded from the scope of the pilot. If the smart metres are installed in these locations before implementation under R-APDRP then the scope of R-APDRP should be reduced accordingly. Also, the data acquisition module under R-APDRP, if compatible with the smart meters, would not be required to be deployed in the pilot else a different data acquisition system would have to be installed.

**COST BENEFIT ANALYSIS**

The proposed cost benefit analysis for the pilot is based on the assumption of reducing Distribution Losses from 14 percent to saving resulting in savings of about 25.5 MUs, reducing cost of billing by up-to 50 percent and increasing revenue collection efficiency from 90 percent to 98 percent. Based on this, the payback has been calculated by utility as six years four months. This payback period is expected to decrease further after considering the moderated project cost.

**METHODOLOGY**

The project proposes AMI system to aid in knowing real time energy input from DT as well as energy consumption by consumers that can instantly help to know losses in the system. Common Meter Data Management System is proposed that shall take data from MOMS of Different meter manufacturer/solution provider and integrate the information for use. The communication between smart meter and meter head end is proposed through either Power Line communication or Low Power Radio and from DCU to Control centre Wide Band Communication medium is considered through Fiber Optics cables on 11kV/22kV lines.

**NEW TECHNOLOGY AND INNOVATION**

The project is proposed to be developed in collaboration with major Smart Grid solution providers available in India. Every solution provider shall deploy their complete solution in one or two feeder and above that a common meter data management solution shall be developed. Proposed Common Meter Data Management System shall take data from MDMS of Different meter manufacturer/solution provider and integrate the information for use. The pilot project also proposes developing a mature model of "time of use tariff and net metering".

### A6.6 UGVCL, Gujarat

UGVCL has proposed the pilot project in Naroda of Sabarmati circle which is an industrial and residential area and Deesa of Palanpur circle which is an agricultural area covering 20,524 consumers in Naroda and 18,898 agricultural unmetered consumer in Deesa-2 division and accounting for input energy of 1,700 MU. The proposal aims to achieve the functionalities of Peak Load Management, Outage Management, and Power Quality Management by implementing Automated Metering Infrastructure (AMI) for industrial, commercial and residential consumers. Some additional functionality like Load Forecasting and asset Management are also proposed.

The estimated project cost initially quoted by the utility was Rs. 64 Cr. and then later it was revised to Rs. 55.06 Cr. The cost mainly includes cost of smart metres, GPRS modems at industrial, commercial, Residential and agriculture consumers. The cost also included the cost for Data Concentrator Units, data centre costs, and costs for hardware and software implementation of data centre. GPRS usage charges were not allowed as a part of project cost. The moderated project cost allowed by the committee is Rs. 48.78 Cr including five percent project management charges and Consultation Deployment charges.

Renewable energy integration was also proposed to be carried out at Patan Solar Park with few roof top installations at some universities. The proposed timeline for the completion of project was given as 12-18 months.

## COST BENEFIT ANALYSIS

The Return of Investments is proposed to be realized through benefits on account of reduces AT&C losses from 12.44 percent to 8.44 percent in Naroda and from 21.69 percent to 15 percent in Deesa. There will also be saving in Peak Power Purchase Cost because of expected reduction of peak load by fivepercent. Transformer failure rate is expected to decrease from 16.52 percent to eight percent in Deesa area. There will also be reduction in number of outages, meter reading cost, and cost of collection and billing. Based on the savings the payback period as calculated by utility is 2.03 years as per revised project cost. The payback period is expected to decrease further.

## METHODOLOGY

In Naroda,AMI is proposed to be used for AT&C loss reduction which will be done by Theft Management/Tamper Detection and improving energy accounting. Peak Load Management is proposed through TOU tariff implementation, Consumer portal for DR and DSM, Demand Side Management and Demand Response Programs, Outage Management. In addition Power quality Management through constant monitoring of harmonics and DTR health Management is also proposed. Apart from this, it is also proposed to implement hybrid model for communication with RE Mesh Topology (Possibly Zigbee) + GPRS13G and in a smaller pocket PLC + GPRS/3G in this area.

In Deesa area, AMI is proposed to be used for AT&C Losses Reduction for detecting and regularizing un-authorized load for unmetered agriculture consumers. Asset management with constant monitoring of all the DTRs is also proposed to bring a reduction of DTR failure rate. For communication medium, use of GPRS/3G is proposed.

Renewable energy integration is also proposed to be achieved through proper and accurate load forecast by real time monitoring of close to 300 substations, 3,500 up to 11 KV feeders and RES generation, mainly wind and solar.

For Utility wide functions the substation feeder meters are proposed to be connected to a concentrator via Modbus and the concentrator to head end system via GPRS/3G.

## NEW TECHNOLOGY AND INNOVATION

The pilot project proposes to introduce TOU tariff with approvals from GERC. Renewable energy integration is proposed through proper and accurate load forecast by real time monitoring of substations, feeders and RES generation.

## A6.7 APCPDCL, Andhra Pradesh

APCPDCL, Andhra Pradesh has proposed a Smart Grid pilot in the Jeedimetla Industrial Area covering 11,904 consumers .The proposed project area is also covered under R-APDRP scheme and so DAS, IT and SCADA shall be implemented. The functionalities of Peak load management, Power Quality and Outage Management are proposed by implementing Automated Metering Infrastructure for residential and industrial consumers.

The estimated project cost initially mentioned by utility was Rs. 59.4 Cr and this was revised to Rs 43.4 Cr by utility in terms of directions of committee Of this around 18.34 Cr has been allotted for Smart meters, DCU and Zigbee repeaters ,Transformer Monitoring Unit (TMU) and equipments for power quality improvements. Around Rs. 22.18 Cr has been allotted for SGMS software and hardware, network upgrade and customer outreach Cost and around Rs. 1.82 Cr for the installation, testing and commissioning and project management consultancy charges. Contingency charges , operating expenditure, Project Management consultancy charges, customer outreach and capacity building charges were not be allowed as part of project cost The moderated project cost allowed by the committee is Rs 41.82 Cr including five percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is approximately 18 months.

It was observed that at some locations like DTs and some industrial consumers AMR metres are envisaged under R-APDRP and accordingly such locations should be excluded from the scope of the pilot. Also if the smart metres are installed in these locations before implementation under R-APDRP then the scope of R-APDRP should be reduced accordingly.

### COST BENEFIT ANALYSIS

The proposed cost benefit analysis for the pilot is based on the assumption of reducing AT&C loss from present 9.48 percent to 7.48 percent and energy saving during peak times by shifting about 35.68 MUs from peak periods and thereby reduced purchase of high cost power at peak hours. Based on this, the payback has been calculated by utility as 2.48 years. This payback period is expected to decrease further after considering the moderated project cost.

### METHODOLOGY

The project proposes Outage Management by way of system strengthening, automation of MV distribution network and introducing DMS so that 'self-healing' can be implemented. The substations of the project area are already provided with required automation components. The Peak Load Management is proposed by introducing Time of Use' tariff, DMS functions with PMS module and educating industries on energy efficiency process. It is proposed to take inputs from SCADA and SGMC (SMART Grid Management Centre) for power availability and volume of shortage, run algorithms considering various constraints and priorities defined by CPDCL and suggest the options to utility officials. The proposed approach is to avoid tripping of feeders for load shedding but to exploit AMI for rolling out DSM program. It also proposes use of

components like Harmonic filters, STATCOMS, Capacitors etc. in the network to manage Power Quality.

### A6.8 APDCL, Assam

APDCL, Assam has proposed a Smart Grid pilot in the Guwahati distribution region, covering 15,000 consumers and involving 90 MUs of input energy. The proposed project area is also covered under R-APDRP scheme and SCADA/DMS implementation. Peak load Management is proposed by implementing Automated Metering Infrastructure for residential and industrial consumers Integration of Distributed Generation (Solar and available back-up DG Set) and Outage Management system. Power Quality Monitoring will be a by-product of the deployment.

The proposed project cost is Rs 43.09 Cr which mainly includes Cost of Smart meters and associated equipments like DCUs, IHDs etc amounting to Rs 22.30 Cr, Data Center hardware Cost amounting to Rs 1.3 Cr, Application Software and IT software Cost amounting to Rs 10.18 Cr, Implementation Services Cost amounting to Rs 2.12 Cr and Project Management Cost amounting to Rs 2.82Cr. In Home Display cost, Project Management and Implementation services costs are not a part of project cost. The moderated project cost allowed by the committee is Rs 29.41 Cr including five percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is 18 months.

**COST BENEFIT ANALYSIS**

The proposed cost benefit analysis for the pilot is based on increased available energy of 55,602.5 kWh during peak time resulting in a saving of Rs. three Cr per year, increased revenue through Power Quality measurements and power factor penalty (assuming a five percent variation in Power factor across 20 percent of the customers, paying an average two percent penalty), reduction in AT&C Losses from 16.7 percent to 12.55 percent, reduction in interest payments due to deferred Capital Investment in sub-transmission networks, improvement of availability (reduction of Customer Minutes Lost) and improved management of power procurement options, unscheduled interchange using Short Term Load Forecasts. Based on this, the payback has been calculated by utility as five years. This payback period is expected to decrease further after considering the moderated project cost.

**METHODOLOGY**

The project proposes implementation of Peak Load Management through restricting the user from using non-essential equipments in residential complexes during peak hours, disconnecting the cellular communication towers during peak hours from the network and allowing them to operate on their backup generation. Using AMI, Time of Use Tariff / Peak pricing tariff is proposed which is to be communicated to consumers through various options for Demand Response and Demand Side Management. For implementing Distributed Generation a PV farm together with its battery

pack is proposed which is to be made grid interactive using smart controller and a bidirectional converter.

It also proposes to implement a comprehensive and integrated outage management system built on top of the AMI infrastructure and which aims to develop a common operations model and decision support environment for its Control Centre. The utility also aims to integrate the solution with the existing GIS that is being implemented as a part of the R-APDRP project and the forthcoming SCADA/DMS.

**NEW TECHNOLOGY AND INNOVATION**

It proposes to introduce to Integrate 100kW solar farm into the distribution network via a bidirectional inverter and use of battery storage, possibly Vanadium redox battery, in conjunction with the solar farm. In addition R&D works are proposed for Forecasting of load based on the weather, social events, festivals etc. and developing various "if-then" scenarios to find optimal course of action for each scenario, Developing controllers for the bidirectional inverter and battery integration, Development of filters for reduction of harmonics injected into the grid and integrating it into the smart meters, Development of messaging systems (for display in house and on mobile) for power consumption information and methods to reduce energy consumption Study of the Guwahati's distribution grid to identify the locations and sizes of the Vanadium redox batteries for peak shaving and valley filling is also proposed.

### A6.9 MSEDCL, Maharashtra

MSEDCL, Maharashtra has proposed a Smart Grid pilot in Baramati town covering 25,629 consumers and having input energy consumption of around 261.6 MU. The functionality of Outage Management (OM) is proposed to be implemented by using AMI for residential/industrial customers. In addition, it has proposed to leverage AMI for remote connect/disconnect of customers, monitoring the consumption pattern, tamper detection, contract load monitoring, load curtailment program, time of Use metering, Dynamic/Real Time pricing, Demand forecasting etc.

The estimated project cost initially mentioned by utility was Rs. 33.58 Cr and this was revised to Rs 26.72 Cr by utility in terms of directions of committee. This cost mainly comprised of cost of smart meters, DCUs, SCADA DMS Control centre(including hardware and software) and consultant deployment and project management cost. FMS cost, contingency charges, Project Management and consultant deployment costs were not allowed as a part of project cost. The moderated project cost allowed by the committee is Rs 21.28 Cr including five percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is 24 months.

**COST BENEFIT ANALYSIS**

Return of investments would be realized through benefits due to reduction in AT&C losses time from 21.41percent to 12percent and requirement of field staff through proper management of

unforeseen outages, improvement in reliability measures like SAIFI, SAIDI, CAIDI etc., reduction in meter reading cost, bringing efficiency in meter reading etc. Based on the above saving factors the payback period is expected to be five years as per the initial project cost. This payback period will decrease after considering revised and moderated project costs.

**METHODOLOGY**

The project proposes OMS system to support trouble and outage management and analysis, operations dispatch, crew management, switching order development etc. Outage detection would be done by using AMI so that whenever there is an outage in an area, based on the configuration, the system will automatically detect the outage area and the affected consumers. Both OMS and AMI solutions are proposed to be integrated with SCADA/ DMS, R-APDRP module, existing ERP solutions as well as home grown web-enabled ancillary systems and introduce centrally controlled metering processes or outage processes like remote connect/disconnect of customers, monitoring the consumption pattern, tamper detection, contract load monitoring, load curtailment program, Demand forecasting etc. It also proposes use of GPRS/CDMA/RF as the communication technologies in the metering environment.

**NEW TECHNOLOGY AND INNOVATION**

It proposes to introduce communication technologies like GPRS/CDMA/RF in the metering environment with common protocol and near real time analytics technologies for meter analytics as well as near real time event insights coming from SCADA systems. Motorization of all feeder breakers and RMUs is also proposed.

### A6.10 CSPDCL, Chhattisgarh

CSPDCL, Chhattisgarh has proposed a Smart Grid pilot in Siltara — Urla area of Raipur District (Chhattisgarh State) by installing smart meters at 508 H.T. and L.T Industrial Consumer premises including 140 smart meters for expected load growth during the implementation phase as well as Automatic Meter Reading (AMR) at 83 DTs including 10 smart meters for expected load growth during the implementation phase The area has around 2140.86 MU input energy consumption. Peak Load Management is proposed by implementing Automated Metering Infrastructure for industrial consumers. It is also observed that the proposed project area is not covered under R-APDRP scheme.

The estimated project cost initially mentioned by utility was Rs. 10.03Cr and this was revised to Rs 5.89 Cr by utility in terms of directions of committee. This cost mainly comprised of cost of for intelligent meters at DTs and consumer premises, software cost, hardware cost, Customer engagement cost and system improvement work of electrical infrastructure.

GPRS usage charges, Facilities Management charges and In Home Display were not allowed as a part of project cost. The moderated project cost allowed by the committee is Rs 5.55 Cr including

five percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is two years from the date of award of the contract.

**COST BENEFIT ANALYSIS**

The proposed cost benefit analysis for the pilot is based on the assumption of reducing Distribution T&D losses from 25.27 percent to 13.91 percent, reducing Peak load consumption through shifting of Peak Load demand to a non-peak time thereby saving UI charges which utility pays at Rs 5-8 per unit and also by reducing cost of billing by up-to 20 percent. Based on this, the payback has been calculated by utility as two years and 10 months. This payback period is expected to decrease further after considering the moderated project cost.

**METHODOLOGY**

The project proposes peak load management through Demand Side Management and Demand Response using AMI for capturing consumer metering data remotely at a Data Acquisition Centre and also remotely controlling the meters. Demand Management is proposed to be done by remotely shutting down only non-essential electrical loads during peak hours and thereby saving on UI charges of up to Rs 5-8 per unit that utility is paying in peak time. For this, the peak management function is proposed to take inputs from Power Controller (DC system) for power availability and volume of shortage and also select, considering constraints, predefined consumer priorities, last curtailment history and carry out load curtailment. The proposed approach by utility is to avoid tripping of feeders for load shedding and manage peak load by partial load curtailment.

For Demand Response constraint of Regulatory approval for Time of use tariff is envisaged and it is proposed to take up the issue with regulators after successful initial phase of one year operation.

The communication between Smart Meter to Meter Head End is proposed through either Power Line Communication (PLC) or Low Power Radio (PR) and from Meter Head End to Master station/Control Centre through General Packet Radio Service (GPRS).

It has also proposed using data of energy input from DT as well as energy consumption by consumers for detecting pilferage in the system, increasing collection efficiency, reducing AT&C losses, outage management, tamper event detection, and Power Quality Management and enabling operator to take informed business decision.

**NEW TECHNOLOGY AND INNOVATION**

The pilot project proposes evolving a model of “Time of Use Tariff” and experimenting techniques like Demand response and Demand management for Peak Load Management and to do research and development for developing a mature model of the same.

### A6.11 HPSEB, Himachal Pradesh

HPSEB, Himachal Pradesh has proposed a Smart Grid pilot in industrial town of Kala Amb covering 650 consumers and having annual input energy consumption of 533 MU. The

functionality of Outage Management (OM) and Peak Load management is proposed by implementing AMI for industrial consumers and Distribution Automation, Substation Automation and Power Quality Management by deploying Power Quality meters at HT consumers.

The estimated project cost initially mentioned by utility was Rs. 29.66 Cr and this was revised to Rs 18.11 Cr by utility in terms of directions of committee. This cost mainly comprised of cost of smart meters, AMI system, Substation Automation, Remote Controlled load break switches, fault pass switches , TMUs for DTRs and control centre setup cost. Cost of meter housing, Trainings and Customer Outreach program costs were not allowed as a part of project cost. Also, cost of high end power quality meters has been moderated to three phase meter cost i.e. Rs.7,000 only. The moderated project cost allowed by the committee is Rs 17.84 Cr including 5percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is 24 months.

**COST BENEFIT ANALYSIS**

The proposed cost benefit analysis for the pilot is based on the assumption of savings by shifting 10 percent peak load, reduction in penalties by 40 percent and reduction in outages by 60 percent. Based on this, the payback has been calculated by utility as 22 months. This payback period is expected to decrease further after considering the moderated project cost

**METHODOLOGY**

The project proposes Demand Response Management system to support peak shifting as well as leverage the AMI infrastructure to estimate the load availability based on the customer enrolment and historical data and compare to the load forecast from EMS. Based on the above demand and estimated amount of MWs required, response signal is sent to pre-established groups of customers. Redundant communication path with HAN for DR is also envisaged by use of internet service providers.

The project also proposes use of OMS for supporting network management and restoration processes using HPSEBs GIS and asset data. Transformer Monitoring Unit is also proposed to be installed for condition based monitoring. OMS functions will integrate with key Smart Grid components such as SCADA system, Distribution Automation and AMI for condition based monitoring of critical assets like distribution transformers, Fault Management and system Restoration (FM and SR), reduction in duration and frequency of unplanned outages, Improved Operational Efficiency etc.

High end power quality meters installed at three consumers, one each of 132, 33 and 11 KV like steel mills etc would be used to remotely capture key power quality parameters like Power factor, Voltage (Sag/Swell), Harmonics spectrum etc and also monitor pollution injected for identifying decision on corrective actions in collaboration with consumers. The project also proposes Communication technologies such as Zig Bee for HAN, PLC, GPRS, 3G, RE Mesh etc. with field replaceable Modular communication modules to safe guard against technology getting obsolete / area specific adaptation in future.

## NEW TECHNOLOGY AND INNOVATION

The pilot project proposed installing of High end power quality meters at HT consumers (Steel Mills), one each at 132, 33 and 11 KV consumers for capturing power quality data remotely for identifying decision on corrective actions in collaboration with consumers.

### A6.12 PSPCL, Punjab

PSPCL, Punjab has proposed a Smart Grid pilot in Industrial Division of city circle Amritsar covering 85,746 consumers. The functionality of Outage Management (OM) and distribution system is proposed to be implemented by using AMI by installing 9000 smart meters and by Transformer Monitoring. The proposed project area is also covered under R-APDRP scheme for SCADA implementation and GIS mapping.

The estimated project cost initially mentioned by utility was Rs. 16.067 Cr and this was revised to Rs 13.15 Cr by utility in terms of directions of committee. This cost mainly comprised of cost of AMI infrastructure including cost of smart meters, transformer monitoring unit (TMU) and software cost. Contingency charges were not allowed as a part of the project cost. The moderated project cost allowed by the committee is Rs 11.34 Cr including five percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is yet not given.

It was observed that at some locations like DTs and some industrial consumers AMR meters are envisaged under R-APDRP and accordingly such locations should be excluded from the scope of the pilot. Also if the smart metres are installed in these locations before implementation under R-APDRP then the scope of R-APDRP should be reduced accordingly.

## COST BENEFIT ANALYSIS

Return of investments would be realized through benefits due to reduction in feeder outage restoration time by 50 percent, transformer outages by 50 percent and transformer outages restoration time by 20 percent. Based on the above saving factors the payback period is expected to be 4.08 years as per the initial project cost. This payback period will decrease after considering revised and moderated project costs.

## METHODOLOGY

The project proposes OMS system which will draw the data from all available information sources including SCADA, TMUs at DT, Trouble Call tracking/reporting system (IVR/Call Centre), AMI. It will then analyze the event and make an estimate on the probable cause and convey the outage information to the affected customers before they call. The field crews will visually inspect the outage area, analyze the situation and confirm a cause for the event and the estimated time for restoration.

The AMI system shall comprise of meters on all 11kV feeders (10 nos.), all distribution transformers and five percent of the consumers by considering strategic locations, Data Concentrator Units/ Meter Head Ends and the AMI server/MDAS. GIS working with AMI will allow utility to pinpoint the outages and integrated-Maintenance utility van shall have GPS for tracking of its location. The communication between smart meter to meter head end is proposed through either Power Line Communication (PLC) or Low Power Radio (LPR) and from meter head end to master control centre through GPRS connection.

**NEW TECHNOLOGY AND INNOVATION**

The pilot project proposes deploying Condition monitoring of DTs, Trouble Call tracking/reporting system (IVR/Call Centre), AMI and Optimized Maintenance crew deployment through OMS in the pilot area.

### A6.13 WBSEDCL, West Bengal

WBSEDCL, West Bengal has proposed the implementation of a Smart Grid pilot taking up 4 nos. Of 11KV feeders under Siliguri town in Darjeeling district area covering 4,404 consumers. The area has 42 MU as input energy consumption. Peak Load Management and AT&C loss reduction is proposed by implementing Automated Metering Infrastructure for residential and industrial consumers.

The estimated project cost initially mentioned was Rs. 282.87 Cr with utility wide scope and this was revised to Rs 8.06 Cr by utility in terms of directions of committee. This cost mainly includes cost of smart meters, modems, relays, data servers, application servers with OS and the software costs. FMS cost, consultancy and roll out costs were not allowed as a part of project cost. The moderated project cost allowed by the committee is Rs 7.03 Cr including fivepercent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is 365 days (one year) from the date of commencement of the project.

**COST BENEFIT ANALYSIS**

Not submitted.

**METHODOLOGY**

The project proposes use of GPRS the communication technology right from the meter end. It also proposes use of AMI for demand response by customers in terms of power incentives/disincentives for reduction of energy use, remote meter reading, network problem identification, load profile for Peak Load management, energy audit, signaling for load control, load curtailment beyond sanctioned limit, and tamper detection.

It was observed that detailed methodology was not mentioned by the utility.

### A6.14 JVVNL, Rajasthan

JVVNL, Rajasthan has proposed a Smart Grid pilot in VKIA Jaipur area covering 2646 consumers mostly dominated by industrial customers and having input energy consumption of around 374.68 MU. It was also observed that the project area has very low losses (0.95 percent) in and reduction of only 0.19 percent in losses envisaged. The proposed project area is also covered under R-APDRP scheme of IT implementation and system strengthening which is likely to be completed by June 2012. Peak Load Management is proposed by implementing Automated Metering Infrastructure for residential and industrial consumers.

The estimated project cost initially mentioned by utility was Rs. 26.42 Cr and this was revised to Rs 18.11 Cr by utility in terms of directions of committee. This cost mainly includes cost of smart meters at domestic, commercial and industrial consumer premises, sensors, consoles (IHD), Data centre amounting to Rs 14.96 and installation cost of Rs 2.24 Cr. Contingency charges, In Home Display and sensor cost were not allowed as a part of project cost. The moderated project cost allowed by the committee is Rs 4.46 Cr including five percent project management charges and Consultation Deployment charges. The proposed timeline for the project completion is yet not given.

It was observed that at some locations like DTs and some industrial consumers AMR metres are envisaged under R-APDRP and accordingly such locations should be excluded from the scope of the pilot. Also if the smart metres are installed in these locations before implementation under R-APDRP then the scope of R-APDRP should be reduced accordingly.

#### COST BENEFIT ANALYSIS

The proposed cost benefit analysis for the pilot is based on the assumption of reducing AT&C losses from 0.95percent to 0.76percent, reducing peak load consumption by up to 20percent by shifting of peak load demand to non-peak time and thereby saving differential UI charges for peak and non-peak which is about Rs 3.18 per unit for the utility. Based on this the payback has been calculated by utility as 3.7 years as per the initial project cost. This payback period is expected to decrease further after considering the moderated project cost.

#### METHODOLOGY

The project proposes use of GPRS from meter to utility central server and RF communication using Zigbee topology as the communication technologies to control the device connected through smart plug for Home Area Network (HAN).The AMI meter will push the data to central server and receive the instruction from central server and Zigbee would be used to control the device connected to smart plug for peak load management. Smart plug is envisaged as an intelligent device with Zigbee communication that is supposed to receive instruction from AMI meter and take action based on instruction for Load control.

In addition, project also proposes IHD to be put for few customers to provide them with convenient, timely and relevant information about their industry energy consumption and make them more aware of their actual energy use.

Of the proposed pilots, Puducherry has already initiated the implementation of the Smart Grid pilot project. The detailed description of the pilot project has been provided below:

## A6.15 SMART GRID PILOT IN PUDUCHERRY

Puducherry is a Union Territory in Southern India. The Smart Grid pilot in Puducherry is the first project of the 14 Smart Grid pilots proposed by the ISGTF and funded by the GoI to be implemented on experimental basis. The Smart Grid pilot vision for Puducherry was to build a smart city in the targeted areas and implement various functionalities of the Smart Grids. Table below provides the description of the proposed pilot, the operating model and the coverage.

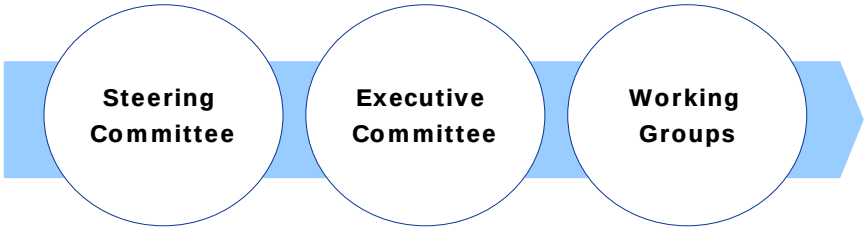
**TableA6.1: Puducherry Smart Grid Pilot**

| Particulars | Description |
|---|---|
| Utility | Electricity Department of Puducherry.<br>*The initiatives has been envisaged as an open initiative being implemented with the PGCIL as a partner along with various other equipment manufacturers, suppliers, software developers, system integrators, consultants and academic institutions. These players have been voluntarily contributing to the initial phase of the pilot in various ways. Key contributes to the pilot besides the PGCIL include Kalkitech, J&J, TMS and Secure. Other collaborators include Itron, Alstom, NexGen, Lanco, IT Power, Powertech, Sugen, Capital, L&T, AMI Tech, HPL, etc* |
| Area Proposed and Coverage | Puducherry Town Limit (Division 1 of Electricity Department of Puducherry) covering 87,000 houses. |

| | |
|---|---|
| Operating Model | Power Grid Corporation of India Ltd. will be implementing the pilot project in Puducherry and will be coordinating with various other partners. The project initially aims to cover 87,000 houses in the town, and is proposed to be completed in four to six months. The project involves installation of Advance Metering Infrastructure with a Central Data Control Center. Through these interventions, the consumer will be able to manage power usage by having information about the usage and billing information.<br><br>The overall requirement of the hardware and software has partly been contributed by various players, while the other is still in process of being mobilized. As of October 2012, control centre with 195 intelligent energy meters, five Data Concentrator Units, one DT energy meter along with meter data management application has already been installed. The control centre was launched on October 19, 2012.<br><br>With the establishment of the Control Centre and the associated equipment, the Electricity Department of Puducherry will be able to monitor online the energy usage pattern of the consumer and trace energy theft. It will also be able to connect and disconnect the power supply online from the Control Center. The AMI will also help the department to send and collect electricity bills online. |
| Estimated Cost | Rs. 77 Cr. out of which Rs. 25 Cr. would be borne by the Ministry of Power and the remaining was to be borne by the State Government. PGCIL has pitched in to contribute the states' share of the envisaged cost i.e. Rs. 52 Cr. A part of it is being met directly and the remaining through various collaborators. |
| Envisaged Savings | Reduction in AT&C losses from the current level of 22.6 percent to 8.86 percent within three years. Similarly, increase in collection efficiency from the existing 90percent to 98percent. Estimated monetary benefit of Rs. 12.24 Cr. per annum. |

For implementing the smart city the following arrangement has been set up:

**Fig A6.1: Pilot program implementing agencies**




The following role has been envisaged for the above groups:

**Project Steering Committee (PSC)**

- To steer and monitor the project progress for successful completion of the project and developmental activities thereafter. PSC shall also resolve the technical issues, if any, put up by the Executive Committee. PSC shall also explore the feasibility of commercial use of functionalities installed at the Smart Grid/City after satisfactory completion of development period in future other cities.

**Executive Committee (EC)**

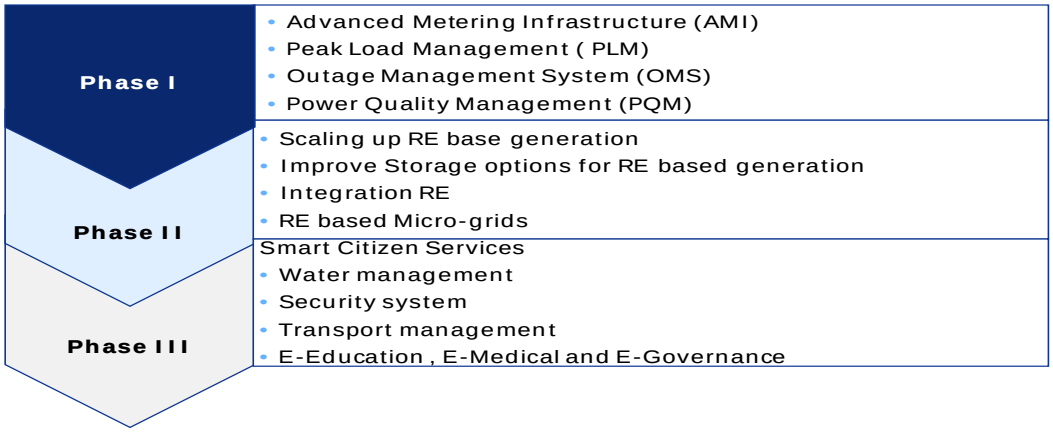
- To finalize the blueprint including different building blocks of the Pilot Smart Grid/City, timeline for each activity, formation of different working groups and scope of work, determine who will do which work/activity, modalities of implementation of each functionalities for the Pilot in a holistic manner. The EC shall inform to outcome to the PSC.

**Working Groups (WG)**

- There will be different working groups for various functionalities. The Working Group shall consist of two representatives of respective parties. Each party shall nominate two members one as prime member and other as an alternate member. Members nominated by the Power Grid shall be the Coordinator of the Working Group. The following working groups have been formed:
    - Working Group 1 – Advanced Metering Infrastructure and Peak Load Management
    - Working Group 2 – Outage Management System and Power Quality Management
    - Working Group 3 – Renewable Energy
    - Working Group 4 – Energy Storage
    - Working Group 5 – Smart City
    - Working Group 6 – Architecture Design
    - Working Group 7 – Project Management

The overall project has been proposed to be implemented in three phases. The following chart lists the activities planned to be undertaken in each phase:

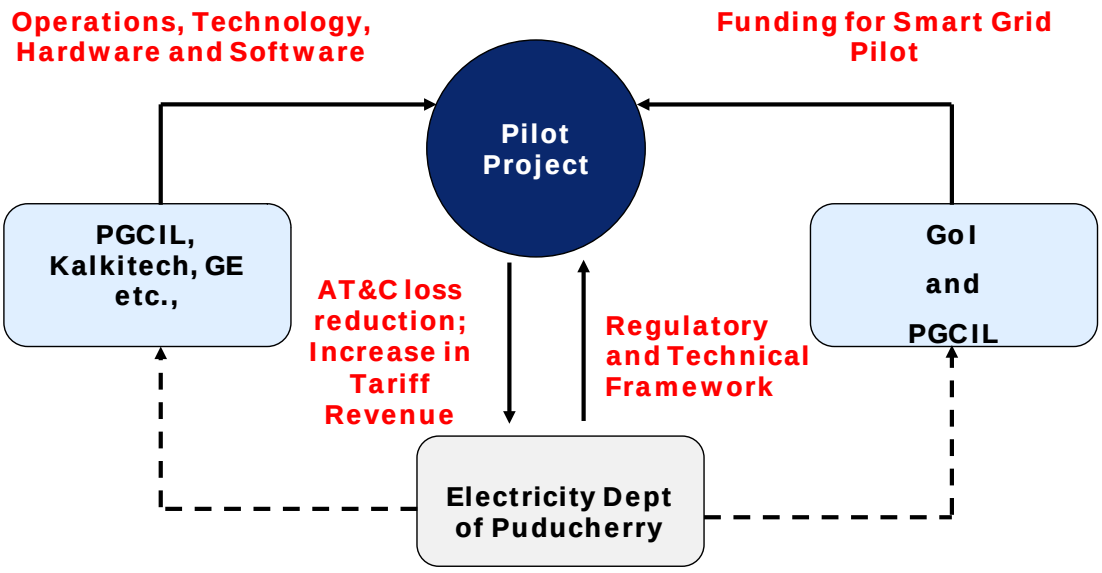
**Fig A6.2: Implementation Plan**




## A6.15.1 BUSINESS MODEL AND ROLES OF VARIOUS ENTITIES INVOLVED

The relationship of various entities involved in the Smart Grid pilot project in Puducherry has been depicted below:

**Fig A6.3: Business Plan**



The business model is fairly simple in this Smart Grid pilot project. PGCIL along with its associates is funding the project along with the GoI. There is no financial burden on the Govt. of Puducherry for the initial phase. This pilot project has been able to mobilize interest from various industry players and in turn has provided them a platform for showcasing their innovative solutions. The Electricity Dept. of Puducherry will gain in terms of reduction in AT&C losses and increase in collection efficiency leading to an estimated gain of Rs. 12.24 Cr. per annum.

### A6.15.2 OUR ASSESSMENT

Since the signing of a MoU between PGCIL and Govt. of Puducherry in March 2012, work has progressed at a steady pace. Recently on October 19, 2012, the Hon'ble Chief Minister of Puducherry inaugurated the Smart Grid Control Centre in the presence of personnel from PGCIL and various other entities such as meter manufacturers, Smart Grid technology solution providers, consultants, IT and ITES firms etc.

PGCIL has already installed 195 smart energy meters, five DCUs and one DT energy meter. Through the smart energy grid control centre, the Electricity Department will be able to monitor electricity usage by consumers on a real-time basis thereby preventing theft of electricity. It can also connect/disconnect any consumer through the control centre. This will lead to the implementation of demand response through which energy consumption can be managed during times of peak demand without resorting to complete power cuts.

This being the first Smart Grid pilot project to be implemented under the aegis of the Ministry of Power, has stirred interest among all the relevant stakeholders in the Smart Grid space and its progress is closely monitored by experts in the Indian power sector. The success of this Smart Grid pilot is likely to create a positive impact on the overall Smart Grid market in India. The work has progressed without any major glitch and is expected to be completed in time. Even the stakeholders present during the inauguration of the control centre were positive about the outcome and timeliness of the project until now.

Provided below are the tentative timelines agreed upon by the steering committee in a meeting held after the inauguration ceremony on October 19, 2012:

- Release of funds from the Ministry of Power - December 2012
- Approval for pending schemes under R-APDRP – December 2012
- Finalization of schemes, components and preparation of Bill of Quantities (BoQ)– March 2013
- Tariff finalization by the Joint Electricity Regulatory Commission (JERC) for RE based generation through establishment of micro-grids – March 2013

- Procurement of technologies under R-APDRP and ISGTF funds – June 2013
- Installation of equipment procured through funds received under R-APDRP and ISGTF – December 2013
- Installation and commissioning of Micro-grids – March 2014
- Deployment of Electric Vehicles and Energy Storage devices for Micro-grids – March 2014

Going forward, the following aspects will be important for scaling up the pilot initiatives:

- **Robust business model to be a basis for scaling up the initiatives**– As part of the pilot most of the contributions were made by the partners on voluntary basis with no financial burden on the Govt. of Puducherry. However, scaling up of the initiatives would require robust business and commercial models to be developed that take into account the actual project economics, viability and payback period into account.
- **Regulatory and other Approvals** – Govt. of Puducherry and the PGCIL were the key entities driving the project, hence the most of the approvals were obtained with ease. Also, since the financial burden was nil, the issue of regulatory approval for pass through of tariff has not arisen as of now. However, as the initiatives are scaled up these will have to be budgeted for both in the costing and the timelines proposed for implementation.
- **Issues with Interoperability** – The pilot project has voluntary contributions by various technology providers. The absence of a system integrator might pose an issue with respect to interoperability of the different technologies due to the use of proprietary standards

## A6.16 SMART GRID PILOT IN BARAMATI TOWN IN MAHARASHTRA

**Baramati Town**: MSEDCL is planning to implement a Smart Grid project in Baramati town of Maharashtra. This town has majorly sugar producing industries. The Part-A scheme under the R-APDRP has been completed in this area and infrastructure upgrade is currently being undertaken under the Part-B scheme and hence is a suitable area for implementing Smart Grid solutions. MSEDCL will be implementing Smart metering solutions, SCADA, DCUs and FRTUs, outage management systems and motorizing all feeder breakers and RMUs.

## ANNEXURE 7: SMART GRID PROGRAMS INITIATED BY VARIOUS FUNDING AGENCIES

| Funding Agency | Beneficiary | Purpose | Year of Sanction |
|---|---|---|---|
| USTDA , US Trade and Development Industry | BESCOM | Feasibility Study for the BESCOM Smart Grid Project | 2011 |
| USTDA | Azure Power | Feasibility study on two 500 kW micro-grid solar photovoltaic power generation pilot projects in state of Gujarat and Chhattisgarh | 2012 |
| USTDA | CESC Limited | Implementation of Smart Grid technologies across the electricity distribution network in Kolkata | 2012 |
| USTDA | PGCIL | Smart Grid project to control electric power on the grid in real time , accommodate renewable energy generation and reduce transmission losses | 2012 |
| ADB (Asian Development Bank) | Government of India | Smart Grid Capacity Development (covers India and Maldives) | 2012 |
| ADB | Rajasthan RajyaVidyutPrasaran Nigam Limited (RVPN) | Preparing the Rajasthan Renewable Energy Transmission – Involves setting up of control centre for RE integration | 2012 |
| ADB | Mahagenco and Mahatransco | Maharashtra Solar Park and Green Grid Development Investment Program | 2012 |
| EPSRC (Engineering and Physical Sciences Research Council) and DST (Department of Science and Technology) | DST (Department of Science and Technology) | Research projects focusing on Smart Energy Grids and Energy Storage | 2012 |

| | | | |
|---|---|---|---|
| Shakti Sustainable Energy Foundation (part of ClimateWorks Foundation) | TANGEDCO | Study on Implementation of Pilot Demand Response Programme in Tamil Nadu | 2012 |
| New Energy and Industrial Technology Development Organization of Japan (NEDO), | Neemrana Industrial Park, Rajasthan | Model Project for a Microgrid System Using Large-scale PV Power Generation and Related Technologies at Neemrana Industrial park in Rajasthan | 2012 **13** |

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