Knowledge Paper on Smart Grids, Automation and Solar Storage
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Role of Technology in Today’s Electricity Sector

Technology awareness is a major concern in the electricity sector. Hence, the union government, during the 2017 budget focused on digitization, infusing technology in our day-to-day lives. Therefore, the budget season has been claimed as “a digital economy budget”, the digital theme being focused in every area.

Further, backed by the initiatives such as Make in India, Digital India and Startup India, the nation is on the verge of transformation into a global manufacturing hub. The government has emphasized on initiating manufacturing centers in the electrical, electronics and heavy industry sectors with conducive policy initiatives and framework.

The vision of “Digital India” focuses on digital infrastructure as a utility to every citizen, government and services on demand and digital empowerment of citizens. It will combine many existing schemes related to e-governance and other digital initiatives. These will be restructured and implemented under the “Digital India” initiative.

The reasons for promoting "Digital India" is to introduce transparency and improve the existing governance system. Recently, India's electricity sectors have noticed outcomes from the “Digital India” initiative. Hence, to efficiently drive this initiative, the following efforts have been launched by the government.

**Grameen Vidyutikaran (GARV) Application:** The application was launched on 20 December 2016, to help citizens track rural electrification under Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY). The application hosts the data of about six lakh villages with over 15 lakh habitations and 17 crore people, which has been mapped to track the household electrification progress for each habitations of these villages. (http://garv.gov.in)

**Vidyut Pravah Application:** This application provides information on electricity price and availability. (www.vidyutpravah.in)

**Unnat Jyoti by Affordable Light-Emitting Diode (LEDs) for All (UJALA) Application:** The application tracks (LED) distribution under the domestic efficient lighting programme (DELP) (http://delp.in)

**Urban Jyoti Abhiyaan (URJA) Application:** The consumer dashboard of URJA App was launched on 16 June 2016, to provide project monitoring and monthly performance information to the Urban Power Distribution Sector for enhancing parameters such as consumer complaints redressal, new service connections, number of interruptions faced by consumers, number of consumers using e-payment methods, energy lost/power theft, i.e., Aggregate Transmission and Commercial (AT&C) loss.

**Mobile Application for Star Labelled Appliances:** The Bureau of Energy Efficiency (BEE) developed an application for consumers for standards and labelling programme (S&L), which is linked with S&L database of BEE, providing a platform for consumers and other stakeholders feedback.
Transmission App for Real Time Monitoring and Growth (TARANG) Mobile Application: This application monitors the status of transmission system and acts as a platform for discovering better prices of interstate transmission projects to be awarded through tariff based competitive bidding (TBCB) process.

Discovery of Efficient Electricity Price (DEEP) e-Bidding Portal: The Portal provides a common e-bidding platform with e-reverse auction facility to expedite nation-wide power procurement through a wider network to generate uniformity and transparency in the power procurement process.

Source: Press Information Bureau (PIB)

Drivers for Smart Grid in India

Table 1: Drivers for Smart Grid In India

<table>
<thead>
<tr>
<th>Sector</th>
<th>Factors</th>
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<tbody>
<tr>
<td>Utilities</td>
<td>• Reduction of transmission and distribution (T&amp;D) losses in all utilities and improved collection efficiency</td>
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<tr>
<td></td>
<td>• Peak load management – multiple options from direct load control to consumer pricing incentives</td>
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<tr>
<td></td>
<td>• Reduction in power purchase cost</td>
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<tr>
<td></td>
<td>• Improved asset management</td>
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<tr>
<td></td>
<td>• Increased grid visibility</td>
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<tr>
<td></td>
<td>• Self-healing grid</td>
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<tr>
<td></td>
<td>• Renewable integration</td>
</tr>
<tr>
<td>Customers</td>
<td>• Electricity expansion – “Power for All”</td>
</tr>
<tr>
<td></td>
<td>• Electricity reliability supply to customers – contracting power outage, diesel generating (DG) sets and inverters</td>
</tr>
<tr>
<td></td>
<td>• Improved supply quality – no more voltage stabilizers</td>
</tr>
<tr>
<td></td>
<td>• User friendly and transparent interface with utilities</td>
</tr>
<tr>
<td></td>
<td>• Increased consumer choices, including green power</td>
</tr>
<tr>
<td></td>
<td>• “Prosumer” (producer and consumer) enablement</td>
</tr>
<tr>
<td></td>
<td>• Saving money through load shifting from peak periods to off-peak periods</td>
</tr>
<tr>
<td>Government and Regulators</td>
<td>• Satisfied customers</td>
</tr>
<tr>
<td></td>
<td>• Financially sound utilities</td>
</tr>
<tr>
<td></td>
<td>• Tariff neutral system upgrade and modernization</td>
</tr>
<tr>
<td></td>
<td>• Reduction in emission intensity</td>
</tr>
</tbody>
</table>

Source: India Smart Grid Forum(ISGF)
What is Smart GRID?

The Smart Grid has no universally accepted definition, but standard agencies across the globe have defined a few based on their Smart Grid implementation.

**The Institute of Electrical and Electronics Engineers (IEEE):** IEEE views Smart Grids as a large “System of Systems” wherein individual Smart Grid domains based on the National Institute of Standards and Technology (NIST) Smart Grid Conceptual Model are expanded into three layers, namely power and energy, communications and information technology (IT). IEEE considers communications and IT layers to enable the power and energy layer’s infrastructure.

**International Energy Agency (IEA):** IEA defines Smart Grids as networks that monitor and manage electricity transportation from all generation sources to meet the varying electricity demands of end users.

**Electric Power Research Institute (EPRI):** EPRI defines Smart Grids as a power system capable of two-way communication between the entities of network-generation, transmission, distribution and consumers. Smart Grids aim to provide monitoring and control to improve the overall system efficiency apart from including renewable energy (RE) resources into the system.

**United State (US) Government, Department of Energy:** The US government’s department of energy defines Smart Grids as network that incorporates information and communications technology into every aspect of electricity generation, delivery and consumption to minimize environmental impacts, enhance markets, improve reliability and service, reduce costs and increase efficiency.

Smart Grid Building Blocks

The traditional electric grid will need to build additional layers of automation, communication and IT systems to transform it to a smarter grid. Some of the applications or building blocks of a smart grid are:

- Supervisory Control and Data Acquisition Systems (SCADA) with Energy Management Systems (EMS) and Distribution Management Systems (DMS)
- Enterprise IT network covering all substations and field offices with reliable communication systems
- Enterprise Resource Planning (ERP)/Asset Management Systems
- Geographic Information Systems (GIS) – mapping of electrical network assets and consumers on geospatial maps
- Modernization of the substations with modern switchgear and numerical relays
- Advanced Metering Infrastructure (AMI) with two-way communication and Meter Data Management Systems (MDMS)
- Electronic Billing Systems and Customer Care Systems
- Distribution Automation (DA), Outage Management Systems (OMS) and Substation Automation Systems
- Mobile Crew Management Systems
- Wide Area Measurement and Control Systems
- Forecasting, Dispatch and Settlement Tools
- Enterprise Application Integration
- Analytics (converting data into business intelligence)

Sources: India Smart Grid Forum(ISGF)
The “smartening” of the electricity system is an evolutionary process, not a one-time event” – IEA

**Figure 1:** Smarter electricity systems

Sources: International Energy Agency (IEA)

**Figure 2:** Technology categories

Sources: Technology categories and descriptions adapted from National Energy Technology Laboratory (NETL) and National Institute of Standards and Technology (NIST)
Smart Grid Architecture Model (SGAM)

**Definition:** Interoperability is seen as the key enabler of Smart Grid. Consequently, the proposed SGAM framework needs to inherently address interoperability. A prominent definition describes interoperability as the ability of two or more devices from the same vendor, or different vendors, to exchange information and use that information for correct co-operation (International Electro technical Commission (IEC) - 61850-2010). In other words, two or more systems (devices or components) are interoperable, if the two or more systems are able to perform cooperatively a specific function by using information which is exchanged. This concept is illustrated in below Figure.

**Interoperability Categories:** These categories are introduced by the Grid Wise Architecture Council (GWAC 2008) and represents a widely accepted methodology to describe requirements for achieving interoperability between systems or components.

*Figure 3:* Adoption of the GWAC Stack in context of the European Smart Grid Reference

*Figure 4:* Overview on the SGAM layer application regarding AMI
## SGAM Domain and Zones

### Table 2: Smart Grid Architecture Model (SGAM) Framework Domain

<table>
<thead>
<tr>
<th>Domain</th>
<th>Roles/Services in the Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Customers are the end users of electricity that generate, store, and manage the energy usage. Traditionally, three customer types are discussed under domains such as residential, commercial and industrial.</td>
</tr>
<tr>
<td>Markets</td>
<td>Markets relate to the electricity market comprising of operators and participants.</td>
</tr>
<tr>
<td>Service Provider</td>
<td>Organizations providing services to electrical customers and utilities.</td>
</tr>
<tr>
<td>Operations</td>
<td>Managers of the movement of electricity.</td>
</tr>
<tr>
<td>Generation</td>
<td>Generation relates to the generators of electricity who store energy for distribution. This domain includes traditional generation sources and distributed energy resources (DER). “Generation” includes coal, nuclear and large-scale hydro generation usually attached to transmission. DER is associated with customer and distribution domain provided generation and storage as well as service provider aggregated energy resources.</td>
</tr>
<tr>
<td>Transmission</td>
<td>Transmissions are the long distance carriers of bulk electricity. These also store and generate electricity.</td>
</tr>
<tr>
<td>Distribution</td>
<td>Distribution refers to the distributors of electricity to and from customers who also store and generate electricity.</td>
</tr>
</tbody>
</table>

### Table 3: Smart Grid Architecture Model (SGAM) Framework Zone

<table>
<thead>
<tr>
<th>Zone</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>Process refers to the physical, chemical or spatial transformations of energy (electricity, solar, heat, water and wind) and the physical equipment directly involved (generators, transformers, circuit breakers, overhead lines, cables, electrical loads and sensors and actuators which are partly or directly connected to the process).</td>
</tr>
<tr>
<td>Field</td>
<td>Field refers to the equipment used for protecting, controlling and monitoring the power system process, e.g., protection relays, bay controller and intelligent electronic devices which acquire and use the power system’s process data.</td>
</tr>
<tr>
<td>Station</td>
<td>Station represents the field level areal aggregation for data concentration, functional aggregation, substation automation, local SCADA systems and plant supervision.</td>
</tr>
<tr>
<td>Operation</td>
<td>Hosting power system control operation in the respective domain, e.g., DMS and EMS in generation and transmission systems, microgrids management systems, virtual power plant management systems (aggregating several DER), electric vehicles (EVs) fleet charging management systems.</td>
</tr>
<tr>
<td>Enterprise</td>
<td>Enterprise includes the commercial and organizational processes, services and infrastructures for enterprises (utilities, service providers and energy traders), e.g., asset management, logistics, work force management, staff training, customer relation management and billing and procurement.</td>
</tr>
<tr>
<td>Market</td>
<td>Reflecting the market operations possible along the energy conversion chain, e.g. energy trading, mass market, retail market.</td>
</tr>
</tbody>
</table>

Source: European Committee for Standardisation (CEN), European Committee for Electrotechnical Standardization (CENELEC) and European Telecommunications Standards Institute (ETSI) - Smart Grid Reference Architecture
Policy and Framework In India

Smart Grid Vision for India

“Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders”

In 2015, the government approved National Smart Grid Mission (NSGM), an institutional mechanism for planning, monitoring and implementing policies and programs related to Smart Grid activities. The NSGM provides support to Smart Grid Projects through assistance in formulation (prefeasibility studies, cost-benefit analysis, financial modeling and so on); partial funding of projects; training and capacity building; consumer engagement and project appraisal post implementation. The approval has been accorded for activities listed above and costing INR 980 crore including a budgetary support of INR 338 crore from the Government of India during the 12th plan period.

Indian Smart Grid Task Force (ISGTF): ISGTF is an inter-ministerial group formed to serve as a government focal point for activities related to the Smart Grid. The group members were selected from concerned ministries (power, home, defence, communications and IT, new and RE, environment and forests and finance) and organizations (Planning Commission, Department of Science and Technology, Central Electricity Authority (CEA), Central Power Research Institute (CPRI), National Thermal Power Corporation (NTPC), Power Grid Corporation of India Limited (PGCIL), Bureau of Indian Standards (BIS), Power Finance Corporation (PFC), Rural Electrification Corporation (REC) and BEE.

ISGTF has undertaken feasibility studies to understand the market environment for Smart Grids in India. The main functions of ISGTF is to ensure awareness, coordination and integration of diverse activities related to Smart Grid technologies, practices and services for Smart Grid research and development; co-ordinate and integrate other relevant inter-governmental activities; collaborate on interoperability framework and review and validate the recommendations from ISGF.

ISGF: ISGF is a public-private partnership initiative of Ministry of Power (MoP) for accelerated development of Smart Grid technologies in the Indian power sector. ISGF advises the government on policies and programs for promoting Smart Grids in India; working with national and international agencies in standards development and assisting utilities; regulators and the industry in technology selection as well as training and capacity building.
Technologies – Internet of Things (IoT) and Data Analytics

**IoT:** This is an inter-networking of devices connected to enable the sensing and control through the Internet. These devices typically operate as individual objects in the network, collect and exchange data continuously for facilitating smart control and efficient operation of the entire system. These devices sense the aspects of real world through devices such as meters, relays, SCADA, RTUs, CTs, security cameras, mobile phones and sensors to automate the decision-making process and optimize the infrastructure usage.

The continuous evolution of Smart Grids accelerates the adoption of technologies such as IoT. The integration of existing electrical power grid with the new communication and information technologies have leveraged the available infrastructure, via, smart technologies and solutions.

**IoT’s Solutions:** The heating or cooling device can sense the atmospheric condition, number of people, and automatically switch on a device to achieve the preferred thermal comfort levels or switch off if there’s nobody inside the house.

The IoT implementation has its own difficulties, which are typically the opportunities for service providers to enter the market. The major difficulties identified are:

- Data security (cyber-attacks)
- Data management (validation and storage)
- Reliable network (internet)
- Data analytics (solution development)

*Figure 5: The Internet of Things*

Source: https://www.pushtechnology.com/blog/tag/internet-of-things/
**Big Data Analytics**: Big data refers to a huge volume of data that cannot be handled through traditional data processing software. Hence, the issues arise from capturing and storage to querying and visualization of huge and complex data sets. Even if traditional databases are able to capture and store huge volumes of data occasionally, the high latency eliminates the practical usage of such systems.

The big data is characterized by three V’s - 1) High Velocity 2) High Variety and 3) High Volume. The big data is not only represented by huge volume of data, but also by high velocity represented by high speed data capturing (which can also be real-time), and high variety in terms of types of data captured.

The unstructured data is rich with potential insights which the stakeholders are interested in leveraging. There is a huge volume of data which is continuously being collected by companies without being used. These datasets can be used to resolve most pain areas of the power sector and implement advance analytical solutions to maximize the usage of available data and generate insights never observed before.

Big data analytics is the application of advanced analytical methods to generate insights and/or develop data solutions for decision making. This allows various stakeholders to adopt data based decision making through the usage of big data thus, gaining new insights for fast and efficient resolution.

The advanced analytical techniques include, not limited to, machine learning, predictive analytics, text/image processing, data mining and statistics.

![Smart Grid data analytics spending trends](source: Pike research ; http://www.rcrwireless.com)

The benefits of successful implementation and usage of big data analytics in developing a Smart Grid is gaining reputation and the same is reflected by Smart Grid data analytics spending trends as shown in the figure. The world market is expected to see continuous increase in investments for Smart Grid data analytics till 2020.

Following are the endless possibilities for developing solutions using IoT and big data analytics:

- Load forecasting
- Automated demand side response
- Asset monitoring solution
- Consumer behavior analytics
- Smart home solutions
Substation Automation

Substation automation is not just the automation of a substation but, a part of a major paradigm shifts for all power system operations

Substation automation is far above automation of substation equipment. It is the first step towards creating a highly reliable, self-healing power system that responds rapidly to real-time events with appropriate actions and that supports the planning and asset management necessary for cost-effective operations. Automation does not simply replace manual procedures but, permits the power system to operate differently, based on timely and accurate information provided to the decision-making applications and devices.

Earlier, the utility attention was focused only on managing the power infrastructure. However, as illustrated in Figure 7, currently, two infrastructures, the power infrastructure and information infrastructure are managed.

Previously, substation automation was not feasible. The communication technologies were unavailable to handle the demands of complex substation automation requirements. For instance, one of the major enablers of substation automation was to recognize the vast point-to-point wiring between the control house and the equipment in the substation yard, which can be eliminated through the use of Ethernet networks. Communication standards have now been developed and can address many such demands. Specifically, IEC 61850 provides solutions to automation issues using state-of-the-art object modelling technologies.

Figure 7: Power and Communication Infrastructure

Source: EPRI - Guidelines for Implementing Substation Automation
Storage Technologies

Emerging Needs for Electrical Energy Storage (EES)

**On-Grid Areas:** In on-grid areas, the increased ratio of renewable generation may cause issues in the power grid (see Figure). In power grid operation, the fluctuation in the output of renewable generation makes it difficult to control the system's frequency, which can deteriorate the system's operation. Conventionally, frequency control is mostly managed by the output change capability of thermal generators. When used for this purpose, thermal generators are not operated at full capacity, but with some positive and negative output margin (i.e., increase and decrease in output) which is used to adjust frequency, and this implies inefficient operation. With greater penetration of renewable generation, this output margin needs to be increased, which decreases the efficiency of thermal generation even more.

**Off-Grid Areas:** In off-grid areas, a considerable amount of energy is consumed, particularly in the transport sector, fossil energy should replace the non-fossil energy in products such as plug-in hybrid electric vehicles (PHEVs) or EVs as shown in the figure below. Precisely, fossil fuels should be replaced by low-carbon electricity produced by renewable generation. The most promising solution is to replace petrol or diesel-driven cars by electric cars with batteries. Despite issues (short driving distance and long charging time) EES is the key technology for EVs.

**Smart Grid Uses:** EES plays an essential role in the future Smart Grid. Some relevant applications of EES are described below. Firstly, EES installed in customer-side substations can control power flow and mitigate congestion, or maintain voltage in the appropriate range. Secondly, EES can support the electrification of existing equipment to integrate the same into Smart Grids. EVs are a good example since they have been deployed in several regions, and some argue for the potential of EVs as a mobile, distributed energy resource to provide a load-shifting function in a Smart Grid. EVs are expected to be not only a new load for electricity but also a possible storage medium that can supply power to utilities during hikes in electricity price. Thirdly, EES is the energy storage medium for EMS in homes and buildings.

Classification of EES systems

***Source:* IEC & Problems in renewable energy installation and possible solutions (TEPCO); Classification of electrical energy storage systems according to energy form (Fraunhofer ISE)***
India's power sector market present conditions might require significant smart grid infrastructure investment. It has one of the highest transmission and distribution (T&D) loss rates in the world. In some states, the T&D loss rates exceed 50%, and almost all states have loss rates above 15%. Most Indian utilities fail to achieve cost recovery, and smart grid investment will be an important tool for utilities to reduce losses and improve revenue collection and operational efficiency.

India is projected to invest USD 44.9 billion smart metering, distribution automation, battery storage and other smart grid market segments over the next decade. These numbers are based on the market research published on “India Smart Grid: Market Forecast (2017-2027)” by Northeast Group, llc. This investment will help to reduce the country’s staggering 22.7% transmission and distribution loss rate.

India represents what is arguably the best smart grid market opportunity among all emerging market countries. It has the second largest electricity customer market size in the world. Unlike China, which has the largest, the Indian market will be open to international vendors, as stated in the central government’s smart grid development strategy. This will create very significant market opportunities for the leading global players. Vendors from across Europe, North America, and Asia have already participated in small-scale pilots and grid upgrade projects, and have been linked with announcements of large-scale rollouts by Indian utilities that are upcoming in the next several years.

The initiatives by the Indian government has paved way for successful pilots of important Smart Grid projects by both Indian and International participants. The expected developments in cybersecurity standards from BIS and proposed large scale rollout of smart meter throughout India, emphasize the seriousness of the Government of India in promoting Smart Grid developments. These developments are investor friendly and reduces the risk associated with the outlook of Government of India and other ministries involved.

The successful pilot projects can be taken as reference while deciding on investment prospects, while their implementation report will guide the investors on operational and financial risks identified. Presently, market sweet spots are to be exploited where minimum or no serious competitor exists.
Annexure

Pilot Projects in India

**Uttar Haryana Bijli Vitran Nigam (UHBVN), Haryana:** The project is located at Panipat City Subdivision (Haryana State). The pilot project covers 30,544 consumers and distribution system of 531 DTs. The area has around 131.8 MU input energy consumption. The proposed project area is covered under RAPDRP Scheme for IT implementation and system strengthening. The functionality of Peak load management is proposed by implementing Advance Metering Infrastructure (AMI) for Residential Consumers and Industrial Consumers.

**Chamundeshwari Electricity Supply Corporation (CESC), Mysore:** The project is located at Additional City Area Division (ACAD), Mysore. Project involves 21,824 consumers with a good mix of residential, commercial, industrial and agricultural consumers including 512 irrigation pump sets covering over 14 feeders and 473 distribution transformers and accounting for input energy of 151.89 MU. The functionalities of Peak load management, Outage Management are proposed by implementing Advance Metering Infrastructure (AMI) for Residential and Industrial Consumers and Integration to Distributed Generation/Micro Grid Integration.

**Tripura State Electricity Corporation Limited (TSECL), Tripura:** The project is located at Electrical Division No.1, of Agartala town. The pilot project covers 46,071 no. of consumers. The proposed project area is covered under RAPDRP Scheme for IT implementation and system strengthening. The functionality of Peak load management is proposed by implementing Advance Metering Infrastructure (AMI) for Residential Consumers and Industrial Consumers.

**Kerala State Electricity Board (KSEB), Kerala:** Pilot is proposed for around 25078 LT Industrial consumers of Selected Distribution Section offices spread over the geographical area of Kerala State. The input energy for the total scheme area is mentioned as 2108 MUs and for the LT Industrial consumers is mentioned as 376 MUs. Part of this area is covered in RAPDRP scheme. By implementing Advance Metering Infrastructure (AMI) it is proposed to provide quality service, prevent tampering and unauthorized usage of load, accurate and timely metering and billing, avoiding costly field visits of Sub Engineers for meter reading, reducing supply restoration time, peak load management through load restriction for Remote Disconnection/Reconnection and Time of Day tariff.

**Electricity Department, Government of Puducherry (PED):** The project is located at Division 1 of Puducherry Project proposes covering 87031 no. of consumers with dominant being domestic consumers (79%). The area has around 367 MU input energy consumption. The proposed project area is also covered under RAPDRP Scheme for IT implementation and system strengthening which is likely to be completed in 2013. The module of Advance Metering Infrastructure (AMI) for Residential and Industrial Consumers are proposed to be implemented to assist with consumer issues like event management & prioritizing, billing cycle review and revenue collection efficiency for Energy auditing and AT&C loss reduction.

**Uttar Gujarat Vij Company Limited (UGVCL), Gujarat:** The project is located at Naroda of Sabarmati circle which is an industrial and residential area and Deesa of Palanpur circle which is an agricultural area Project proposes covering 20,524 consumers in Naroda and 18,898 agricultural unmetered consumers in Deesa-II division and accounting for input energy of around 1700MU (Naroda : 374.52 MU & Deesa : 1321.27 MU for 2010-11). The functionalities of Peak load management, Outage Management, Power Quality Management are proposed by implementing Advance Metering Infrastructure (AMI) for Industrial, Commercial and Residential Consumers.
Andhra Pradesh Central Power Distribution Company Ltd (AP CPDCL), Andhra Pradesh: The project is located at Jeedimetla Industrial Area. The Project proposes covering 11,904 consumers. The proposed project area is covered under RAPDRP Scheme; DAS, IT and SCADA shall be implemented. The functionalities of Peak load management, Power Quality and Outage Management are proposed by implementing Advance Metering Infrastructure (AMI) for Residential Consumers and Industrial Consumers.

Assam Power Distribution Company Ltd. (APDCL), Assam: The project is located at Guwahati distribution region. The pilot project covers 15,000 consumers involving 90MUs of input energy. APDCL is in the process of IT Implementation under R-APDRP and SCADA/DMS implementation is also to be taken up shortly. APDCL has proposed the functionality of Peak Load Management using Industrial and Residential AMI, Integration of Distributed Generation (Solar and available back-up DG Set) and Outage Management system. The utility has envisaged that Power Quality Monitoring will be a by-product of the deployment.

Maharashtra State Electricity Distribution Co. Ltd. (MSEDCL), Maharashtra: The project is located at Baramati Town Project proposes covering 25,629 consumers with a mix of residential, commercial and industrial consumers and input energy of 261.6 MU. The functionality of Outage management is proposed by implementing Advance Metering Infrastructure (AMI) for Residential Consumers and Industrial Consumers.

Chhattisgarh State Power Distribution Company Limited (CSPDCL), Chhattisgarh: The project is located at Siltara – Urla area of Raipur District (Chhattisgarh State). The pilot project includes installing smart meters at 508 H.T. & L.T Industrial Consumer premises as well as Automatic Meter Reading (AMR) at 83 DTs. The area has around 2140.86 MU input energy consumption. The proposed project area is not covered under RAPDRP Scheme. The functionality of Peak load management is proposed by implementing Advance Metering Infrastructure (AMI) for Industrial Consumers.

Himachal Pradesh State Electricity Board Ltd.(HPSEB), Himachal Pradesh: The project is located at Industrial town of KalaAmb. The pilot project covers 650 consumers and having annual input energy of 533 MUs. The functionality of peak load management and outage management is proposed by implementing Advance Metering Infrastructure (AMI) for Industrial Consumers, Distribution Automation and Substation Automation and power quality management by deploying Power Quality meters at HT consumers.

Punjab State Power Corporation Limited (PSPCL), Punjab: The project is located at Industrial Division of City Circle Amritsar. The functionality of Outage Management (OM) is proposed to be implemented in the project area for all the 85746 consumers and distribution system in area using AMI by installing 9000 Smart Meters and by Transformer Monitoring. The proposed project area is covered under RAPDRP Scheme for SCADA Implementation and GIS Mapping.

West Bengal State Electricity Distribution Company Limited (WBSEDCL), West Bengal: The project is located at Siliguri Town in Darjeeling District. The pilot project proposes to take up 4 nos. of 11 KV feeders for implementation of Smart Grid covering 4404 consumers. The area has 42 MU input energy consumption. The utility has proposed the functionality of AT&C loss reduction and Peak Load Management using Advance Metering Infrastructure (AMI) for Residential and Industrial Consumers.

Jaipur Vidyut Vitran Nigam Ltd. (JVVNL), Rajasthan: The project is located at VKIA Jaipur. Project proposes covering 2646 no. of consumers, dominated by Industrial consumers (56.46%) and around 374.68 MU input energy consumption. Proposed project area is also covered under RAPDRP Scheme for IT implementation and system strengthening. The functionality of Peak load management is proposed by implementing Advance Metering Infrastructure (AMI) for Residential Consumers and Industrial Consumers.

Source: ISGF
### Smart Grid Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>Open Geospatial Consortium Geography Markup Language (GML)</td>
<td>A standard for exchange of location-based information addressing geographic data requirements for many Smart Grid applications.</td>
</tr>
<tr>
<td>IEC 62351 Parts 1-8</td>
<td>This family of standards defines information security for power system control operations.</td>
</tr>
<tr>
<td>IEC 61851</td>
<td>Applies to equipment for charging electric road vehicles at standard alternating current (ac) supply voltages (as per IEC 60038) up to 690 V and at direct current (dc) voltages up to 1 000 V, and for providing electrical power for any additional services on the vehicle if required when connected to the supply network.</td>
</tr>
<tr>
<td>IEEE 1686-2007</td>
<td>The IEEE 1686-2007 is a standard that defines the functions and features to be provided in substation intelligent electronic devices (IEDs) to accommodate critical infrastructure protection programs. The standard covers IED security capabilities including the access, operation, configuration, firmware revision, and data retrieval.</td>
</tr>
<tr>
<td>SAE J2836/1</td>
<td>This document establishes use cases for communication between plug-in electric vehicles and the electric power grid, for energy transfer and other applications.</td>
</tr>
<tr>
<td>IEEE 1815 (DNP3)</td>
<td>This standard is used for substation and feeder device automation, as well as for communications between control centers and substations.</td>
</tr>
<tr>
<td>IEC 60870-6/Telecontrol Application Service Element 2 (TASE.2)</td>
<td>This standard defines the messages sent between control centers of different utilities.</td>
</tr>
<tr>
<td>IEC 61850 Suite</td>
<td>This standard defines communications within transmission and distribution substations for automation and protection. It is being extended to cover communications beyond the substation to integration of distributed resources and between substations.</td>
</tr>
<tr>
<td>GREEN BUTTON Standards</td>
<td>Green Button standards represent the contributions made by the OpenADE, NAESB ESPI, and NIST SGIP-PAP20, PAP10.</td>
</tr>
<tr>
<td>IEEE C37.118-2005</td>
<td>This standard defines phasor measurement unit (PMU) performance specifications and communications for synchrophasor data.</td>
</tr>
<tr>
<td>IEEE 1547 Suite</td>
<td>This family of standards defines physical and electrical interconnections between utilities and distributed generation (DG) and storage.</td>
</tr>
<tr>
<td>IEEE 1588</td>
<td>Standard for time management and clock synchronization across the Smart Grid for equipment needing consistent time management.</td>
</tr>
<tr>
<td>IEEE C37.238</td>
<td>Profile of IEEE 1588 for electric power systems.</td>
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<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>Internet Protocol Suite, Request for Comments (RFC) 6272, Internet Protocols for the Smart Grid.</td>
<td>IPv4/IPv6 are the foundation protocol for delivery of packets in the Internet network. Internet Protocol version 6 (IPv6) is a new version of the Internet Protocol that provides enhancements to Internet Protocol version 4 (IPv4) and allows a larger address space.</td>
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<tr>
<td>MultiSpeak</td>
<td>A specification for application software integration within the utility operations domain; a candidate for use in an Enterprise Service Bus.</td>
</tr>
<tr>
<td>NEMA Smart Grid Standards Publication SG-AMI 1-2009 – Requirements for Smart Meter Upgradeability</td>
<td>This standard will be used by smart meter suppliers, utility customers, and key constituents, such as regulators, to guide both development and decision making as related to smart meter upgradeability.</td>
</tr>
<tr>
<td>NAESB WEQ19, REQ18, Energy Usage Information</td>
<td>The standards specify two-way flows of energy usage information based on a standardized information model.</td>
</tr>
<tr>
<td>NISTIR 7761, NIST Guidelines for Assessing Wireless Standards for Smart Grid Applications</td>
<td>This report is a draft of key tools and methods to assist smart grid system designers in making informed decisions about existing and emerging wireless technologies. An initial set of quantified requirements have been brought together for Advanced metering infrastructure (AMI) and initial Distribution Automation (DA) communications. These two areas present technological challenges due to their scope and scale. These systems will span widely diverse geographic areas and operating environments and population densities ranging from urban to rural.</td>
</tr>
<tr>
<td>Organization for the Advancement of Structured Information Standard (OASIS) EMIX (Energy Market Information eXchange)</td>
<td>EMIX provides an information model to enable the exchange of energy price, characteristics, time, and related information for wholesale energy markets, including market makers, market participants, quote streams, premises automation, and devices.</td>
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<tr>
<td>Open Automated Demand Response (OpenADR)</td>
<td>The specification defines messages exchanged between the Demand Response (DR) Service Providers (e.g., utilities, independent system operators (ISOs) and customers for price-responsive and reliability-based DR</td>
</tr>
<tr>
<td>OPC-UA Industrial</td>
<td>A platform-independent specification for a secure, reliable, high-speed data exchange based on a publish/subscribe mechanism. Modern service-oriented architecture (SOA) designed to expose complex data and metadata defined by other information model specifications (e.g. IEC 61850, BACnet, OpenADR). Works with existing binary and eXtensible Markup Language (XML) schema defined data</td>
</tr>
</tbody>
</table>
About PHD Chamber Of Commerce And Industry

PHD Chamber of Commerce & Industry, a leading Industry Chamber of India, ever since its inception in 1905, has been an active participant in the India Growth Story through its Advocacy Role for the Policy Makers and Regulators of the Country. Regular interactions, Seminars, Conference and Conclaves allow healthy and constructive discussions between the Government, Industry and International Agencies bringing out the Vitals for Growth. As a true representative of the Industry with a large membership base of 48000 direct and indirect members, PHD Chamber has forged ahead leveraging its legacy with the Industry knowledge across sectors (58 Industry verticals being covered through Expert Committees), a deep understanding of the Economy at large and the populace at the micro level.

At a Global level we have been working with the Embassies and High Commissions in India to bring in the International Best Practices and Business Opportunities. A staunch believer in strength of the Indian Industry and MSME segment, we have mobilized tie-ups with a network of 60 world-wide chambers of commerce for allowing a one-to-one interaction between the industry and Govt. peers across the borders. PHD represents the interests of all local, national, regional, bilateral and transnational industry and provides a platform for exchange to better serve and promote SME members worldwide.

It is more than just an organization of the business community, as it lives by the chosen motto ‘In Community’s Life & Part of It’ and contributes significantly to socio-economic development and capacity building in several fields. Industrial Development, Health, Education & Skill Development, Housing, Infrastructure, Agriculture & Agri-business and Digital India are the seven key thrust areas of the Chamber.

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About Idam Group

**Idam Infrastructure Advisory Pvt. Ltd.** is a company established by professionals with vast experience in energy and infrastructure domains. Since its inception in 2007, Idam team has gathered rich and valuable experience and gained deeper insights across the entire value chain of energy infrastructure. Idam has strong capability in design, development and implementation of energy efficiency, renewable energy and climate change policies at central and state government level.

Idam offers Energy related IT services through **Enfragy Solutions India Pvt Ltd.**, a wholly owned subsidiary of Idam infrastructure Advisory Pvt. Ltd. Enfragy is in the business of offering energy conservation initiatives to a wide spectrum of clients targeting different sectors. Enfragy offers end to end solution in Energy, Carbon, Water and Sustainability Development, Advisory, Compliance and Reporting, working right through Energy project cycle effectively leading to a successful carbon trading program.

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Knowledge Paper on Smart Grids, Automation and Solar Storage