REQUEST FOR PROPOSAL (DRAFT RfP)

VOLUME II

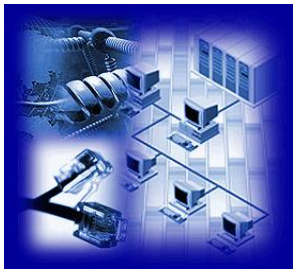
for the appointment of

SYSTEM INTEGRATOR

for

SMART GRID PILOT PROJECT

IN INDIA


NAME OF THE UTILITY

CONTENTS

1 Introduction and General Information

1.1 Introduction

Global energy scenario is witnessing key changes in terms of shift of focus towards green energy and sustainable growth and SMARTGRID is getting evolved by integrating end-to-end, advanced communications infrastructure and information systems into the electric power system. Objective of Smart Grid is to use advancements of information and communication technology to make the power grid more efficient, reliable, secure and resilient while minimizing costly investments in new centralized generation capacity. One of the main points about Smart Grid is an increased level of observation and control of a complex power system to facilitate distributed and renewable energy generation. This can only be achieved by an increased level of information sharing between the individual components and sub-systems of the power system. Standardization plays a key role in providing the ability of information sharing which will be required to enable the development of new applications. Smart Grid can provide consumers near real-time information on their energy use, support pricing that reflects changes in supply and demand, and enable smart appliances and devices to help consumers exercise choices in terms of usage of energy. Utilities can better manage the grid in terms of increased visibility of network, improved billing and realization efficiency, increased availability of grid and access of power to rural areas.

The Smart Grid is integrating the electrical and information, communication technologies in the complete power system value chain enabling every point for generation and every point as controllable consumption.

Ministry of Power has taken up the initiative for establishing Smart Grid in India for increasing power availability, reducing AT&C losses and optimal utilization of resources for sustainable growth. MoP is planning to develop Smart Grid in India in stages by taking up pilot Smart Grid projects as suggested by India Smart Grid Task Force. Pilots will be evaluated for techno commercial benefits, technology evaluation and then scaled out into full projects.

'India Smart Grid Task Force' is an inter-ministerial group and serves as Government's focal point for activities related to "Smart Grid" and to evolve a road map for implementation of Smart Grids in India. Shri Sam Pitroda, Adviser to Prime Minister on Public Information Infrastructure and Innovation is the Chairman of India Smart Grid Task Force. Other members of 'Smart Grid Task Force' are senior officials from concerned Ministries (Home, Defense, Communications & IT, new and Renewable Energy, Environment and Forest and finance etc.) and organizations (Planning commission, Department of science and Technology, CERC, CEA, CPRI, BEE, NTPC, POWERGRID, BIS, PFC and REC etc.). ISGTF Secretariat is currently being facilitated by POWERGRID.

1.2 Intent of the Project

Intent of the RFP is to select a system integrator, SI (the term contractor and SI shall be used interchangeably throughout the document) that can design the solution for the proposed Smart Grid Pilot, implement the same along with its partners (if any) in a time bound manner and evaluate the outcome of the Pilot Project. The SI must have sound knowledge of SCADA systems/ IT applications/Communication Systems/ Smart Meters and Power System. SI will also provide the facility management services for a period of two years after completion of evaluation period as per Project Schedule and defect liability period of one year.

SI needs to evaluate the current power system network environment and suggest the changes in existing power system network elements wherever required.

1.3 ISGTF SECRETARIAT

POWERGRID, the Central Transmission Utility of India and one of the largest Transmission Utility of the World, is handing the Secretariat role for ISGTF. In addition, POWERGRID is also carrying out pilot projects on Smart Grid for implementation of Wide Area Measurement system (WAMS) in Indian Power Sector and collaborating worldwide as founder member of Very Large Power Grid Operators (VLPGO).

1.4 Employer/Utility

<Write-up of Employer/Utility detailing the Background of the Employer/Utility/ Utility and Context and Situation of the Employer/Utility with regard to the present project>

(i) Existing Network

(ii) Existing Demand Supply Scenario

(iii) Future Demand Supply Scenario

(iv) Existing Manpower

(v) Existing Organizational Structure

(vi) Existing Assets

(vii) Existing Business Process Systems

a. Outage Management

b. Asset Management

c. Capacity Addition

d. Customer Service

e. Inventory Management

f. Accounting

(viii) Existing Power System Communication Systems

(ix) Existing IT systems/SCADA systems

(x) Existing Renewable Generation

1.5 Scope of Work

Eight Pilot Projects have been identified by ISGTF for the purpose of gaining experience of Smart Grid Technology and Evaluating the same for scalability and the envisaged benefits from its wide scale rollouts. The functionalities for each of the eight pilot sites are as follows:

		Pilot Sites							
Section	**Functionality**	A	B	C	D	E	F	G	H
3.1	AMI for residential	√					√		√
3.2	AMI for industrial		√		√		√		
3.3	Outage Management			√					
3.4	Peak Load Management				√		√		
3.5	Power Quality					√	√		
3.6	Micro Grid							√	
3.7	Distributed Generation								√

The SI shall perform the following actions to implement Smart Grid pilot as per objectives in the above table:

(i) Prepare a detailed project plan for Smart Grid pilot

(ii) Assess the existing environment

a. Electrical grid

b. Communications infrastructure

c. IT/SCADA/Automation Systems

d. Operation and Maintenance Processes pertaining to network

e. List of Manuals/Business Processes pertaining to monitoring and control of network and energy usage.

(iii) Determine the short term as well as long term benefits from the proposed pilot

(iv) Capture the baseline parameters/KPIs that are proposed for improvement

(v) Select suitable technology partners

(vi) Procure necessary technology, equipment, services for the project

(vii) Install, test and commission the proposed solution

(viii) Suggest the new business processes and organisation structure

(ix) Customer Outreach and Education plan prepared on the basis of survey

(x) Documentation

(xi) Training

(xii) Operation of the pilot project for minimum 6 months

(xiii) Evaluate the project outcome and improvement in KPIs

a. In the same time frame with reference to an area where Smart Grid functionality is yet to be implemented

b. With the same consumers/system under consideration in terms of change in parameters/KPIs before and after implementation of Smart Grid pilot

(xiv) Develop Smart Grid Business Plan including the cost benefit analysis, the road map for Roll out of Smart Grid Project, its integration requirements with other systems.

(xv) Develop an overall Smart Grid Architecture capable of upgrades and scaling out as per future requirements.

(xvi) System Security and access with due consideration of data privacy, confidentiality cyber security guidelines.

(xvii) Identifying, listing and initiating skillset map for workforce.

1.6 Project Deliverables

The project deliverables will include, but are not limited to:

(i) Audit report of the existing Employer/Utility environment before implementation of Pilot

(ii) Electrical and communication equipment like Smart Meter, Sensors, RTU, FRTU etc.

(iii) Product details including model number, brochure, documentation, O&M manuals.

(iv) List of spare parts

(v) List of Hardware, Software and licenses.

(vi) Reports designed for EMPLOYER/UTILITY

(vii) Suggestion for regulatory changes

(viii) New process design and documentation

(ix) Evaluation report of Pilot Smart Grid Project vis-à-vis KPIs

(x) Training

(xi) Documentation

(xii) Overall Smart Grid Architecture

(xiii) Road Map for Smart Grid Roll out in other parts of the same Utility including challenges and pre-requisites

(xiv) Skillset map – current and proposed

2 General Requirements

2.1 General Responsibilities and Obligations

SI is to adhere to the time schedule agreed in the project plan, supply quality services and material that are scalable and meet the standards requirement.

Employer/Utility personnel will identify the single point of contact (Project Manager) and ensure readiness of facilities in time bound manner for the project.

2.2 Cooperation

SI has the overall responsibility to manage the implementation of the Smart Grid System. The Employer/Utility has those responsibilities as are set forth in sec-2.5. In order to successfully implement the Smart Grid Pilot, the cooperation of the Parties as well as certain third party vendors will be required. EMPLOYER/UTILITY will make its Project Manager and related facilities/resources reasonably available to meet the project requirement. The SI will make its Project Manager and related personnel available to meet with or consult with EMPLOYER/UTILITY's personnel on matters pertaining to this project. The EMPLOYER/UTILITY's Project Manager will be the primary coordination and control point for all EMPLOYER/UTILITY activities related to this project.

2.3 Access to EMPLOYER/UTILITY Facilities

EMPLOYER/UTILITY shall provide the SI's personnel and third party vendors with safe and reasonable access, space for data centre, working space and facilities, including air conditioning, light, ventilation, electric power and outlets. The SI personnel shall comply with all applicable rules, regulations and requirements relating to visitors on the premises of EMPLOYER/UTILITY.

2.4 Responsibilities for the Implementation Plan

The SI shall be responsible for development of detailed project implementation plan. The implementation plan shall be modeled such that it provides Power Supply for the activation of equipment & System before delivering of Hardware at Site, Data base development, Commissioning of new system, interface with existing system etc. The Implementation plan shall include the activities of both the SI and the Employer/Utility, showing all key milestones and clearly identifying the nature of all information and project support expected from the Employer/Utility and nodal agency. In consultation with the Employer/Utility, SI shall finalize the detailed Implementation plan following award of the contract.

The timelines for following may be included in the schedule given in proposal:

(i) Submission of detailed project plan for pilot for approval

(ii) Submission of Assessment report of existing Utility environment with baseline

measurements of KPIs

(iii) Selection of Sub Vendors and their approval

(iv) Procure/Manufacture equipment

(v) Type Testing

(vi) Factory Acceptance Testing

(vii) Equipment Installation

(viii) Submit Regulatory Changes proposal

(ix) Site acceptance testing

(x) Design of software applications

(xi) Software Testing

(xii) Documentation

(xiii) Design Interface to existing applications wherever required

(xiv) Integrated system testing

(xv) Submit proposed Organization Structure and team skillset requirement

(xvi) Submit redesigned Business Processes for review

(xvii) Conduct Training

(xviii) Run Pilot

(xix) Evaluation of Pilot

SI to also indicate which of the devices can be sourced from multiple vendors. The system should rely on open, published international/Indian standards. SI to design the system with redundancy for devices and systems which are mission critical to delivery of electricity. The design will be submitted by SI to Employer/Utility/Nodal Agency for review and the suggestions will be incorporated to meet the objectives of project. Successful implementation of project will be responsibility of SI.

Licensing and Source Code: SI must transfer all the licensing rights to the Employer/Utility for software wherever applicable. The same shall be listed as part of deliverables and shall form part of documentation plan.

2.5 Contractor's Responsibilities and Obligations

The Contractor shall be responsible for all cables and wiring associated with the equipment provided both inside and outside buildings. The Contractor shall also be responsible for determining the adequacy of the local power source for the equipment and for cabling to it, with adequate circuit protective breakers, as required. In addition, the Contractor shall be responsible for shielding equipment and cabling to eliminate potential interference to or from the equipment and for earthing of all cabinets and shields as required for system.

Contractor's obligations include, but are not limited to, the following:

(i) To provide a working system that meets or exceeds the functional and performance requirements of this specification without affecting the operation of the existing systems.

(ii) To perform equipment engineering and design specific to each location including review of, and conformance with local environmental and earthing considerations.

(iii) Installation of field devices, hardware, software and communication system.

(iv) To develop O&M guidelines.

(v) Overall integration of equipment/subsystem.

(vi) Integration of existing & new Meters

(vii) Integration with Central Control System

(viii) Buying and maintaining of spares identified under AMC along with main items to ensure system availability during installation and Maintenance period.

(ix) Project management, project scheduling, including periodic project reports (weekly/monthly basis) documenting progress during the contract period. This shall include impact and comparative analysis and reports for the Smart Grid components.

(x) To provide engineering and technical assistance during the contract warranty and maintenance period as stated in section 5.7.

(xi) To identify all additional Equipment and services necessary to ensure compatibility between new and existing equipment.

(xii) To implement all minor civil works necessary for installation of proposed equipment and provide the details of such work to the Employer/Utility.

(xiii) To define source power requirements for each cabinet/ rack of equipment provided

and the total power requirements to run the system

(xiv) To ensure that all the required hardware, software, and firmware satisfy the requirements of this specification and are suitable for future scaling, optionally with upgrades.

(xv) To conduct factory and site testing of all hardware and software.

(xvi) To provide Type Test report to the Employer/Utility and if required, conduct type test.

(xvii) Testing for protocol integration with the Existing systems.

(xviii) To provide a Quality Assurance Plan and access to the manufacturing process, as required.

(xix) Shipment of all equipment to designated locations and/or storing areas.

(xx) To provide storing, maintenance of storing area and security including full responsibility for protection from theft and fire for all the items to be supplied. The warehouse may be a temporary storage area to be constructed by SI or the same may be taken on rent in Employer/Utility's premises.

(xxi) Prepare and submit all documentation and drawings in hard copy as well as soft copy.

(xxii) Supply all required spare parts, maintenance aids, and test equipment, software maintenance and testing tools

(xxiii) Training of the Employer/Utility's personnel.

(xxiv) Hardware, software, and firmware maintenance, debugging, and support of the software applications, and maintenance of all supplied equipment.

(xxv) To provide full backup of all installed software applications and data.

(xxvi) To test restoration of the system from the backup provided.

(xxvii) Availability of service, spare and expansion parts for the supplied items for the complete design life i.e. 7 years from the operational acceptance of the system as per details in various parts of this specification.

(xxviii) Auxiliary Power Supply comprising of UPS for 8 hours battery backup along with all necessary distribution.

The SI is to comply with the safety rules as mentioned in the Section-18.3.3.21 of the GCC.

Detailed descriptions of the Contractor's obligations, in relation to individual items and services offered, are delineated in other sections of this specification.

2.6 Exclusions from Contractor's Scope

The contractor shall be responsible for providing all the hardware & software, development of database and services required for commissioning of the project except

(i) Buildings

(ii) Air conditioning

(iii) Fire-fighting system

(iv) A.C. input power supply

2.7 Employer/Utility's Responsibilities and Obligations

The Employer/Utility will provide the following items and services as part of this Project:

(i) Overall project management

(ii) 3 Phase 415V AC Source power at (nominal) 230 volts, except auxiliary power supply included in the scope of this Project.

(iii) Review and approval of the Contractor's designs, drawings, and recommendations.

(iv) Existing system network and device data

(v) Review and approval of test procedures.

(vi) Participation in and approval of Type Test, factory and site acceptance tests, as defined in the Section-5.6 of this document.

(vii) Review and approval of training plans.

(viii) Providing support and access to facilities at the sites.

(ix) Implement the major civil works such as expansions or construction of rooms, trenches etc. as required for the equipment to be provided by the Contractor.

(x) Coordination of the Contractor's activities with the Employer/Utility's concerned departments.

(xi) Provide to the extent possible drawings for existing sites and facilities for which equipment installations are planned.

(xii) Arranging appropriate shut down to facilitate erection testing and commissioning of

System.

(xiii) Any statutory clearance/ entry permit as required.

(xiv) Releasing funds to SI as per agreed terms of Payment.

(xv) Approvals/Suggestions for change in submitted documents/ reports will be given to SI in time bound manner.

(xvi) Regulatory support/changes as required.

2.8 Overview of the Proposed Project

The availability of uninterrupted and quality power is an important requirement for sustained industrial growth and consequent influence on society. Supply to a large area is affected, many a times, even though the fault is localized. In the absence of reliable power supply the consumers, primarily industries resort for own captive generation. Further, high AT&C losses remain a major challenge for most of the utilities that can be reduced by improving visibility of the network, load balancing and proper network planning with properly sized transformers and distribution equipment. The loss reduction will also reduce electricity costs and improve system reliability.

The proposed Smart Grid Pilot Project will enable measurable improvements including:

(i) Reliability

(ii) System costs and peak demand

(iii) Environmental impact

(iv) Reduced greenhouse gas emissions

(v) Analysis of response to system disturbances

(vi) Operating resiliency

(vii) Optimization of asset utilization and operating efficiency of the electric power system

2.9 System Architecture

SI is to submit proposed system architecture for the given Pilot Project for review from EMPLOYER/UTILITY/Nodal Agency, that should be based on distributed architecture in line with organizational hierarchy. The architecture will include the available technology options, criteria for selecting the proposed technology, the technical specifications of the products to be installed and the functional description of IT applications, designed to meet the given functionalities. Due consideration is to be given for selecting technology that is interoperable, evolvable and scalable in future. SI is to describe the evolvability of the proposed solution to accommodate new features and functions. SI is to

classify each element of system design as critical or non-critical from customer's/ Employer/Utility's perspective.

Optimization of asset utilization and operating efficiency of the electric power system.

Software applications should facilitate interface to other systems through web services. List of standards to be followed and suggested architecture is enclosed at Annexure-I.

2.9.1 Performance Requirements of Solution:

SI is to clearly indicate the performance parameters of the proposed solution in terms of size, scalability, latency, response time, user interface features. Devices and systems which are mission critical to the delivery of project objective should have sufficient redundancy to meet the specified availability of the IT, surveillance and communication system as 99.5% and desired response time The suggested performance parameters for some functions are as given below:

User Interface Requirements	**Response time**
Any real time display and application display on workstation console, Complete display & data values shall appear on screen	Within 2 sec after acknowledgement of request
Manual Data entry of the new value shall appear on screen	Within 2 sec
Display update rate	Every 2 sec for 4 displays together
Response time for display of Alarm and event after receipt in system	Within 1 sec of receipt in system
Alarm and event acknowledgement	Within 2 sec
Requests for printing of displays (to be acknowledged with an indication of request is being processed)	Within 2 sec
Requests for generation of reports (to be acknowledged with an indication of request is being processed)	Within 2 sec

The software execution rates, response times and performance requirements shall not deteriorate during the peak loading conditions. The following conditions as applicable shall define the additional peak level of system activity:

(i) System Alarms

a. 300 alarms in a scan cycle starting the five-minute period (50% status changes and 50%analog limit violations)

b. 200 alarms per minute for five minutes

c. 50% of the alarms shall be acknowledged within the five-minute period (automatic acknowledgement is unacceptable).

(ii) Display Requests: 6 display requests per minute per console

(iii) Supervisory Control: 4 Supervisory control actions per minute

(iv) Communication System Disturbances: 10 disturbances within the five minute period

2.9.2 Security

SI shall comply to the standard security requirements and include the following details as part of its proposal:

(i) Security Architecture:

a. Please explain how your solution will meet ITU-T/CERT-IN/Other security standards/ guidelines regarding Security requirements for systems providing end-to-end communications.

a. Mitigation plan designed for Service impacting attacks (e.g. DOS, DDOS, etc.).

b. Please explain what capabilities are incorporated in your solution for mitigating service impacting attacks?

c. What capabilities exist in your proposed solution to revoke passwords, authentication tokens, and encryption keys?

d. What Intrusion Detection System (IDS) and Intrusion Prevention System (IPS) are you proposing to mitigate attacks, and detect traffic anomalies for your solution?

(ii) Security Requirements

b. Please explain how your solution will operate relative to ITU-T/CERT-IN/Other security standards

c. Please explain why you selected your proposed security performance solution for the management and control network you are proposing.

d. Please explain what mechanism you are proposing to secure (e.g. encrypt) all Management and Control traffic. (e.g. IPsec, SSL, etc.).

e. Please specify the encryption options for the Management and Control traffic both for IP and http traffic currently available with your solution.

(iii) Access Control

a. Access to entities on the Management and Control network (e.g. MDMS) must be secured .Please specify which token based (e.g. SecureID) authentication system you are proposing for this solution and why?

b. In your proposed solution is authentication used to secure the local asynchronous or Ethernet port on the Grid Elements as well as the network and web access interfaces?

c. Please describe the method of single sign on in your solution, if incorporated.

d. Please describe any options available for your solution to support single sign on.

e. How does your proposed solution make use of https for secure web access?

f. What encryption algorithm is used to encrypt all passwords stored and used by your solution?

g. Can the token based authentication be used instead of passwords universally in your proposed solution?

h. What authentication options will operate with your proposed solution?

i. In your proposed solution how are failed login attempts, and login account lockouts logged?

j. What method is used to consolidate and archive failed login attempt logs?

k. Can archived and current logs be used by the security management system to view a long term perspective of a situation?

l. All methods of insecure access shall be disabled (e.g. rlogin, FTP, etc.).

m. All methods of file sharing (e.g. CIFS) shall be disabled on all systems in your solution.

n. The network management protocol used for network management will have a community name string at least 8 characters long and requiring at least one uppercase letter, one lower case letter, a number, and a special character in the community name string and password. No default will be available for these strings, and they must be entered to install or update the software.

(iv) Security Management

a. What security management systems are you proposing and why?

b. Communications security (specifically authentication, authorization and confidentiality) between Grid Elements and Management Systems on the Management and Control network shall be configured and operate as if it were on an “Untrusted Network Segment” even where physical access to network media is limited.

c. Management and Control network direct login security shall be based on authentication (e.g. SecurID).

d. Describe the process for notifying the customers of vulnerabilities within your products and their potential impacts.

(v) Security Patches

a. Software delivered over the Internet, including security patches shall be encrypted and signed (e.g. PGP, MD5, etc.).

b. Specify how security requirements and encryption keys shall be maintained.

c. Please specify the method of patch distribution over the Internet and the encryption method and verification method.

d. Software updates and security patches shall be applied while the system is in operation and shall not require a reboot (e.g. applied to one processor in a dual processor configuration). A secure (e.g. https) remote method of initiating a rollback to the software prior to the update or patch shall be provided.

e. Please describe the method you propose to securely apply software updates and patches.

f. Please specify the method you propose to use to securely initiate a rollback to the software state prior to an update or patch.

(vi) Vulnerability Management

a. The vendor must certify the solution to be free of backdoors, Trojan horses, viruses, worms, and other vulnerabilities specified as high risks by CERT organization at the time of operational acceptance.

b. The vendor solution will be required to pass a vulnerability assessment prior to operational acceptance which will test for any CVE “high” risk vulnerabilities.

c. What vulnerability testing is performed as a part of your solution security testing?

d. At what points in your solution development and deployment cycle are security vulnerability assessments performed?

2.9.3 Technical proposal

The following items shall be included in the Technical Proposal by SI:

(i) Executive Summary

(ii) Project Implementation Schedule

(iii) Table of Compliance with reference to section 2,3,4,5 in the document

(iv) System Architecture and description, Security Architecture, Tentative BoQ, Specifications of items

(v) QA/QC program as described in sec 5.6.1.2

(vi) Business Process which may need redesign

To facilitate the proposal evaluation, the Table of Compliance, System Architecture and design will serve as the primary source of information. The proposal must also be supplied in an editable format (e.g., word processing, spreadsheet). Non-editable formats (e.g., Acrobat .PDF) will not be accepted for these documents.

2.9.3.1 *Executive Summary*

The Vendor shall provide an executive summary, presenting the essence of the proposed system and services.

2.9.3.2 *Project Implementation Schedule*

The Vendor shall provide a preliminary version of the project schedule in line with basic schedule given at Annexure- including documentation submittal dates, showing major system delivery/implementation activities and indicating milestone events with the interdependencies between events.

2.9.3.3 *Table of Compliance*

The Vendor shall prepare a Table of Compliance. Non-Compliance is defined as non-availability of functions as described in any section, paragraph or sentence that is not fully compliant with the specification. The Vendor shall use the form given below to present its table with the associated compliance symbols described as follows:

Table of Compliance

Section Page/Para/Line	Symbol	Description

Where:

Section =Specification Section

Para/Line =Paragraph or line number in section. If entire section, this field is left blank

Symbol =

C – Comply Vendor complies

A – Alternate Vendor proposes Functional Equivalent

CL – Clarification Vendor needs to clarify/state assumption for its compliance

X - Exception Vendor does not propose the functionality specified

Description=Explanation for the deviation from the specification.

Unless a specific section, paragraph, line or word is listed in this table, it is clearly understood that vendor fully complies with the specification requirement.

3 Functional Requirements

3.1 AMI for residential

Objective:-Remote meter reading for error free data, network problem identification, Load profile, Energy Audit and signal for partial load curtailment.

The system will also allow to test technology, evaluate meter functionality, communications capabilities, error free data for billing and billing system integration, engineering performance, computer systems and software needed to manage and maintain meter network and supply. The major components of this pilot project would be:-

(i) Smart Meters (accuracy 1%)

a. Installation

b. Development of Smart Meter Network

(ii) Master Station/Control Centre/Central Computer System

(iii) Meter Data Acquisition System that will capture

a. Usage with Time stamp

b. Voltage

c. Current

d. Events and generate alarms

(iv) Meter data Management System

a. Billing Application based on TOU/CPP

b. Energy Accounting

c. Load Analysis/Business Intelligence

(v) Analytics and reports

(vi) Network and Communications

(vii) Customer Outreach and Education

3.1.1 Smart Meters

AMI meters for the project are advanced solid state digital devices capable of recording hourly and sub-hourly data that includes energy consumption and may include voltage and power factor information. The meter shall calculate both TOU and CPP rate based consumption. The meters shall be based on the specifications finalized by CEA and may have the following minimum features:

1. Store and communicate requested data as per programmed interval
2. Detect, resolve abnormal & tamper events and store the same with alert to Employer/Utility personnel.
3. Inbuilt memory to store all relevant meter data, events for a minimum of 35 days.
4. Facilitate both prepaid and postpaid metering.
5. Shall be configurable remotely including remote firmware upgrade
6. Support remote load management by sending load curtailment signals that can be direct display/SMS/Web application.
7. Record violation of sanctioned load as per parameters set by Employer/Utility
8. Load Reconnect / Disconnect switch – Requirements shall be :
    i. All smart meters shall have a supply Disconnect / Reconnect switch / contactor for part/full load.
    ii. The AMI system shall support remote disconnect / reconnect of customer supply only via the supply contactor.
    iii. When the smart meter performs a disconnect operation, all outgoing power circuits from the meter shall be disconnected.
    iv. To confirm the current state of a meter, the AMI system shall support "on-demand" remote polling of the meter to determine whether the supply SI is open or closed/whether meter is energized or not.

The meter shall provide clear local visual indication of the status (open/closed) of the Supply contactor, consumption, last bill details.

3.1.2 Master Station/Control Centre

Master station /Control centre will be located in the space provided by the EMPLOYER/UTILITY. All hardware for MDMS will be installed in this premise and the operator(s) will be seated in this centre to manage the Smart Grid system through their desktops.

3.1.3 Meter Data Acquisition System

Meter Data Acquisition System, is the critical interface to the field devices, which shall support Meter Data Acquisition, Two way communication, poll meters for data collection, send remote firmware upgrades/programmable parameter inputs to meters, send Load Curtailment signals, Connect/ Disconnect and sending of pricing and other signals as generated from the MDMS/Other Applications to the Smart meter. This will interface with MDMS over SOA/Web services, and the data exchange models and interfaces shall comply with CIM/XML / IEC 61968/62056.

3.1.4 Meter Data Management System

It is the heart of AMI. MDMS shall be a single repository of all meter data. SI shall design this system based on open standards and using SOA principals. It will facilitate the following:

3.1.4.1 *Billing System*

A billing system capable of handling the billing of time based rates and existing Employer/Utility billing rate will be required to be deployed. SI to describe the billing system design.

3.1.4.2 *Energy Accounting*

This module shall support the following functions:

(i) Generate report of Loss analysis for different groups and categories of consumers on daily basis.

(ii) Generate report of AT&C loss calculation on weekly basis.

(iii) Generate report for accounting and auditing at Feeder level, Distribution Transformer level and DCU level.

(iv) Create graphical representation of all results that can be displayed on monitor and printed as per requirement.

3.1.4.3 *Load Research*

The proposed load research application shall be using the data of project area LT network. This should provide the following functions for analyzing :

(i) LT load requirements in short term and long term

(ii) Consumer load pattern

(iii) DTR loading and balancing

This will help the Employer/Utility in forecasting their load for short term, as well as plan network augmentation in long term. The data shall also be analyzed to aid in the day to day operation.

3.1.4.4 *System Requirements*

The minimum requirements of MDMS are listed below.

(i) Rule based Validation, Estimation & Editing (VEE) of consumption data

(ii) Detect & publish abnormal consumption events and patterns

(iii) Schedule based and on-demand reading from meters

(iv) Receive tamper events from meters and take appropriate action including sending alerts

(v) Receive power loss/restoration events from meters and take appropriate action like alarm generation or work order for maintenance crew

(vi) SI to describe how the system will receive, store and present data from non-meter sources, including customer equipment, distribution automation devices, RE sources, Network components configurable for different pricing plans, including TOU/CPP.

(vii) Enterprise class reporting engine. E.g. from Oracle, Microsoft, IBM etc.

(viii) Describe how the project is scalable to the system requirements in terms of number of additional meters and number of additional parameters for each meter) without performance degradation with suitable hardware upgrade.

(ix) Load analysis / research for decision support.

(x) Process and generate billing for customers of pilot project area.

(xi) Designed with adequate Cyber Security and Controls

(xii) Provide an interface to consumer portal

(xiii) Provide an interface with already existing IT systems of the utility– GIS, IT-applications so as to minimize data duplicity.

3.1.5 AMI Network and Communications

3.1.5.1 *AMI System Design:*

(i) The proposed solution (including the communication network and equipment) should be scalable to support future customer growth at the rate of 100% in 7 years.

(ii) Detailed design of the communication infrastructure of AMI system should be provided, which should include but not limited to communication technology, communication packet sizes, data rates, communication protocols, error detection and correction techniques, network data capacities, and bandwidth and margin at full system load (defined as quarter-hourly requests for most recent 5 and 15 minute interval data for all meters).

3.1.5.2 ***Time Synchronization:***

SI is to include Time Synchronization system for all components of Pilot.

3.1.5.3 ***Public Network:***

In case of use of public network for communication, information regarding the following parameters must be made available :

(i) Details of the network usage in terms of cost of operation and extended life of the system.

(ii) Security

(iii) Reliability

3.1.5.4 ***Expected operating life and performance reliability:***

(i) System operating life: It is expected to be 15 years for meters and 7 years for rest of the system.

(ii) System Reliability: The system must have sufficient fault tolerance, redundancy, failover, self-healing to guarantee system information requirements. A systematic failure analysis of all the elements must be done and ensure that there is no single point of failure which leads to more than 2% of data disruption for not more than 24 hours.

(iii) Predictive/preventative reliability: Tracking and reporting performance of all elements of the AMI system to ensure system reliability and proactively identify potential situations that could become system problems.

3.1.5.5 ***Technical obsolescence:***

The system elements which are at a risk of technical obsolescence over the operating life of the system should be identified; this should include end-of-sale and end-of-support policies governing the proposed technologies. Forward and backward compatibility need to be considered and mitigation options described in detail. The mitigation shall not be limited to periodic update from OEM/System supplier.

3.1.5.6 ***Equipment siting:***

The criteria and flexibility in physically siting all the equipment must be listed prior to deployment of the system.

3.1.5.7 ***IT Infrastructure and System Integration:***

(i) Describe the head end system/ Data concentrator functionality in detail.

(ii) The provider's head end system/ Data Concentrator should fully support all functionality described in the scope of work.

3.1.5.8 ***Interoperability criteria:***

(i) The proposal should specify the points of interface, where this part of the system interacts with other elements, like GIS, SCADA, DMS, portal, existing metering, billing and other

IT applications.

(ii) The project should use standard communication protocols and describe the protocols used for the system

3.1.5.9 ***Customer Interface:***

The system shall provide periodic updates to the customers and via media (website, SMS, e-mail, meter displays etc.) shall be clearly defined. The system shall support all the above media and delivery shall include at least three out of above.

3.1.6 Analytics and Reports

Business Intelligence tools shall be supplied to generate analytics and reports. SI is to suggest and design the reports in line with redesigned business processes and the details of such reports are to be included in the technical proposal

The SI needs to suggest and design reports for

a. Time frames like weekly / daily / monthly / yearly.

b. Objects, objects executed (actuals) or combination of both.

c. in MS Excel or Web (Internet Explorer).

d. exporting to Excel, ASCII files, PDF and HTML or third party reporting tools (Crystal Reports)

e. user based templates be created & used for reports.

f. for calculations, filters and exceptions during reporting.

g. to be scheduled to run in batch

h. scheduling to run the reports event-based or time based

i. delivering the reports to the online users through email, portal, and report server.

j. providing for metadata objects to be viewed during reporting.

k. provide for saving the report /queries for repetitive execution as and when required by the users.

l. analysis of historical & consolidated data across systems

m. monitoring the performance of data warehousing system

3.1.7 Network Management

The contractor shall provide a Network Management System with the following functions:

(i) The network monitoring system shall help the computer system operators to easily identify the problem areas and hence to take necessary corrective action remotely or manually.

(ii) The meter and the DCU and communication equipment in the network need to be monitored and tracked continuously in addition to the other IT networks.

(iii) The Network Management System shall have visibility of the accessibility of each of the end equipment, communication devices, and other intermediaries in the network to give the operator real-time status and alarms in case of any of the nodes and channels being un-reachable.

(iv) The equipment to be monitored shall include data concentrators, backbone connectivity, last mile connectivity, end points, etc.

(v) The monitoring data shall be store for 1 month and shall include lost packet.

3.1.8 Network and Data Security

The following items need to be considered for adequate security at different levels i.e. systems, data, network and security and SI needs to provide

(i) Systematic description of how data security is maintained from the meters to the system head end. All elements of the proposed system shall support protection of data, confidentiality, data integrity and operational security. Physical security to prevent on-site tampering to be ensured.

(ii) System should enable creation and maintenance of accounts, passwords and functionality access levels, along with log details.

(iii) Description of the in-built anti-virus capabilities provided in connection with all proposed software platforms and solutions.

(iv) Description of methods to detect and prevent attacks including but not limited to Denial of Service and Intrusion.

3.1.8.1 *Access Control*

(i) There shall be an identity and access management system which shall control and log the access control of all users to the smart grid systems.

(ii) The identity and access management system shall be able to define the access control levels of each user based on roles, responsibilities or hierarchy.

(iii) The identity and access management system shall be able to define which user can

access which function of the individual systems. For example, the identity and access management system shall define which user can initiate a load disconnect function for a particular consumer, and therefore rest of the unauthorized users will not be able to perform load disconnect function.

(iv) The identity and access management system shall be integrated with rest of the Centralized Computer Systems.

3.1.8.2 *Network Security:*

(i) Since Centralized Computer System has to access external environment through GPRS and Internet cloud it is important to have adequate network security systems.

(ii) There shall be intrusion detection and prevention systems deployed at the central layer.

(iii) There shall also be firewalls which will be a separate system from the intrusion prevention system.

(iv) The firewall shall control the demilitarized zones in the data centre and control room, and also the systems and ports which will be open to public network/ VPN.

(v) If fixed IP and operator VPN is not available/possible and Dynamic IP is being used, then the devices shall support SSL/VPN and the data shall be encrypted before send / received on GPRS/CDMA last mile network, for devices consisting of Smart Meter Network SMN.

3.1.8.3 *Systems and Data Security:*

(i) The systems deployed shall have the application scanning, hardware scanning tools in order to identify any vulnerability so as to mitigate any potential security threats.

(ii) The application databases shall have exclusive security tools in order to prevent any potential internal attacks like SQL injection etc.

(iii) The data shall be encrypted wherever supported by existing systems/devices/technology.

3.1.9 Customer Outreach and Education

The customer data acquired will be the basis of the design of suitable outreach programs to be executed by EMPLOYER/UTILITY with the help of the SI if necessary to address the issues captured in the survey exercise. These programs will be focused to the class(es) of consumer(s) and aim at creating awareness of the pilot and its benefit , dispel misgivings and carry all customers along with the SI/EMPLOYER/UTILITY during the implementation of the pilot. The programs shall cover road shows to attract customer voluntary participation, booklets for general distribution, compilation of consumer survey data, workshops etc. In all these the SI is only expected to design and assist in preparation and the

EMPLOYER/UTILITY will actually execute the programs. The expertise of the SI should be made available during these interactions.

3.1.10 Consumer Portal

SI needs to design Consumer portal on standard off the shelf product that can be easily managed by Employer/Utility personnel after completion of Pilot project. Consumer Portal is one of the most important components of Smart Grid. The objective of Consumer portal is to provide high quality experience for the customers and business associates that will provide them a user friendly portal and will make it easy for them to communicate with the Employer/Utility through the web instead of direct phone calls or visits. This portal will also act as a source of information for the customers regarding policies and procedures. This in turn will improve customer satisfaction and reduce work load on the employee. This will host the web application for:-

(i) Display of Load profiles selectable based on organizational hierarchy of the Employer/Utility

(ii) Display of Reliability Indices selectable based on organizational hierarchy of the Employer/Utility

(iii) Bill payment services

(iv) Other Information Sharing requirements based on standard Information Architecture

3.2 AMI for industrial

Objective:-, Load profile for peak load management, network problem identification, Energy Audit, Load curtailment in place of load shedding

AMI will help in improving billing efficiency, demand side management for reduction of energy use, provide the utilities and consumers with better outage management, provide load profile data, and quality data to improve power quality that can be charged a premium price and to gauge customer perception and Employer/Utility benefits.

This project will be similar to AMI for Residential pilot but will have a more sophisticated meter for capturing additional parameters like for power quality and demand control by way of load curtailment from remote end.

The major components of this pilot project would be:-

(i) Smart Meters

a. Installation

b. Development of Smart Meter Network

(ii) Master Station/Control Centre/Central Computer System

(iii) Meter Data Acquisition System that will capture

a. Usage with Time stamp

b. Voltage

c. Reactive power

(iv) Meter data Management System

a. Billing Application based on TOU/CPP

b. Energy Accounting

c. Load Analysis/Business Intelligence

(v) Analytics and reports

(vi) Network and Communications

(vii) Customer Outreach and Education

3.2.1 Smart Meters – 3 Phase

AMI meters for the project are advanced solid state digital devices capable of recording hourly and sub-hourly data that includes energy consumption and may include voltage and power factor information. The meter shall calculate both TOU and CPP rate based consumption. The meters shall have the following minimum features:

(i) Measure and Compute electrical parameters as per standards available

(ii) The meter shall have a provision for at least 6 time zones and 4 tariff registers

(iii) Communicate requested data as per programmed interval.

(iv) The programmable parameters shall be:

- Real Time Clock – Date and Time
- Demand Integration Period: It is the duration over which the maximum demand is averaged.
- Profile Capture Period: It is the load survey period for capturing and logging the electrical parameters as mentioned in (ix) below.
- Billing Dates

- TOU time
- Prepaid tariffs

(v) Detect, abnormal & tamper events and store the same with alert to Employer/Utility personnel

(vi) Inbuilt memory to store all relevant meter data, events for a minimum of 35 days.

(vii) Shall be configurable remotely including remote firmware upgrade

(viii) Support remote load management by sending load curtailment signals

(ix) Record violation of sanctioned load as per parameters set by Employer/Utility

(x) The following groups of data shall be captured

- Electrical Parameters – as per IS 15959
- Power Quality parameters – Voltage sag and swell, monitoring of current harmonics, monitoring of load unbalance
- Abnormal events

(xi) Load Reconnect / Disconnect switch – Requirements shall be :

- All smart meters shall have a supply Disconnect / Reconnect switch / contactor for part/full load.
- The AMI system shall support only remote disconnect / reconnect of customer supply via the supply contactor.
- When the smart meter performs a disconnect operation, all outgoing power circuits from the meter shall be disconnected.
- To confirm the current state of a meter, the AMI system shall support "on-demand" remote polling of the meter to determine whether the supply contactor is open or closed/whether meter is energized or not.
- The meter shall provide clear local visual indication of the status (open/closed) of the Supply contactor, consumption, last bill details.

3.2.2 Master Station/Control Centre

Master station /Control centre will be located in the space provided by the EMPLOYER/UTILITY. All hardware for MDMS will be installed in this premises and will be manned by round the clock

operator(s) who will manage the Smart Grid system thru their desktops like managing the AMI end points, communication network, scheduling and collection of meter readings, coordination of customer and meter changes

3.2.3 Meter Data Acquisition System

Meter Data Acquisition System, is the critical interface to the field devices, which shall support Meter Data Acquisition, Two way communication, poll meters for data collection, send remote firmware upgrades/programmable parameter inputs to meters, send Load Curtailment signals, Connect/ Disconnect and sending of pricing and other signals as generated from the MDMS/Other Applications to the Smart meter. This will interface with MDMS over SOA/Web services, and the data exchange models and interfaces shall comply with CIM/XML / IEC 61968/62056

3.2.4 Meter Data Management System

It is the heart of AMI. MDMS shall be a single repository of all meter data. SI shall design this system based on open standards and using SOA principals. It will facilitate the following:-

3.2.4.1 *Billing System*

A billing system capable of handling the billing of time based rates and existing Employer/Utility billing rate will be required to be deployed. SI to include the details of billing application in the proposal.

3.2.4.2 *Energy Accounting*

This module shall support the following functions:

(i) Generate report of Loss analysis for different groups and categories of consumers on daily basis.

(ii) Generate report of AT&C loss calculation on weekly basis.

(iii) Generate report for accounting and auditing at Feeder level, Distribution Transformer level and DCU level.

(iv) Create graphical representation of all results that can be displayed on monitor and printed as per requirement.

3.2.4.3 *Load Research*

The proposed load research application shall be using the data of project area LT network. This should provide the following functions for analyzing :

(i) LT load requirements in short term and long term

(ii) Consumer load pattern

(iii) DTR loading and balancing

This will help EMPLOYER/UTILITY in forecasting their load for short term, as well as plan network

augmentation in long term. The data shall also be analyzed to aid in the day to day operation.

3.2.4.4 ***System Requirements***

The minimum requirements of MDMS are listed below:

(i) Rule based Validation, Estimation & Editing (VEE) of consumption data

(ii) Detect & publish abnormal consumption events and patterns

(iii) Schedule based and on-demand reading from meters

(iv) Receive tamper events from meters and take appropriate action including sending alerts

(v) Receive power loss/restoration events from meters and take appropriate action, like alarms or generating work order for maintenance crew.

(vi) Describe how MDMS will receive, store and present data from non-meter sources, including customer equipment, distribution automation devices, RE sources, Network components configurable for different pricing plans, including TOU/CPP.

(vii) Record import as well as export of energy from consumer premises separately and also net calculation on day/week/other period basis.

(viii) Provide enterprise class reporting engine/BI tools. e.g. from Oracle, Microsoft, IBM etc.

(ix) Describe how the proposed system will scale to accommodate the increased number of meters and increased amount of data from each meter without performance degradation with suitable hardware upgrade.

(x) Load analysis / research for decision support.

(xi) Process and generate billing for customers of pilot project area.

(xii) Designed with adequate Cyber Security and Controls

(xiii) Provide an interface to consumer portal.

(xiv) Provide an interface with already existing IT systems of the Employer/Utility– GIS, IT-applications.

(xv) Provide an interface to communication system.

3.2.5 AMI Network and Communications

3.2.5.1 *AMI System Design:*

(i) The proposed solution (including the communication network and equipment) should be scalable to support future customer growth at the rate of 100% in 7 years.

(ii) Detailed design of the communication infrastructure of AMI system should be provided, which should include but not limited to communication packet sizes, data rates, communication protocols, error detection and correction techniques, network data capacities, and bandwidth and margin at full system load (defined as quarter-hourly requests for most recent 5 and 15 minute interval data for all meters).

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SI is to include Time Synchronization system for all components of Pilot.

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In case of use of public network for communication, information regarding the following parameters must be made available :

(i) Details of the network usage in terms of cost of operation and extended life of the system.

(ii) Security

(iii) Reliability

3.2.5.4 *Expected operating life and performance reliability:*

(i) System operating life: It is expected to be 15 years for meters and 7 years for rest of the system. The system is further expected to remain operational, with upgrades/replacement, for another 7 years.

(ii) System Reliability: The system must have sufficient fault tolerance, redundancy, failover, self-healing to guarantee system information requirements. A systematic failure analysis of all the elements must be done and ensure that there is no single point of failure which leads to more than 2% of data disruption for not more than 6 hours

(iii) Predictive/preventative reliability: Tracking and reporting performance of all elements of the AMI system to ensure system reliability and proactively identify potential situations that could become system problems.

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The system elements which are at a risk of technical obsolescence over the operating life of the system should be identified; this should include end-of-sale and end-of-support policies governing

the proposed technologies. Forward and backward compatibility need to be considered and mitigation options described in detail. The mitigation shall not be limited to periodic update from OEM/System supplier.

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The criteria and flexibility in physically siting all the equipment must be listed prior to deployment of the system.

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3.2.5.8 *Interoperability criteria:*

(i) The proposal should specify the points of interface, where this part of the system interacts with other elements, like GIS, SCADA, DMS, portal, existing metering, billing and other IT applications.

(ii) The project should use international standard communication protocols. SI is to describe the protocols to be used in the proposed system.

3.2.5.9 *Customer Interface:*

The system shall provide periodic updates to the customers and via media (website, SMS, e-mail, meter displays etc.) shall be clearly defined. The system shall support all the above media and delivery shall include at least three out of above.

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The SI needs to suggest and design reports for

(i) Time frames like weekly / daily / monthly / yearly.

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The contractor shall provide a Network Management System with the following functions:

(i) The network monitoring system shall help the computer system operators to easily identify the problem areas and hence to take necessary corrective action remotely or manually.

(ii) The meter and the DCU and communication equipment in the network need to be monitored and tracked continuously in addition to the other IT networks.

(iii) The Network Management System shall have visibility of the accessibility of each of the end equipment, communication devices, and other intermediaries in the network to give the operator real-time status and alarms in case of any of the nodes and channels being un-reachable.

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The following items need to be considered for adequate security at different levels i.e. systems, data, network and security and SI needs to provide

(i) Systematic description of how data security is maintained from the meters to the system head end. All elements of the proposed system shall support protection of data, confidentiality, data integrity and operational security.

Physical security to prevent on-site tampering to be ensured.

(ii) System should enable creation and maintenance of accounts, passwords and functionality access levels, along with log details.

(iii) Description of the in-built anti-virus capabilities provided in connection with all proposed software platforms and solutions.

(iv) Description of methods to detect and prevent attacks including but not limited to Denial of Service and Intrusion.

3.2.8.1 ***Access Control***

(i) There shall be an identity and access management system which shall control and log the access control of all users to the smart grid systems.

(ii) The identity and access management system shall be able to define the access control levels of each user based on roles, responsibilities or hierarchy.

(iii) The identity and access management system shall be able to define which user can access which function of the individual systems. For example, the identity and access management system shall define which user can initiate a load disconnect function for a particular consumer, and therefore rest of the unauthorized users will not be able to perform load disconnect function.

(iv) The identity and access management system shall be integrated with rest of the Centralized Computer Systems.

3.2.8.2 ***Network Security:***

(i) Since Centralized Computer System has to access external environment through GPRS and Internet cloud it is important to have adequate network security systems.

(ii) There shall be intrusion detection and prevention systems deployed at the central layer.

(iii) There shall also be firewalls which will be a separate system from the intrusion prevention system.

(iv) The firewall shall control the demilitarized zones in the data centre and control room, and also the systems and ports which will be open to public network/ VPN.

(v) If fixed IP and operator VPN is not available/possible and Dynamic IP is being used, then the devices shall support SSL/VPN and the data shall be encrypted

before send / received on GPRS/CDMA last mile network, for devices consisting of Smart Meter Network SMN.

3.2.8.3 ***Systems and Data Security:***

(i) The systems deployed shall have the application scanning, hardware scanning tools in order to identify any vulnerability so as to mitigate any potential security threats.

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3.2.10 Consumer Portal

SI needs to design Consumer portal on standard off the shelf product that can be easily managed by Employer/Utility personnel after completion of Pilot project .Consumer Portal is one of the most important components of Smart Grid. The objective of Consumer portal is to provide high quality experience for the customers and business associates that will provide them a user friendly portal and will make it easy for them to communicate with the Employer/Utility through the web instead of direct phone calls or visits. This portal will also act as a source of information for the customers regarding policies and procedures. This in turn will improve customer satisfaction and reduce work load on the employee. This will host the web application for:-

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(ii) Display of Reliability Indices selectable based on organizational hierarchy of the Employer/Utility

(iii) Bill payment services

(iv) Other Information Sharing requirements based on standard Information Architecture

3.3 Outage Management

Objective:- Improve availability and reliability, customer satisfaction, proactive maintenance to avoid failures

Outage management is extremely important for the Utilities and the customers they serve. The Utilities will leverage existing OMS (if exists) and utilize the capabilities of AMI and grid automation to improve grid reliability by self-healing and more quickly and accurately identifying the location and magnitude of an outage, resulting in faster restoration. The self-healing is that part of automation which provides for auto routing of power flow, in the event of a fault, to the load. This feature is also termed as 'Fault Location Isolation and Service Restoration – FLISR'. The automation components provide the network status there by aiding the OMS in resolving the faulty network section. Subsequently through the process of, isolation of faulty section and identifying the alternate network path, the appropriate line components are activated to restore power. This process is completed in the least possible time. Further, condition based monitoring of critical assets like distribution transformers will help in taking proactive corrective action based on alarms from remote sensors.

The system will include:-

(i) Condition-based monitoring

(ii) Fault Management and system Restoration (FM &SR):

(iii) Remote Terminal Units, Sensors to monitor distribution grid/ substations/ distribution transformers as required

(iv) Communication to data centre/Master Station

(v) Analytics, with asset mapping

(vi) Cyber Security tools and applications

(vii) Tools for software application and Network Management

3.3.1 Condition Based Monitoring

3.3.1.1 *TMU –Transformer Monitoring Unit*

SI is to install TMU and other field devices for condition based monitoring. TMU is used to monitor oil filled transformer‘s vital parameters online from any location. The RTMU remote data acquisition with risk analysis engine provides early indication of impending fault so that early diagnosis and early actions can be initiated in time. SI needs to design the same to easily integrate with transformers of different ratings and perform functions like asset performance data monitoring, energy/power flow data measurement and alarm reporting. The TMU is required to be installed at each of the Distribution Transformer in the project area and it shall monitor the various parameters (physical and electrical) and transmit the data to central system. The design of TMU shall be suitable for outdoor mounting and should be provided with clamps and fixtures. The enclosure shall withstand natural weather conditions (To be protected against dust, water and rain). It shall conform to IP-66 requirements. TMU shall analyze based on the physical and electrical parameters the condition of the DTR and alert the operator for possible vulnerabilities points.

3.3.1.2 *Minimum features of Condition based monitoring module will include*

(i) Sensor package for

- Oil level & top-of-oil temperature sensors
- Ambient temperature sensor
- Terminal surface temperature sensor
- Fence door & product door sensor

(ii) Power flow metering

(iii) Remote data access

(iv) Alarm reporting

Time stamped events / alarms for:

- Power or communication failure
- Low oil level

- Tampering indication
- Loading level
- Unbalance

(v) GUI for monitoring energy & asset parameters

The system will include GUI for monitoring the energy and asset health parameters from the master station.

3.3.2 Fault Management and system Restoration (FM &SR):

(i) SI is to provide a solution such that a comprehensive view of the situation of the network shall be presented to the operator, allowing to quickly assess the nature and importance of the reported disturbances/trippings.

(ii) The corresponding work permits will be generated by the system for disturbances/trippings and shall be assigned to maintenance crews. The progress of the maintenance work is to be properly managed, including the monitoring of partial restorations.

(iii) The Fault Management & System Restoration function designed by SI provides assistance to the OMS dispatcher for detection, localization, isolation and restoration of the distribution system. In case of permanent fault in the Distribution network, the function proposes switching plans to restore the supply in the healthy parts of the faulty feeder.

(iv) The function shall be designed so as to be usable to compute switching plans to assist in the cases of reconfiguration of the network required by maintenance operations or partial load transfer of an overloaded feeder to the neighboring feeder(s).

3.3.3 Master Station/Control Centre

Master station /Control centre will be located in the space provided by the EMPLOYER/UTILITY. All hardware for Smart Grid Central System will be installed in this premises and will be manned by round the clock operator(s) who will manage the Smart Grid system thru their desktops

3.3.4 **Network Management**

The contractor shall provide a Network Management System with the following functions:

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and tracked continuously in addition to the other IT networks.

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(i) The systems deployed shall have the application scanning, hardware scanning tools in order to identify any vulnerability so as to mitigate any potential security threats.

(ii) The application databases shall have exclusive security tools in order to prevent any potential internal attacks like SQL injection etc.

(iii) The data shall be encrypted wherever supported by systems/devices/technology

3.4 Peak Load Management

Objective :- Optimal utilization of energy resources by uniform distribution of load across the day, to save additional investment in capacity addition, improved access of power to rural areas, reduction in technical losses, enhanced customer satisfaction by load curtailment in place of load shedding

This pilot will provide the information necessary to properly plan, forecast, and understand system loads and formulate decisions for more effective results. Properly sized transformers and distribution equipment will reduce electricity costs and improve system reliability.

The peak management refers to controlling the demand and matching it to the available supply at the instant of peak. The peak management function shall take inputs from SCADA for power availability and volume of shortage. Based on the shortage, the peak management function shall run algorithms

considering various constraints and priorities predefined on the basis of customer profile by SI in association with Employer/Utility personnel, and suggest the options to Employer/Utility officials. The approach shall be to avoid tripping of feeders for load shedding and manage peak load either by load curtailment thru AMI or by price incentives/disincentives.

SI need to design and deliver

(i) Distribution Management System-DMS

(ii) Remote Terminal Units to monitor distribution grid, substations and distribution transformers as required

(iii) Communication to data centre/Master Station

(iv) Analytics, for load forecast with reference to time of day for different seasons

(v) Access to SCADA for information about generation and load

(vi) Customer profiles

(vii) Remote control: Signal to customer to shed load

(viii) TOU/CPP notified on the basis of day ahead load forecast and power supply availability

(ix) Meters with two-way communications (cut power if customer does not curtail)

3.4.1 The Distribution Management System-DMS

This system uses existing SCADA information from Employer/Utility, in application software to improve the distribution system performance and customer satisfaction.

The proposed DMS Scheme uses RTUs/FRTUs (Remote Terminal Units), for capturing data of substation devices, distribution transformers and feeders. The data from RTU/Data Concentrator is transmitted to Master Station/DMS Control Centre over suggested Communication link to be provided by the SI.

A GPS based time synchronization system shall be provided at the SCADA/DMS Control Centre. All Substation RTU/ Data Concentrators shall be time synchronized from the SCADA/DMS Control Centre System.

3.4.1.1 *Feature of DMS Control Centre Hardware and Software/functionalities*

As per industry practice the DMS Control Centre/Master Station hardware and software shall be based on Open System & Distributed Architecture to facilitate portability, interoperability, interconnectivity and expandability of the DMS system. The salient feature of Hardware and Software of DMS Control centre is described below:

3.4.1.1.1 Distribution Management System (DMS) application Software

SI needs to design Distribution Management Applications that help in increasing efficiency of the control centre action, satisfaction of customers and need to be deployed in advisory or close loop control mode.

- In closed loop the control function will be initiated automatically as and when the need arises for performing any requisite corrective action.
- In advisory mode operator can analyze the exigencies and available options and issue the appropriate instructions to the O&M personnel at substations for performing appropriate control action.
- The choices of application are dependent on the adaptability of field configuration/ system to move to the desired optimal state suggested by application.

The description of applications that need to be designed by SI is as follows:

(i) Load Shed Application (LSA)

The load-shed application is to be designed by SI so that it automates and optimizes the process of selecting the best combination of switches to open in order to shed the desired amount of load. Given a total amount of load to shed, the load shed application will recommend different possible combinations of switches to open, in order to meet the requirement.

The operator will be presented with various combinations of switching operations based on an evaluation of load priorities and current load levels, which will result in a total amount of load shed, closely resembling the specified total. The operator can then chose any of the recommended actions, and execute them through a single action at the console.

(ii) Power Flow Application

A power distribution network normally consists of a large number of devices; a correspondingly large number of measurements are thus needed to describe its state. In most cases, however, relatively small portions of the electrical quantities are actually measured. The load flow application to be designed by SI needs to provide values for those electrical quantities at network locations where measurements are not available. These values are useful both in terms of providing a more complete view of the network to the operator in real -time, and as the basis for the remaining DMS software for which the load flow results serve as inputs.

(iii) Network Connectivity Analysis (NCA)

The network connectivity analysis function to be designed by SI will form the basis of the analysis/decision/action tools available to operators. Aside from providing live/dead status information to the operator in real-time, the results of the NCA function serve as inputs to virtually every other application in the DMS software package.

The NCA function will be designed to determine the topology of the distribution network based on the physical connectivity of devices in the network and the status of connecting devices such as switches. In addition, the NCA function also needs to determine the electrical status of each device in the network, which can then be presented dynamically to the operator on one-line displays. The dynamic display rendering of electrical status will provide an indication of energized/de-energized state, and whether the device forms part of a loop or a parallel path.

(iv) Loss Minimization via Feeder Reconfiguration

The loss minimization optimization study functions to be designed by SI shall provide recommendations, which may allow operators to reduce overall system losses, thereby reducing operating costs. Also, the loss minimization recommendations would result in improved quality of service and increased reliability. The loss minimization via feeder reconfiguration study application will identify an alternative network topology, which, while meeting the same nodal power demands, incurs smaller distribution losses. Given that the losses across a device are proportional to the square of its current, the total losses incurred by two devices which are similarly loaded are, in general, less than the total losses that would be incurred were one device is heavily loaded and the other lightly loaded. The application recommends pairs of switching operations (close one switch and open another), which will reduce the total distribution loss.

(v) Load Balancing

SI needs to design load balancing study function to identify opportunities to transfer load between feeders in an effort to increase network reserve loading capacity. If one considers the capacity reserve of a network to be limited by the smallest capacity reserve of its component devices, then the load balancing via feeder reconfiguration application can be said to identify opportunities for shifting reserve capacity between individual devices in order to maximize the reserve capacity of the network. To this end, the function needs to recommend a series of switching operations, each consisting of opening one switch and closing another switch, in order to transfer load from one feeder to another.

(vi) Geographical Information System

SI needs to design Geographical information system for superimposition of the electrical network state on geographical map of the area. The breakers and switch status (on/off/lock) will be indicated. Feeder condition (Live / Dead / Maintenance) will also be displayed on the screen. This increases effectiveness of Operator in guiding the maintenance team and efficiency of the team throughput is greatly enhanced.

(vii) Load Forecast (LF)

SI needs to design this function for predicting the load which shall help to tie up bulk power purchase optimally and track the load history of the system. The LF shall be based on historical load profile database. In this function, a number of different profiles based on time interval of 15/30 minutes load basis are stored in the database and depending upon the day of week and having seasonal consideration, the load for future days can be forecasted.

(viii) Real Time Calculation

This sub-system is to be designed by SI to allow operators to define calculations on analog and status data acquired from field. Once these calculations are defined in the database, they are executed in real-time and results are presented on suitable displays.

3.4.2 Master station /Control centre

Master station /Control centre will be located in the space provided by the EMPLOYER/UTILITY. All hardware for

Smart Grid Central System will be installed in this premises and will be manned by round the clock operator(s) who will manage the Smart Grid system thru their desktops

3.4.3 Network Management

The contractor shall provide a Network Management System with the following functions:

(i) The network monitoring system shall help the computer system operators to easily identify the problem areas and hence to take necessary corrective action remotely or manually.

(ii) The field devices and communication equipment in the network need to be monitored and tracked continuously in addition to the other IT networks.

(iii) The Network Management System shall have visibility of the accessibility of each of the end equipment, communication devices, and other intermediaries in the network to give the operator real-time status and alarms in case of any of the nodes and channels being un-reachable.

(iv) The equipment to be monitored shall include field devices, backbone connectivity, last mile connectivity, end points, etc.

(v) The monitoring data shall be store for 1 month and shall include lost packet

3.4.4 Network and Data Security

The following items need to be considered for adequate security at different levels i.e. systems, data, network and security and SI needs to provide

(i) Systematic description of how data security is maintained from the field devices to the central system. All elements of the proposed system shall support protection of data, confidentiality, data integrity and operational security. Physical security to prevent on-site tampering to be ensured.

(ii) System should enable creation and maintenance of accounts, passwords and functionality access levels, along with log details.

(iii) Description of the in-built anti-virus capabilities provided in connection with all proposed software platforms and solutions.

(iv) Description of methods to detect and prevent attacks including but not limited to Denial of Service and Intrusion.

3.4.4.1 *Access Control*

(i) There shall be an identity and access management system which shall control and log the access control of all users to the smart grid systems.

(ii) The identity and access management system shall be able to define the access control levels of each user based on roles, responsibilities or hierarchy.

(iii) The identity and access management system shall be able to define which user can access which function of the individual systems. For example, the identity and access management system shall define which user can initiate a load disconnect function for a particular consumer, and therefore rest of the unauthorized users will not be able to perform load disconnect function.

(iv) The identity and access management system shall be integrated with rest of the Centralized Computer Systems.

3.4.4.2 ***Network Security:***

(i) Since Centralized Computer System has to access external environment through GPRS and Internet cloud it is important to have adequate network security systems.

(ii) There shall be intrusion detection and prevention systems deployed at the central layer.

(iii) There shall also be firewalls which will be a separate system from the intrusion prevention system.

(iv) The firewall shall control the demilitarized zones in the data centre and control room, and also the systems and ports which will be open to public network/ VPN.

(v) If fixed IP and operator VPN is not available/possible and Dynamic IP is being used, then the devices shall support SSL/VPN and the data shall be encrypted before send / received on GPRS/CDMA last mile network, for devices consisting of Smart Grid System.

3.4.4.3 ***Systems and Data Security:***

(i) The systems deployed shall have the application scanning, hardware scanning tools in order to identify any vulnerability so as to mitigate any potential security threats.

(ii) The application databases shall have exclusive security tools in order to prevent any potential internal attacks like SQL injection etc.

(iii) The data shall be encrypted wherever supported by systems/devices/technology

3.5 Power Quality

Objective:-Improved Customer satisfaction, reduction in losses, increase in Employer/Utility Revenue by charging a premium price for power quality

The pilot will include:

(i) Remote Terminal Units to monitor distribution grid, substations and distribution transformers

(ii) Communication to data centre/Master Station

(iii) Analytics, with asset mapping

(iv) Access to SCADA

(v) Field devices for Quality control

(vi) Voltage control

(vii) SI to give details for the solution proposed for Management of harmonics

(viii) Management of reactive power

(ix) Load balancing

(x) Cyber Security tools and applications

(xi) Tools for software application and Network Management

(xii) Design of Applications for:

a) Voltage / VAR Control (VVC)

The VVC function will be designed by SI to monitor the set of telemetered voltage measurements associated with each VVC-controllable device. If the VVC function detects a limit violation,

It advises the corrective control actions to operator. VVC-controllable devices are the set of transformers and capacitor banks selected by the operator for VVC control. Corrective controls include incrementing/decrementing the transformer tap position, and switching in/out a capacitor in a capacitor bank.

b) Load Balancing

SI needs to design load balancing study function to identify opportunities to transfer load between feeders in an effort to increase network reserve loading capacity. If one considers the capacity reserve of

a network to be limited by the smallest capacity reserve of its component devices, then the load balancing via feeder reconfiguration application can be said to identify opportunities for shifting reserve capacity between individual devices in order to maximize the reserve capacity of the network. To this end, the function needs to recommend a series of switching operations, each consisting of opening one switch and closing another switch, in order to transfer load from one feeder to another

c) Management of Harmonics

SI is to design this solution such that it will send control signals to power quality devices based on inputs received from AMI system on quality parameters

3.5.1 Master station /Control centre

Master station /Control centre will be located in the space provided by the EMPLOYER/UTILITY. All hardware for Smart Grid Central System will be installed in this premises and will be manned by round the clock operator(s) who will manage the Smart Grid system thru their desktops

3.5.2 Network Management

The contractor shall provide a Network Management System with the following functions:

(i) The network monitoring system shall help the computer system operators to easily identify the problem areas and hence to take necessary corrective action remotely or manually.

(ii) The field devices and communication equipment in the network need to be monitored and tracked continuously in addition to the other IT networks.

(iii) The Network Management System shall have visibility of the accessibility of each of the end equipment, communication devices, and other intermediaries in the network to give the operator real-time status and alarms in case of any of the nodes and channels being un-reachable.

(iv) The equipment to be monitored shall include field devices, backbone connectivity, last mile connectivity, end points, etc.

(v) The monitoring data shall be store for 1 month and shall include lost packet

3.5.3 Network and Data Security

The following items need to be considered for adequate security at different levels i.e. systems, data, network and security and SI needs to provide

(i) Systematic description of how data security is maintained from the field devices to the central system. All elements of the proposed system shall support protection of data,

confidentiality, data integrity and operational security. Physical security to prevent on-site tampering to be ensured.

(ii) System should enable creation and maintenance of accounts, passwords and functionality access levels, along with log details.

(iii) Description of the in-built anti-virus capabilities provided in connection with all proposed software platforms and solutions.

(iv) Description of methods to detect and prevent attacks including but not limited to Denial of Service and Intrusion.

3.5.3.1 ***Access Control***

(i) There shall be an identity and access management system which shall control and log the access control of all users to the smart grid systems.

(ii) The identity and access management system shall be able to define the access control levels of each user based on roles, responsibilities or hierarchy.

(iii) The identity and access management system shall be able to define which user can access which function of the individual systems. For example, the identity and access management system shall define which user can initiate a load disconnect function for a particular consumer, and therefore rest of the unauthorized users will not be able to perform load disconnect function.

(iv) The identity and access management system shall be integrated with rest of the Centralized Computer Systems.

3.5.3.2 ***Network Security:***

(i) Since Centralized Computer System has to access external environment through GPRS and Internet cloud it is important to have adequate network security systems.

(ii) There shall be intrusion detection and prevention systems deployed at the central layer.

(iii) There shall also be firewalls which will be a separate system from the intrusion prevention system.

(iv) The firewall shall control the demilitarized zones in the data centre and control room, and also the systems and ports which will be open to public network/ VPN.

(v) If fixed IP and operator VPN is not available/possible and Dynamic IP is being used, then the devices shall support SSL/VPN and the data shall be encrypted before send / received on GPRS/CDMA last mile network, for devices consisting of Smart Grid

System.

3.5.3.3 ***Systems and Data Security:***

(i) The systems deployed shall have the application scanning, hardware scanning tools in order to identify any vulnerability so as to mitigate any potential security threats.

(ii) The application databases shall have exclusive security tools in order to prevent any potential internal attacks like SQL injection etc.

(iii) The data shall be encrypted wherever supported by systems/devices/technology

3.6 Micro Grid

Objective:-Tap the potential for renewable resources, Improve power access in rural area, Reduced carbon emissions

This pilot project will be taken up in areas with existing distribution network but facing acute power shortage. The various combination of proportion of wind, hydel and solar projects to be listed based on available potential of these non-conventional resources. This list will include the proposed capacity and likely availability of each component. For example, by having 12 MW RE farms, commissioned at a remote site and feeding to project area and with typical availability of 75%, 9 MW of equivalent energy for 200 days can be harnessed which will be about 15MUs This would contribute towards green energy and reduction of carbon foot print. The following needs to be provisioned.

(i) Renewable integration

(ii) Two way metering with feed-in tariffs or two separate meters

(iii) Remote Terminal Units to monitor micro grid

(iv) Communication to data centre

(v) Analytics, with asset mapping

(vi) Grid-isolation mechanism

(vii) Change in protection system to compensate for source intermittency

(viii) Cyber Security tools and applications

(ix) Tools for software application and Network Management

(x) Energy Storage solution as applicable

3.6.1 Technical Issues of Integration

Integration of Renewable sources improves reliability of smart grid but poses a variety of issues like dynamic response and advanced protection to take into account the bidirectional flow of power. When Renewable energy sources are connected to the distribution system, the power flow gets altered and this would necessitate a change in the protection system settings. Also, sudden connection or disconnection of renewable energy sources due to faults etc. may result in unacceptable transients in voltages in the distribution system which needs to be addressed. These and other issues if any shall become part of the solution designed for managing Renewable Integration

3.7 Distributed Generation

Objective:- Sustainable growth, , Improve power access in rural area

Development and implementation of new and innovative technologies for distributed generation. Includes technology, products, and vendors and solutions evaluation and design of suitable solution for managing renewable integration. Examples are technologies and solutions related to EV/PHEV (Plug-in Hybrid and/or Electric Vehicles), wind, photovoltaic and other distributed generation technologies, systems and solutions supporting flexibility of interaction with customers, energy usage/exchange, demand and losses management, management of transactions, pricing and billing, etc. Proposal may include evaluation of state of technology and industry lessons-learned, implementation of technologies and subsequent maintenance and operation, and other services. The pilot will include

(i) Two way AMI metering with feed-in tariffs
(ii) Mechanism to send only excess power to the grid
(iii) Grid-isolation mechanism
(iv) Cyber Security tools and applications
(v) Tools for software application and Network Management

Technical Issues of Integration

Integration of Renewable sources improves reliability of smart grid but poses a variety of issues like dynamic response and advanced protection to take into account the bidirectional flow of power. When Renewable energy sources are connected to the distribution system, the power flow gets altered and this would necessitate a change in the protection system settings. Also, sudden connection or disconnection of renewable energy sources due to faults etc. may result in unacceptable transients in voltages in the distribution system which needs to be addressed. These and other issues if any shall become part of the solution designed for managing Renewable Integration

The detailed functionalities of Smart grid pilots are at Appendix-I

3.8 System Specifications

SI should give detailed specifications for the following equipment (as applicable):

The proposed system specifications are to be included in the technical proposal for evaluation.

- Meters
    - Manufacturer
    - Model
    - Module Description
    - Accuracy
    - Memory size
    - Parameters that can be captured
    - Interfaces and protocols
    - Standards that it complies
    - Power source/capacity
    - Others
- Other Hardware Components/Field Devices
    - Manufacturer
    - Model
    - Power rating
    - Interfaces and protocols
    - Processor(if exists)
    - Memory size
    - Others
- Software
    - Programming language/platform
    - Database description

  - Licenses
  - Scalability
  - Interfaces and protocols
  - Use Case
  - Response time
  - Tools for managing application
  - Minimum Hardware and Operating System requirements
  - Others
- Communications Networking
  - Technology
  - Equipment Model
  - Manufacturer
  - Interfaces and Protocols
  - End to end Capacity
  - End to end Latency
  - Others

- Communications Network Equipment
  - Manufacturer
  - Model
  - Interfaces and protocols
  - Capacity
  - Throughput
  - Power Rating
  - Others

- IT systems
    - Describe as applicable
- Standards (IEC, BIS, IEEE etc.)

  Names of standards and areas of application
- Data Collection Equipment
    - Model
    - Channels and Capacity
    - Data storage capacity
    - Power rating
    - Interfaces and protocols
    - Others

4 Training Requirements

(a) SI should facilitate training for the following: (These are suggestive courses-to be finalized detailed engineering stage)

Item No.	Description	No. of Trainees	Duration in weeks		Total Man-weeks	
			At Employer/Utility's facility	At Contractor's facility	At Employer/Utility's facility	At Contractor's facility
1	Smart Grid components Hardware and Software Course	6	0	2	0	12
2	Database, Report and Analytic Building Course	4	2	0	8	0
3	Application Software	5	2	2	10	10
4	Operator training	8	1	0	8	0
5	Network and Cyber Security Training course	2	1	1	2	2
	Total	**25**	**6**	**5**	**28**	**24**

(b) Training shall be conducted by Contractor personnel who are experienced instructors and speak understandable English.

(c) All necessary training material shall be provided by the Contractor. Each trainee shall receive individual copies of all technical manuals and all other documents used for training.

(d) Class materials, including the documents provided to the trainees as well as class handouts, shall become the property of Employer/Utility. Employer/Utility reserves the right to copy such materials, but for in-house training and use only.

(e) Hands-on training shall utilize equipment similar to that being supplied under the contract. In general training duration shall be 50% for hands on except database and dispatcher which could go up to 80% for hands on training.

(f) For all trainees the travel (e.g., airfare) and daily expenses will be borne by the Employer/Utility.

(g) The Contractor shall quote training prices individually for each of the courses as per Table 4-1.

(h) The schedule, location, detailed contents and batches for training for each course shall be finalized during detail engineering. The number of participants in the training program may undergo change.

(i) Employer/Utility will have the option to cancel any or all training courses. In the case of cancellation, the rate quoted against the respective course will not be paid to the Contractor.

The training courses, their duration, and the number of Employer/Utility's personnel to be trained in each course are identified in Table 4-1. Employer/Utility training course requirements are described below in terms of the contents of each course to be provided. Training shall be provided on supplied system database for the application software course, database and display building, the operator training course and the associate training courses.

4.1 Database, Report and Analytic Building Course

The database and Report and Analytic Building course shall be primarily a hands-on course. The course shall be designed to train Employer/Utility personnel in how to develop the databases, displays, reports and configure analysis for the supplied smart grid system components.

Course objectives shall include:

(a) How to identify database fields, entries, records, tables and contents

(b) How to build tables, arrays and report formats.

(c) How to build report and displays

(d) How to perform database maintenance

(e) How to generate the database from source information

(f) How to Track and reverse database changes

(g) How to do Online editing of Databases and Report

(h) How to generate reports using database queries and Web Services.

On course completion, all participants shall be able to prepare the necessary input data to define the system operating environment, build the system database, build business intelligence case analysis and reports and prepare the database administrator to maintain and modify the database and its structures.

4.2 Smart Grid components Hardware and Software Course

The training course shall be designed to give Employer/Utility personnel sufficient knowledge of the overall design and operation of the system so that they can correct the problems, configure the hardware, perform preventive maintenance, run diagnostic programs and communicate with contract maintenance personnel. The following subjects shall be covered:

(a) System Hardware Overview: Configuration of the system hardware. Preventive maintenance techniques and diagnostic procedures for each element of the system, e.g., processors, auxiliary memories, LANs, DCU, Meters, routers, firewall, IPS, IDS and printers.

(b) System Expansion: Techniques and procedures to expand and add equipment such as meter, printer, communication channels, router ports, router firewalls, DCU, work stations and control centres.

(c) System Configuration & Maintenance: Procedures of configuring Router ports, VLANs, Firewall Policy definitions and Interfacing web services. Basics of operation and maintenance of the redundant hardware configuration, fail over and fail over switches.

(d) Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Employer/Utility equipment, or on similarly configured systems.

(e) System Administration: Familiarization to system architecture, Effect of tuning/configuration parameters of OS software, System Software, Application Software, Network software, database software, firewall, IPS antivirus etc. on the performance of the system, Administration of Database.

(f) Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service and Employer/Utility functions; and system expansion techniques and procedures.

(g) System Initialization and Failover: From cold warm setup Including design, operation and practice

(h) Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,

(i) Software Documentation: Orientation in the organization and use of system software documentation.

(j) Hands-on Training: with allocated computer time for trainee performance of

unstructured exercises and with the course instructor available for assistance as necessary.

(k) System hardening and Cyber security: Orientation in changing defaults parameters (hardware and Operating System) to harden the systems cyber security posture.

4.3 Application Software Course

The Contractor shall provide a comprehensive application software courses covering all applications. The training shall include:

(a) Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.

(b) Application Functions: Functional capabilities, configuration, associated maintenance and expansion techniques.

(c) Software & Protocol Administration: Techniques and conventions to be used for the preparation and integration of new software functions including Application Program Interface (API) interfaces and Web services. This shall also include configuration of system for Security Web services, OPC and other Standards specified in the Specification.

(d) Cyber security related features of application: e.g. user authentication, encryption, etc.

4.4 Operator Training

Operator training shall familiarize EMPLOYER/UTILITY PERSONNEL's for operation of delivered system operation. The training shall include user displays, on demand data acquisition, remote and local configuration, management and download as well as connect disconnect.

4.5 Network and Cyber Security Training course

The course shall familiarize trainees with requisite skills for network partitioning, configuration & diagnostics for security equipment such as IPS, IDS, and firewalls, signature as well as patch update for equipment. The course shall familiarize and develop participant's skills about possible cyber incidences, response and mitigation methods for delivered systems and components including but not limited to SQL injection, virus, buffer overflow etc.

5 Project Management, Testing and Documentation

5.1 Project Management

Employer/Utility will designate a Project Manager (PM) to coordinate all Employer/Utility project activities. PM in association with partner organization like POWERGRID or CPRI will lead the Smart Grid effort. PM will be responsible for the direction and administration of contract. Regulatory changes, wherever required will be issued by the concerned agency for successful implementation of the project.

The Contractor shall assign a Project Manager with the authority to make commitments and decisions that are binding on the Contractor. All communications between Employer/Utility and the Contractor shall be coordinated through the Project Managers. The Project Managers shall also be responsible for all communications between other members of the project staffs including sub-contractor, if any.

SI should follow the Project Managers direction and make all out efforts to complete the project in given time schedule.

Project plan should be prepared by SI in tools such as MS Project and tracking should also be done using the same tool. SI is to provide the project management software license used for preparing project plan, as part of the project to facilitate Employer/Utility in managing the project.

Team size and skill set of personnel proposed to be deployed for the project should be submitted by the SI along with the proposal.

Weekly progress reports should be made by the SI, highlighting the critical area and Report on Project management metrics as suggested below:

5.1.1 Metrics and measures

Following metrics is suggested to be included in progress reports wherever applicable :

5.1.1.1 *Customer Level Metrics*

The number and percentage of customers and the amount of load served by the following will be measured:

- AMI
- Dynamic Pricing (CPP and TOU)
- Load Management and Direct Load Control

- In-home Customer Equipment
- Grid Connected Renewable Distribution

Additional customer level metrics will include asset utilization improvements.

5.1.1.2 *Distribution Level Metrics*

The number and percentage of installations and magnitude of total load served by:

- Substations or feeder lines that use automation equipment

In addition to the above, system losses and increased efficiency and reliability will be measured.

5.1.1.3 *Employer/Utility Operational Performance Metrics*

The Utilities plan to utilize the information provided by the Smart Grid project to further enhance and to optimize system and Employer/Utility operations:

- Load Profile Data from individual customers will be aggregated to provide more accurate information on transformer and equipment loading for more efficient application and design optimization.
- Rate Structures – the hourly, possibly 15 minute, interval data provided by AMI will be used to optimize new dynamic rate structures.
- Peak Load Analysis – analysis of demand response program and peak load reduction.
- Outage Management
- Reduce system losses and outage times while optimizing the design process for equipment loading and operations based on system data.
- Discover effects of demand response, direct load control, and technological support of distributed generation dispatch, control and demand-side management

5.2 Project Schedule

A tentative project schedule is included in the proposal at Annexure-3 . Based upon this the SI shall submit a preliminary project implementation schedule along with the bid. A detailed project schedule shall be submitted for approval by Employer/Utility within one month of the signing of the Contract. The duration of project activities and scheduling of deliverables in the detailed schedule shall be the same as in the tentative schedule included in the proposal, except as otherwise agreed during Contract negotiations.

It shall include at least the following activities:

(i) Site Survey

(ii) Testing at Site for interface with existing systems

(iii) Documents, DRS, Drawing submission and approval

(iv) Database development

(v) Type Testing Schedule

(vi) Hardware purchases, development/manufacturing and integration

(vii) Dispatch Schedule

(viii) Receipt, Storage, Installation & Field update schedule

(ix) Factory & Site Testing Schedule

(x) Training schedule

The project implementation schedule shall include the estimated period for completion and its linkage with other activities. The Project implementation schedule shall also contain Employer/Utility activities required for the Contractor to complete the system.

5.3 Progress Report

A detailed progress report shall be prepared by the Contractor each month against the activities listed in the project schedule, in addition to weekly reports. The monthly report shall be made available to Employer/Utility on a monthly basis, e.g., the 10th of each month and it should include project tracking in the soft copy as well. The progress report shall include all the completed, ongoing and scheduled activities and transmittals issued and received for the month.

5.4 Project correspondence Procedures

Every document, letter, progress report, change order, and any other written transmissions exchanged between the Contractor and Employer/Utility shall be assigned a unique transmittal number. The Contractor shall maintain a correspondence index and assign transmittal numbers consecutively for all Contractor documents. Employer/Utility will maintain a similar correspondence numbering scheme identifying documents and correspondence that Employer/Utility initiates.

5.5 Review Meetings

Progress meetings shall be scheduled by the Project Manager and attended by the Contractor and Employer/Utility each reporting period to review progress of the project. Progress meetings shall be used to review the progress report, written correspondence exchanged since the last

meeting, and open action items.

The Contractor shall also attend technical meetings as required to discuss technical aspects of the project and to review Employer/Utility comments on approval documents. When appropriate, these technical meetings shall be conducted as extensions to the progress meetings.

5.6 Quality Assurance & Testing

5.6.1 Inspection and Test

All materials furnished and all work performed under this Specification shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, all deficiencies have been corrected to Employer/Utility's satisfaction, and the equipment has been approved for shipment by Employer/Utility.

Should any inspections or tests indicate that specific hardware, software or documentation does not meet the Specification requirements, the appropriate items shall be replaced, upgraded, or added by the SI as necessary to correct the noted deficiencies. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The test shall be considered complete when (a) when all variances have been resolved (b) all the test records have been submitted (c) Employer/Utility acknowledges in writing the successful completion of the test.

5.6.1.1 *Inspection*

Access to the SI's facilities while manufacturing and testing are taking place, and to any facility where hardware/software is being produced for Employer/Utility shall be available to Employer/Utility representatives. The SI shall provide to Employer/Utility representatives sufficient facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification. Inspection rights shall apply to the SI's facilities and to Sub vendor facilities where equipment is being manufactured.

Inspections will be performed by Employer/Utility, which will include visual examination of hardware, enclosure cable dressings, and equipment and cable labeling. SI documentation will also be examined to verify that it adequately identifies and describes all wiring, hardware and spare parts. Access to inspect the SI's hardware quality assurance standards, procedures, and records that are applicable to the facilities shall be provided to Employer/Utility.

Employer/Utility representatives shall be allowed access to the SI's facilities during system manufacturing and testing and to any facility where hardware or software is being produced. Office facilities, equipment, and documentation necessary to complete all inspections and to verify that the Smart Grid system is being produced and maintained in accordance with the Specification shall be provided to Employer/Utility's representatives by the SI.

Employer/Utility representatives shall be allowed to review and verify the functional implementation of the Smart Grid System informally in conjunction with scheduled project meetings at the SI's facilities. No test plans, procedures or reports are required to support these

informal software demonstrations.

Employer/Utility representatives shall be allowed to inspect the SI's hardware and software quality assurance standards, procedures, and records. Documents identified in the approved software quality assurance plan will be inspected to verify that the SI has performed the required quality assurance activities.

The inspection rights described above shall not apply to sub vendors supplying standard computer hardware, peripheral equipment, and third-party software products. The inspection rights shall apply to sub vendors developing new software for inclusion in the SMART GRID system and to sub-system suppliers.

All materials and parts of the system/sub-system to be supplied under the project shall be of current manufacturer from a supplier regularly engaged in the production of such equipment.

5.6.1.2 *Quality Assurance and Quality Control Program*

The SI shall maintain a Quality Assurance/Quality Control (QA/QC) program that provides that equipment, materials and services under this specification whether manufactured, designed or performed within the SI's plant, in the field, or at any Sub-Vendor source shall be controlled at all points necessary to assure conformance to contractual requirements.

The program shall provide for prevention and ready detection of discrepancies and for timely and positive corrective action. The SI shall make objective evidence of quality conformance readily available to the Employer/Utility.

Instructions and records for quality assurance shall be controlled and maintained at the system levels.

The SI shall describe his QA/QC program in the Technical Proposal, (along with samples from his QA/QC manual) and shall submit his QA/QC Manual for review and acceptance by the Employer/Utility.

Such QA/QC program shall be outlined by the SI and shall be finally accepted by Employer/Utility after discussions before the award of Contract. A Quality Assurance Program of the SI shall cover but not be limited to the following:

1. The organization structure for the management and implementation of the proposed Quality Assurance Program.
2. Documentation control system.
3. Qualification data for key personnel.
4. The procedure for purchase of materials, parts/components and selection of Sub-Vendor's services including vendor analysis, source inspection, incoming raw material inspection,

verification of material purchases, etc.

5. System for shop manufacturing including process controls.
6. Control of non-conforming items and system for corrective action.
7. Control of calibration and testing of measuring and testing equipment.
8. Inspection and test procedure for manufacture.
9. System for indication and appraisal of inspection status.
10. System for quality audits.
11. System for authorizing release of manufactured product.
12. System for maintenance of records.
13. System for handling, storage and delivery.
14. A Quality Plan detailing out the specific quality control procedure adopted for controlling the quality characteristics of the product.

The Quality Plan shall be mutually discussed and approved by the Employer/Utility after incorporating necessary corrections by the SI as may be required.

Neither the enforcement of QA/QC procedures nor the correction of work mandated by those procedures shall be cause for an excusable delay. An effective Quality Assurance and Quality Control organization shall be maintained by the SI for at least the duration of this Contract.

The personnel performing QA/QC functions shall have well-defined responsibility, authority, and organizational freedom to identify and evaluate quality problems and to initiate, recommend, or provide solutions during all phases of the Contract.

The QA/QC organization of the SI shall be an independent administrative and functional structure reporting via its manager to the SI's top management. The QA/QC manager(s) shall have the authority within the delegated areas of responsibility to resolve all matters pertaining to quality to the satisfaction of Employer/Utility when actual quality deviates from that stated in the Work Statement.

The SI shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employer/Utility's inspection of equipment/materials.

The Employer/Utility or his duly authorized representative reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the SI's/his vendor's Quality Management and Control Activities.

The scope of the duties of the Employer/Utility, pursuant to the Contract, will include but not be limited to the following:

1. Review of all the SI's drawings, engineering data etc.
2. Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the Contract.
3. Inspect, accept or reject any equipment, material and work under the Contract in accordance with the specifications.
4. Issue certificate of acceptance and/or progressive payment and final payment certificate
5. Review and suggest modification and improvement in completion schedules from time to time; and
6. Monitor the Quality Assurance program implementation at all stages of the works.

5.6.1.3 *Inspection Certificate*

The SI shall give the Employer/Utility two weeks in case of domestic supplies and six weeks in case of foreign supplies written notice of any material being ready for testing. Such tests shall be to the SI's account except for the expenses of the Inspector.

The Employer/Utility, unless witnessing of the tests is waived, will attend such tests on the scheduled date for which Employer/Utility has been so notified or on a mutually agreed alternative date. If Employer/Utility fails to attend the testing on the mutually agreed date, SI may proceed with the test which shall be deemed to have been made in the Inspector's presence and SI shall forthwith forward to the Inspector, duly certified copies of the test results in triplicate.

The Employer/Utility shall, within fourteen (14) days from the date of inspection as defined herein, give notice in writing to the SI of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The SI shall give due consideration to such objections and shall make the modifications that may be necessary to meet said objections.

When the factory tests have been completed successfully at the SI's or Sub-Vendor's works, the Employer/Utility shall issue a certificate to this effect within fourteen (14) days after completion of tests but if the tests are not witnessed by the Employer/Utility, the certificate shall be issued within fourteen (14) days of receipt of the SI's Test Certificate by the Employer/Utility.

The completion of these tests or the issue of the certificates shall not bind the Employer/Utility to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

In cases where the Contract provides for tests, whether at the premises or works of the SI or of any Sub-Vendor, the SI except where otherwise specified shall provide free of charge items such as labour, materials, electricity, fuel, water stores, apparatus and instruments, as may be

reasonably demanded by the Employer/Utility or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall provide facilities to the Employer/Utility or his authorized representative to accomplish testing.

The inspection by Employer/Utility and issue of Inspection Certificate thereon, shall in no way limit the liabilities and responsibilities of the SI in respect of the agreed Quality Assurance Program forming a part of the Contract.

The SI shall keep the Employer/Utility informed in advance of the time of starting of the progress of manufacture of material in its various stages so that arrangements can be made for inspection.

Record of routine test reports shall be maintained by the SI at his works for periodic inspection by the Employer/Utility's representative.

Certificates of manufacturing tests shall be maintained by the SI and produced for verification as and when desired by the Employer/Utility. No material shall be dispatched from its point of manufacture until it has been satisfactorily inspected and tested. Testing shall always be carried out while the inspection may be waived off by the Employer/Utility in writing only.

However, such inspection by the Employer/Utility's representative(s) shall not relieve the SI from the responsibility for furnishing material, software, and equipment to conform to the requirements of the Contract; nor invalidate any claim which the Employer/Utility may make because of defective or unsatisfactory material, software or equipment.

5.6.1.4 *Test Plans & Procedures*

Test plans and test procedures shall be provided by the SI, for all tests to ensure that each factory and field test is comprehensive and verifies the proper performance of the SMART GRID elements under test for Employer/Utility approval before the start of testing.

The SI shall prepare detail testing procedure in line to specification and submit for Employer/Utility’s approval. The procedure shall be modular to the extent possible, which shall facilitate the completion of the testing in the least possible time.

During the development of test plans and test procedures for the system, emphasis shall be placed on testing each conditional logic statement, checking error conditions, and documenting the simulation techniques used. The test plans and test procedures shall be modular to allow individual test segments to be repeated as necessary. They shall be subject to Employer/Utility approval.

Test Plans

The test plans shall describe the overall test process, including the responsibilities of individuals

and the documentation of the test results. The following shall be included in the test plans:

(a) Test schedule on a day-by-day basis

(b) Responsibilities of SI and Employer/Utility personnel

(c) Record-keeping assignments, procedures, and forms

(d) Procedures for monitoring, correcting, and retesting variances

(e) Procedures for controlling and documenting all changes made to the hardware and software after the start of testing

(f) Block diagrams of the hardware test configuration, the external communication channels, and any test or simulation hardware.

Test Procedures

The test procedures shall describe the individual tests segments and the steps comprising each segment, particularly the methods and processes to be followed. The test procedures shall include the following items:

(a) Name of function to be tested

(b) References to the functional, design, user, and any other documents describing the function

(c) List of test segments to be performed and the purpose of each test segment

(d) Set-up conditions for each test segment, including descriptions of the test equipment

(e) Descriptions, listings, and instructions for test software tools and displays if any.

(f) Step-by-step descriptions of each test segment, including user actions for each test step

(g) Expected results for each test segment, including pass/fail criteria

(h) Descriptions of the techniques and scenarios to be used to simulate system field inputs and controlled equipment

(i) Copies of any certified test data to be used in lieu of testing.

Test Records

The complete record of all factory and field acceptance tests results shall be maintained by the SI. The records shall be maintained in a logical form and shall contain all the relevant information. The test reports shall be signed by the testing engineer and the engineer witnessing the tests. The records shall be keyed to the test procedures. The following items shall be included in the test records:

(a) Reference to appropriate test procedure

(b) Date of test

(c) Description of any test conditions, input data, or user actions differing from that described in the test procedure

(d) Test results for each test segment including a pass/fail indication

(e) Identification of SI's test engineer and Employer/Utility's representative if any.

(f) Provision for comments by Employer/Utility's representative

(g) Copies of any variance reports generated

(h) Copies of reports, display copies, and any other hardcopy generated as part of the test.

Reporting of variances

Starting from the dry run test period, a variance report shall be prepared by SI personnel each time a deviation from the requirements of this Specification is detected in areas such as system functions, design parameters, performance, documentation, test plans, and test procedures. All such variances shall be closed in mutually agreed manner.

However, at any stage if Employer/Utility feels that quality of variances calls for suspension of the testing the testing shall be halted till satisfactory resolution of variances, which may involve retesting also.

The report shall include a complete description of the variance, including:

(a) Sequential identifying number assigned to the variance

(b) Date and time the variance was detected

(c) Appropriate references to the test procedures and this Specification

(d) Description of test conditions at the time the variance was detected

(e) Identification of SI and Employer/Utility representatives

(f) Estimated date and time when variance is expected to be fixed

(g) Description of the corrective actions taken (to be completed as part of the variance resolution process)

(h) Dated signature lines for the Employer/Utility and SI representatives to signify reporting and correction of the variance.

Each variance shall be assigned to one of three classes defining the action to be taken to resolve the variance:

(a) Class 1: Testing will immediately stop and the SI will evaluate and correct the variance before testing is resumed

(b) Class 2: Testing will continue and the variance will be evaluated and corrected by the SI at the end of the current session but prior to further testing

(c) Class 3: Testing will continue and the variance will be evaluated and corrected at a mutually

agreed upon time.

The class shall be assigned by the SI with Employer/Utility approval.

Variance reports shall be available to Employer/Utility for review and comment at all times and shall be submitted by the SI to Employer/Utility at the start of the availability test. The SI shall maintain and periodically distribute a variance summary that lists for each variance the report number, a brief description of the variance, its class, and its current status (open or resolved). A variance summary shall also be submitted with the progress report.

All actions taken to correct variances shall be documented on the variance report by the SI. Sufficient information shall be provided to enable an Employer/Utility representative to determine the need for and extent of retesting, the need for testing interactions of the correction with any previously tested hardware or software, and the need for updating appropriate documentation. A variance shall be deemed resolved after retesting has been performed to the satisfaction of Employer/Utility and the SI and Employer/Utility representatives have acknowledged correction of the variance on the variance report.

5.6.1.5 *Test Initiation*

The following conditions must be satisfied before starting any test

(a) All test plans and procedures for the test shall be approved by Employer/Utility.

(b) All hardware and software engineering **design change orders** shall be incorporated into the system under test.

(c) All relevant documentation including drawings, lists of deliverables, and software functional and design documents, and user manuals shall be approved by Employer/Utility.

(d) A complete regeneration of the software under test shall be performed immediately prior to the start of factory testing.

(e) All operating system parameters, files, and configuration information shall be saved to archive media so that the Smart Grid Systems operating environment can be recreated starting with an un-initialized system. The existence and completeness of this data shall be demonstrated to Employer/Utility.

(f) All database, display, and report definitions shall be saved to archive media so that the databases, displays, and reports can be recreated if necessary.

(g) The image backup of all applications of Smart Grid Systems shall be taken on the archive media so that Smart Grid systems software can be regenerated if necessary.

(h) A complete dry run of each factory test (excluding the integrated system test) shall be conducted by the SI using the approved test plans and test procedures. Written certification that the dry run has been successfully completed shall be provided to Employer/Utility at least one week prior to the start of each factory test. At Employer/Utility's option, Employer/Utility representatives will witness and participate in the dry run of any test.

5.6.1.6 *Test Completion*

A test shall be deemed to be successfully completed only when:

(a) All variances have been resolved to the satisfaction of Employer/Utility

(b) All test records have been transmitted to Employer/Utility

(c) Employer/Utility acknowledges, in writing, successful completion of the test.

5.6.1.7 *Test Suspension*

Any time Employer/Utility representatives believe that the quantity or severity of variances warrants suspension of any or all testing, the test shall be halted, remedial work shall be performed, and the complete test shall be repeated. The repeat of the test shall be scheduled for a date and time agreed upon by both the SI and Employer/Utility.

5.6.1.8 *Factory Test*

The factory tests shall be conducted on all the equipment and shall include, but not be limited to the following, appropriate to the equipment being tested:

1. Verification of all functional characteristics and requirements specified.
2. Inspection and verification of all construction, wiring, labeling, documentation and completeness of the hardware

Before the start of factory testing, the SI shall verify that all changes applicable to the equipment have been implemented. As a part of the factory tests, unstructured testing shall be performed to allow Employer/Utility representatives to verify proper operation of the equipment under conditions not specifically tested in the above structured performance test. The SI's test representative shall be present and the SI's technical staff members shall be available for consultation with Employer/Utility personnel during unstructured test periods. All special test facilities used during the structured performance test shall be made available for Employer/Utility's use during unstructured testing.

Factory Test Requirements:

The database, displays and the report formats developed by the SI shall be demonstrated and verified by the Employer/Utility before factory testing.

All Field Device, SMART GRID SYSTEMS functions, communication & networking systems as well as performance shall be tested and demonstrated. The Employer/Utility will participate in and witness these tests.

The SI shall also carry out testing of the standard protocol implementation for successful integration by interfacing with existing Systems before the FAT starts. The database, displays and the report formats developed by the SI for Central System shall be verified by the Employer/Utility before factory testing.

All hardware and software associated with SMART GRID SYSTEMS shall be staged and completely

tested with simulated data at the SI's facility.

The MICC for all hardware shall be issued only after successful completion of FAT as per specification. At least 10 Field Devices for each protocol shall be connected with each central system and the remaining Field devices shall be simulated in the factory test environment. The data exchange between central systems shall also be simulated in the factory test environment.

The SI is responsible for conducting all factory tests. Employer/Utility will witness all tests and will perform selected test procedures. Knowledgeable SI personnel shall be present at all times to assist Employer/Utility representatives with factory testing as needed. Employer/Utility will not accept un-witnessed test results of any hardware or software without previous written authorization.

Each of the factory tests described below (i.e. the hardware integration test, the functional performance test, and the integrated system test, unstructured tests) shall be carried out under factory test.

Hardware Integration Test

The hardware integration test shall confirm that the computer hardware conforms to this Specification and the SI-supplied hardware documentation. The hardware integration test shall be performed when the computer hardware has been installed in the SIs factory. The operation of each item shall be verified as an integral part of the system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. Equipment expansion capability shall also be verified during the hardware integration test.

Functional Performance Test

The functional performance test shall completely verify all features of the Smart Grid Systems hardware and software. As a minimum, the following items shall be included in the functional performance test:

Inspection of all equipment for conformance to drawings/document and satisfactory construction and appearance

Testing of the proper functioning of all software, including test cases with normal and exception user-entered inputs and responses

1. Simulation of local error and failure conditions
2. Verification that ultimate expansion requirements are met.
3. Verification of data link interfaces with other Central systems
4. Verification of Field Device communication interfaces and data link interfaces with other central

systems.

5. Simulation of Field Device and data link communication errors and channel failures, including incorrect check codes and random channel noise bursts
6. Testing of all user interface functions, including random tests to verify correct database linkages
7. Simulation of hardware failures and input power failures to verify the reaction of the system to server and device failure
8. Demonstration of all features of the database, display, and report generators and all other software maintenance features
9. Demonstration of the software utilities, libraries, and development tools.
10. Verification that the computer system meets or exceeds Employer/Utility's performance requirements
11. Verification of the accuracy of hardware and software documentation via random tests
12. Testing of spare parts

5.6.1.9 *Integrated System Test*

The integrated system test shall verify the stability of the Smart Grid Systems hardware and software after the functional performance test has been successfully completed. During the integrated system test, all Smart grid Systems functions shall run concurrently and all SI-supplied equipment shall operate for a continuous 100-hour period. The test procedure shall include periodic repetitions of the normal and peak loading scenarios defined in specification. This minimum level of activity may be augmented, at the discretion of Employer/Utility, by other activities that represent normal day-to-day operation of the system as long as these activities are conducted in accordance with the training and documentation provided with the system. These other activities may include, but shall not be limited to, database, display, and report modifications, software development activities, configuration changes (including user-commanded server and device failovers), and the execution of any function described in this Specification.

The integrated system test shall assure Employer/Utility that the computer system is free of improper interactions between software and hardware while the system is operating as an integrated unit. In case during the 100 hour period testing uncommanded functional restart or server or device fail occurs the test shall be extended by 24 hours each time such a fail over occurs. Further the test shall not be conducted with the failed device.

Unstructured Testing

Periods of unstructured testing shall be allocated to allow Employer/Utility representatives to verify proper operation of the Smart Grid Systems under conditions not specifically included in the approved test procedures. Unstructured testing shall be conducted in compliance with the following conditions:

(a) A minimum of 25 percent of the actual test period shall be reserved for unstructured test of the system by Employer/Utility representatives

(b) The SI's test representative shall be present and the SI's other technical staff members shall be available for consultation with Employer/Utility personnel during unstructured test periods

(c) All simulation software, test cases, and other test facilities used during the structured portions of the factory tests shall be made available for Employer/Utility's use during unstructured testing

(d) Unstructured testing shall not begin prior to the start of the functional performance test

(e) Unstructured testing shall be allowed at Employer/Utility's discretion both at the end of a structured test segment and after completion of the functional performance test.

5.6.1.10 *Field Performance Test*

After the equipment has been installed, the SI shall start up and check the performance of the equipment of field locations. All hardware shall be aligned and adjusted, interfaces to all inputs and outputs installed, operation verified, and all test readings recorded in accordance with the SI's recommended procedures. The field performance test shall exhibit generally all functions of the equipment and duplicate factory test. All variances must be corrected prior to the start of the field performance test. The list of final tests to be carried out in the field shall be listed in the site-testing document.

5.6.1.11 Field Tests

The SI's maintenance records shall be reviewed prior to field (also referred as site) testing to identify all hardware and software modified, repaired, or replaced between the completion of factory tests and the start of field testing. Interfaces to all communications circuits shall be established by the SI and the proper operation of these circuits shall be verified.

For the purpose of interpreting the requirements for test plans, test procedures, test records, test initiation, and test completion, field testing shall be considered a single test accomplished for each computer system in three phases: (1) the field installation test, (2) Pre-field performance test, and (3) the field performance test.

1. Field Installation Test

The field installation test shall provide verification that computer system is operationally equivalent to the system that successfully completed factory testing. The responsibility for the conduct of the field installation test shall rest with the SI. Employer/Utility will witness all tests and will perform selected test procedures. Knowledgeable SI representatives shall be present at all times to assist Employer/Utility representatives with the testing.

The field installation test shall consist of the functional performance test to confirm operation of basic functions such as data acquisition, user interface, and the support and Employer/Utility functions. All hardware shall be tested by running diagnostics. The exact content of the field installation test shall be determined jointly by the SI and Employer/Utility.

2. Pre-Field Performance Test

After the field installation test, the SI shall: (1) verify the operation of FIELD DEVICE, data links and remote consoles (2) correct and update the database, reports, and displays (3) install and test Employer/Utility/owner-developed software if any and (4) establish connectivity with SMART GRID systems and other IT application provided by Employer/Utility/owner. The SI shall be responsible for providing and installing corrections for all variances found during this period prior to the start of the field performance test. Further the SI shall also train the dispatchers before field performance test starts.

3. Field Performance Test

After the completion of activities as per the clause "Test Duration and Criteria for Acceptance" clause, the SI shall conduct the field performance test to verify those parts of the functional performance test (as mentioned in the above clause of Pre-Field Performance Test) that were not fully tested as part of the field installation test. All variances found during this period shall be fixed by the SI or otherwise resolved to Employer/Utility's satisfaction prior to the start of the availability test.

The field performance test shall concentrate on areas of Smart Grid Systems operations that were simulated or only partially tested in the factory (e.g., system timing and loading while communicating with a full complement of Field Devices and data links and system reaction to actual field measurements and field conditions). The validity of factory test results determined by calculation or extrapolation shall be examined. The SI shall be required to repeat selected portions of the field installation test during the field performance test if Employer/Utility believes that previously tested functions have since been modified and are not operating in accordance with the Specification. Provisions for unstructured testing by Employer/Utility personnel shall be provided.

5.6.1.12 *Availability Test*

After field performance test, a 1000-hour availability test shall be conducted on supplied systems under normal day-to-day operating conditions. The test shall verify the reliability and integrity of the Field devices, Central Systems, Communication & networking systems, database, displays, report and all communication interfaces and, under these conditions, verify system availability for 99.5%. Further each server and device & field Devices if applicable shall meet a minimum availability of 98% individually. In case of Field Devices, if applicable , downtime of individual Field devices are to be excluded from system availability calculations, however, minimum 50% Field Devices shall be reporting for test to continue.

5.6.1.13 ***Test Responsibilities***

Employer/Utility will be responsible for conducting the availability test. The test shall consist of normal Smart Grid Systems operations without special test equipment or procedures. Test

records defined in the availability test plan and procedures will be maintained by Employer/Utility personnel. Employer/Utility/Owner will operate and maintain the system according to procedures described in the approved SI documentation. Smart Grid Systems maintenance on an on-call basis shall be provided by the SI during the availability test period. When on-site maintenance support is needed, qualified SI personnel shall arrive at the site within maximum four (4) hours of notification and shall keep Employer/Utility/Owner fully informed of the progress in problem resolution. For availability purposes, this service response time and the associated on-site maintenance time shall be taken into account as defined in Sections of "Downtime" & "Hold time".

The SI shall maintain an inventory of spare parts, which may be required to achieve the specified availability. These spares shall be in addition to the mandatory spares. All spare parts used during the availability test shall be drawn from SI's inventory.

During the availability test period, Employer/Utility reserves the right to modify the databases, displays, reports, and application software. Such modifications will be described to the SI at least 48 hours in advance of implementation to allow their impact on the availability test to be assessed, except where such changes are necessary to maintain control of the power system.

Downtime

Downtime occurs whenever the criteria for successful operation defined in Section "SI's Maintenance Responsibility till Operational Acceptance" mentioned below are not satisfied. Downtime shall be measured from the start of diagnostic procedures until full service is restored. In the event of multiple failures, the total elapsed time for repair of all problems (regardless of the number of maintenance personnel available) shall be counted as downtime. For onsite response the delay in response time (more than four hours) shall be added to downtime.

Hold time

During the availability test, certain contingencies may occur that are beyond the control of either Employer/Utility or the SI. These contingencies may prevent successful operation of the system, but are not necessarily valid for the purpose of measuring SMART GRID SYSTEMS availability. Such periods of unsuccessful operation may be declared "hold time" by mutual agreement of Employer/Utility and the SI. Specific instances of hold time contingencies are:

(a) Scheduled Shutdown: During scheduled shutdowns, or if an equipment failure occurs while its backup device is scheduled out-of-service, the resulting system outage shall be hold time, provided that service can be restored according to SI-specified procedures within 30 minutes.

(b) Power Interruption and Environmental Excursion: Loss of power or manual shutdown in the event of loss of environmental control shall be considered hold time. If the system is operated during periods of power or environmental conditions beyond those specified, any resultant

downtime shall also be considered hold time.

(c) Intermittent Failure: Periods during which an intermittent, recurring software or hardware failure is experienced will be considered hold time, provided that the SI is engaged in remedial action and normal functions can be restored by SI-defined procedures whenever the failure occurs. Instead of accounting for the actual intermittent downtime, one hour of downtime shall be counted for each 120 hours of otherwise successful operation while the problem persists.

(d) Failure of Employer/Utility's Software: Time during which the system is down due to failure of software written and independently produced by Employer/Utility shall be considered hold time. If a failure in such software cannot be overcome by SI- defined procedures, execution of the failed program will be suspended. Programs developed by Employer/Utility personnel under SI supervision are specifically excluded from this provision.

(e) Service Response Time:A maximum four (4) hours of hold time will be allowed for the SI to respond to each call for maintenance support. The time between detection of a failure and the start of diagnostic procedures shall also be considered hold time when performed by Employer/Utility's personnel.

(f) Corrected Design Defect: Hold time may be declared by mutual agreement to ensure against similar future occurrences if a failure occurs due to a defect in system design for which the SI defines and implements corrective measures. In such a case, hold time shall be allowed in increments of 120 hours to allow verification of the corrective action.

5.6.1.14 *Test Duration and Criteria for Acceptance*

After the elapse of 1000 hours of cumulative test time, the availability shall be calculated considering the downtime recorded. Should availability falls short of specified percentage, the SI may either (a) Continue the test by moving the starting time of the test forward and continuing the test until the consecutive hours have been accumulated and the specified availability has been achieved subject to maximum of 75 days, Or (b) the SI may restart the test for 1000 hours, however, more than two such restart shall not be allowed.

To establish that all failures have been satisfactorily repaired prior to the end of the availability test, no downtime, intermittent (hold time) failures, or more than one uncommanded fail over shall have occurred within 240 hours of the test's conclusion.

Criteria for successful operation

The Smart Grid system shall be designed to meet the total system availability of 99.5%. That is, the ratio of total operational time minus downtime to total operational time shall be equal to or greater than 0.999. Total operational time shall not include the hold time. The system shall be considered available as long as all the functional requirements defined under section-3 are available. Further each server and device and Field Devices shall meet a minimum availability of 98% individually.

5.6.1.15 *SI's Maintenance Responsibility till Operational Acceptance*

During this period, the SI shall make available resident Project Manager, hardware & software specialists, who shall be available upon notification by the Employer/Utility /Owner about any problem(s) that may exist. The SI's specialists shall be required to respond to the Employer/Utility/Owner's notification in line with the provisions of technical specifications. The SI shall replace or repair all defective parts and shall have prime responsibility for keeping the system operational.

5.6.1.16 *Type Testing*

Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

The SI shall submit, within scheduled period as per project plan, copies of test reports and certificates for all of the Type Tests that are specified in the specifications and that have previously been performed. These certificates may be accepted by the Employer/Utility only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical to those specified in this specifications carried out at nationally/Internationally accredited labs and witnessed by third party / customer's representatives .

Type Tests shall be performed for all equipment types for which certification is not provided as required in (a) above, or if it is determined by the Employer/Utility that the certification provided is not acceptable. If any of the type tests are required to be carried out, the same shall be carried out by the SI. The SI shall quote testing charges for each type test individually.

Type Tests shall be certified or performed by nationally/internationally reputed laboratories using material and equipment data sheets and test procedures that have been approved by the Employer/Utility. The test procedures shall be formatted as in the specifications and shall include a complete list of the applicable reference standards and submitted for Employer/Utility approval at least four (4) weeks before commencement of test(s). The SI shall provide the Employer/Utility at least 30 days written notice of the planned commencement of each type test.

The SI shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the Employer/Utility/ Consultant.

Testing charges for all the type tests listed in the specifications shall be indicated separately for each item (excluding expenses of Inspector/ Employer/Utility's representative) in the prescribed schedule of the bidding document. The total amount of these charges will be considered in the bid evaluation process.

The SI shall ensure that all type tests can be completed within the time schedule offered in his

Technical Proposal.

In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type tests at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

Documentation for all factory, field, and availability tests that apply to Owner's system shall be provided in accordance with the requirements defined in this section of specification.

5.7 Project Evaluation

High and low costs and benefits must be developed for each Smart Grid capability, including the evaluation of distribution system, environmental and customer benefits derived from the Pilot Project in terms of KPI improvements. After completion of Evaluation period we should be able to determine:

- What are the value prepositions of each functionality?
- What is the overall cost-benefit of a full deployment of smart grid capabilities?
- What are the key assumptions that drive this value?
- What are the biggest risks?
- What are the additional steps required to replicate Smart Grid project in other parts of country?

5.8 Maintenance & Support services

5.8.1 Introduction

The scope of maintenance work shall include a comprehensive maintenance of all the software and hardware provided by the contractor for the various systems and components of Smart Grid Pilot under this project. The maintenance practices to be followed shall be as per ISO 20000 Standard. The essence of the maintenance services is to provide maintenance support for the designated hardware and software, with the goal of meeting the availability as set forth herein. SI is to hand hold the EMPLOYER/UTILITY team to take over maintenance and support services after completion of SI's AMC period. The project/ system devices should allow their functionalities to be upgraded without disruption to the existing functionalities by downloading new software and configuration information.

5.8.1.1 *Maintenance support*

The period of maintenance support shall be the one year Warranty (Defect Liability) period commencing from Operational Acceptance and two year Maintenance period thereafter.

The nature of maintenance support required for the different type of systems and components are described in the Table 5.1 below:

Table 5.1 Maintenance support and Availability requirements

Sl.no.	System	System Availability requirements
1	Smart Grid IT, Communication and Surveillance System	99.5%

The system availability shall be measured for entire System. Similarly, the availability of various systems of Smart Grid System elements Hardware and Software, Field devices, Communication & Networking Systems shall be considered separately control Centres wise. Individual device availability shall be at least 98%.

For all third party equipment (Hardware & Software) and services (communications) Contractor shall have back to back support along with supply of spare and service level agreement with appropriate response time from OEM/OEM Authorized representatives. Contractor shall be responsible for coordination with the OEM for all matter related to that equipment. But the Contractor shall be responsible for meeting the overall response times and availability requirements specified below.

The maintenance of the System shall be comprehensive and shall comprise of the following category of works which is further elaborated for each of the different subsystems:

(a) Preventive Maintenance Activity (performance monitoring, system backup, patch management, updates and troubleshooting)

(b) Maintaining a minimum no. of specified spares.

(c) Integration of new equipment (Field devices, central systems, Communication & networking systems) and integration of a new or existing central system.

5.8.1.1.1 Preventive Maintenance Activity

The preventive maintenance activity are be performed by the Contractor to keep the system running at optimum level by diagnosis and rectification of all hardware and software issues and would broadly include

- There should not be any unnecessary and unscheduled downtime of system services
- Configuration of the replaced hardware and software, periodic routine checking as part of a preventive maintenance program (as described in further detail in this document) which would include checking of functionality of hardware and software,
- Monitoring of the performance of the system and doing necessary tuning for optimum performance to accommodate any changes such as addition of new components.
- Providing all necessary assistance to Employer/Utility for addition and modification of database and displays, Database sizing activities including Backup and restore of the system
- Restoration of the systems upon its failure and to restore the functioning of the various systems at the central systems
- Log analysis to zero in developing issues

Routine works and other day-to-day operational activity would primarily be the responsibility of Owner and in case of any difficulty in this regard the same shall be referred to the contractor for support.

5.8.1.1.2 Hours of Cover

The Contractor shall provide engineers who have an experience and skill to maintain the Smart Grid System to the desired level of availability. The contractor's on-site support for central systems, shall be standard hours of service i.e. Monday to Saturday- 9:00 am to 5:30 pm local time (IST), excluding public and Owner Company holidays, throughout a year. At least one experienced personnel having expertise in Smart Grid System shall be available during the standard hours of service. The timings for Emergency Support would be 24 hours a day, 7 days a week throughout the year.

The support personnel so deployed shall be qualified personnel having at least 5 years of experience in the delivered smart grid elements/parts. The contractor shall submit the CV's and recommendation letter from customers for all support personnel(s) to Employer/Utility for approval before deployment at site. The Employer/Utility can ask the Contractor to replace the personnel deployed for maintenance support if his performance is not found to be satisfactory.

5.8.2 Service Response requirements

The severity levels are defined in coming sections and the requirement of response time for various severity levels is defined below:

Emergency Support for Severity 1 issues are to be provided 24 hours a day, seven days a week. The on-call support team shall include all key technical competencies so that any aspect of a

system failure can be attended. The team shall comprise of experienced technical staff that are skilled in troubleshooting of the various systems covered under AMC. Severity 1 problems shall be reported by telephone for rapid response; target response times are defined in this section . For severity 1 problems, the key objective is to restore the system to an operational state as quickly as possible, including by a temporary workaround. Resolution of the defect may be completed during standard hours.

Severity 2, 3, and 4 problems shall be reported by Owner/Employer/Utility through a call tracking system to be provided by the contractor. Resolution of problems may also be provided by an individual fix that will be installed by the contractor at no extra cost to Owner.

5.8.3 Monitoring

The operation and performance of the various systems under AMC shall be monitored on a bi-weekly basis; the contractor shall review the following, analyze the results, and submit report to Owner. The contractor shall conduct at least the following monitoring, for the all Control Centres.

5.8.3.1 *Log Monitoring*

- System logs for a selected day
- System history log
- Aggregate data collection
- Events Collection

During monitoring if any defect/ abnormality is found, the contractor shall undertake corrective maintenance for the same.

5.8.3.2 *Resource Monitoring*

Resource Monitoring services comprises checking the system's major node resources, gather log data, analyze results, and advise Owner/Employer/Utility on the appropriate actions to be taken and undertake any agreed upon actions. The supplied system tools shall be used to continuously collect the following information:

- CPU loading (Peak and Average)
- Memory utilisation (Peak and Average)
- Disk utilization (Peak and Average)
- LAN utilization (Peak and Average)
- Operating system resource utilisation
- System error log

The SI shall submit the procedures details to meet the above along with the offer.

5.8.3.3 *Cyber security System monitoring*

The Contractor shall also be responsible for monitoring of the cyber security system. The logs of the system shall be analyzed for exceptions and the possible incident of intrusion/trespass shall be informed to the Employer/Utility.

The monitoring shall encompass the various cyber security devices installed at Control Centre such as firewalls, Intrusion prevention system (both network based and host based), routers. The Centralized Monitoring Console (CMC) shall monitor and continuously collect the above logs.

The Cyber security system shall also be subjected to Annual Security Audit from CERT-In listed auditors at the cost of the Contractor. Contractor shall implement the recommendations/remedial actions suggested by the Auditor after audit.

5.8.4 Patch Management

The contractor shall also be responsible for providing updates/patches for the software products supplied under the project. All other patches of third party product like Operating System and Anti-virus shall be tested by the Contractor prior to installing in the Employer/Utilitys network. Other products like IPS, Network IPS, Host based IPS, Firewalls shall also be provided with secure patch management. A secure patch management and deployment system is to be established which shall be provided with single point of Internet connectivity. All the patches shall be downloaded through this single point of connection. Internet connection shall also be provided and shall be shown in System Architecture diagram submitted during Bid submission.

Software updates and patches shall be applied while the system is in operation and shall not require a reboot (e.g. applied to one processor in a dual processor configuration). A secure (e.g. https) remote method of initiating a rollback to the software prior to the update or patch shall be provided.

SI to describe the method proposed to securely apply software updates and patches. SI to also specify the method proposed to use to securely initiate a rollback to the software state prior to an update or patch.

The Contractor shall describe a mechanism for patch management so that it is known that what patches have been applied, what all patches are pending but available with us and what is the recent release of patches for the various products as part of cyber security documentation. Any patch shall be applied only with express permission of the Employer/Utility's representative.

5.8.5 Physical maintenance

The contractor shall undertake physical maintenance of all equipment/modules under the scope of this contract, in accordance with this section. The physical maintenance shall include cleaning, dusting, inspection of equipment for loose connections, damage to insulation, pest infections etc. Equipment shutdown approval for preventive maintenance shall be required from Employer/Utility.

5.8.6 Spares inventory

The Contractor shall maintain a spares inventory at his own cost to meet the spare availability

requirements of the system. The spares shall be used as and when required and no separate charges are payable except the maintenance charges. The Contractor shall decide the items and components to be maintained as spare but a minimum number of spares as given **Table below** shall be kept at the respective Centres. This shall be periodically verified by the Employer/Utility. If the replenishment of the spare takes more than 30 days then it will be considered as non-availability as per **Severity-2**.

Table - 5.2 Mandatory Spares inventory at Control Centres

Sl.no	Item description	Unit	Qty
A	Servers	Lot	1*
	Work Station	Lot	1*
	Router and Switches	Lot	1*
	Communication Equipment	Lot	1*
	Field Devices	Lot	1*
	Meters DCU and other field devices	Lot	1*
* Note : One of each Type Supplied as part of system. Wherever one configuration can replace multiple type of elements supplied only 10% (Minimum one) such equipment shall be taken as spare			

(a) Integration of new equipment

All future Field devices & other System integration shall be the responsibility of contractor and shall be part of the maintenance charges.

(b) Problem/Defect Reporting

The SI shall propose an appropriate problem/defect reporting procedure to meet the requirement of all severity level cases along with the offer.

The problems will be categorized as follows:

Table 5-3 Severity Levels

Category	Definition
Severity 1 – Urgent	Complete system failure, severe system instability, loss or failure of any major subsystem or system component such as to cause a significant adverse impact to system availability, performance, or operational capability
Severity 2 – Serious	Degradation of services or critical functions such as to negatively impact system operation. Failure of any redundant system component such that the normal redundancy is lost Non-availability of Man-power at Central system during working hours, non-availability of spares
Severity 3 – Minor	Any other system defect, or unexpected operation not covered under severity 1 or 2
Severity 4 – General/Technical Help	Request for information, technical configuration assistance, "how to" guidance, and enhancement requests.

5.8.7 Severity levels

The detail of the systems under different severity levels is as below:

1. *Severity-1 (Urgent support)*

This support is required when there is a complete system failure, severe system instability, the loss/ failure of any major sub-system / system or its components, which may significantly impact the system availability, performance, or operational capability at central system. For example, loss of data to the operator due to any problem software/Hardware-related in Smart Grid System, outage of any important software functionality which is required to discharge operational functions, outage of both main and standby routers, and loss of data exchange with other computer systems or other Central systems would be included under this category. The failure of complete UPS (uninterrupted Power Supply) system resulting into loss of UPS output supply at both Output ACDB is covered under this category.

Upon receiving intimation, the representative of the contractor would immediately attend to the problem. The problem shall be attended by the contractor at the earliest, and it shall arrange all resources and take all steps to restore the data availability and functionality at the earliest.

2. *Severity-2*

Degradation of services or critical functions such as to negatively impact system operation.

Failure of one Data Server, stoppage of data collections for archiving, at the respective Central system, and outage of other applications not covered under severity-1 are included in this category.

Failure of one UPS system, Failure of Battery System and failure of any other system of Auxiliary Power supply not covered under Severity-1 are included in this category.

Coverage under this severity would be outages that do not immediately cause on line data loss but subsequently could result into Severity-1 category outage, loss of an important subsystem that may affect the day-to-day works and loss of archived data.

Failure of any redundant system component affecting the critical redundancy would also be included in this category.

Non-availability of designated contractor's Man-power at central system as well as required inventory of spares specified here will also be covered under this category.

3. Severity-3 (Standard support)

The support services included under this category are when the outage or loss of functionality is neither of an emergency nor priority functionalities as indicated in severity level 1 or 2 above.

4. Severity-4 (General Technical Help)

Request for information, technical configuration assistance, "how to" guidance, and enhancement requests are included under this category.

Response and Resolution Time

This section describes the target times within which the contractor should respond to support requests for each category of severity. The Initial Response Time is defined as the period between the initial receipt of the support request (through approved communications channels) and the acknowledgment of the contractor. The Action Resolution Time is the period between the initial response and the contractor delivering a solution. This period includes investigation time and consideration of alternative courses of action to remedy the situation. The Action is defined as a direct solution or a workaround.

Table: 5.4 Support Response/Resolution Time

able: 4.4 Support Response/Resolution Time

Severity	Initial Response time(Working Hours)	Initial Response Time(Non-working hours)	Action Resolution Time	Action

1	5 minutes	30 minutes	2 hours	An urgent or emergency situation requiring continuous attention from necessary support staff until system operation is restored – may be by workaround.
2	5 minutes	2 Hours	24 Hours	Attempt to find a solution acceptable to Owner/ Employer/Utility (dependent on reproducibility), as quickly as practical.
3	2 hours	1 day	2 days	Evaluation and action plan. Resolution time is dependent on reproducibility, ability to gather data, and Owner/ Employer/Utility's prioritisation. Resolution may be by workaround.
4	2 hours	1 day	2 days	Report on the problem/query is to be furnished.

(c) Availability and maintenance charges payment Calculation

It is the endeavor of both the contractor and Owner to maximize system availability to the extent possible. The contractor shall provide guaranteed availability for various types of Severity levels as specified in section above.

The non-availability hours for availability calculation shall be counted from the end of the allowed Action Resolution time. A standardized register shall be maintained at each site containing full details of each outages, actions taken by Owner to correct the problem, applicable Severity level, time of reporting to the contractor support engineer/support centre pursuant to the appropriate methods in the Agreement, allowed Response time as per the Response times defined in above section, actual Resolution time, and signature of Engineer-in-charge as well as the contractor's support engineer of the site.

Duration of outages over and above the Action Resolution time in each of the Severity levels shall be counted for the non- availability computation and shall be clearly brought out in the register. The resolution may be accomplished by a work around, and such solution shall mark the end of non-availability.

In the event of multiple failures at a site, due to a common cause, the first FPR (Field Problem,

Report) logged shall be used for the purpose of availability calculation.

5.8.8 Availability computation for System

Availability computation shall be done on per quarter per site basis. The formula to be used for availability computation shall be as under:

Availability per quarter (per site) = $\frac{THQ - (S1 \times 1 + S2 \times 0.8 + S3 \times 0.5)}{THQ} \times 100\%$

Where THQ is total hours in the quarter

S1 is the total non-available hours in Severity Level-1

S2 is the total non-available hours in Severity Level-2

S3 is the total non-available hours in Severity Level -3

5.8.9 Payment of maintenance charges (based on Smart Grid System availability)

In the event of availability below a certain level, the maintenance charges would be proportionately reduced as follows: The same shall be applicable for the Auxiliary Power supply system with the availability specified for the respective systems.

For Software:

Availability of central system / quarter	**Deduction as % of the apportioned price of total AMC (Software Portion) for central system portion of the contract applicable (quarterly software price)**
≥99.5%	NIL
Less than 99.5%	Deduction of 2% of the apportioned quarterly AMC charges for every 0.5% or part there of decrease in availability under 99.5%.

For Hardware:

Availability for each elements per quarter	**Deduction as % of the apportioned price of total AMC (Hardware portion) for central system portion of the contract applicable for that site (quarterly hardware price)**
≥98%	NIL

Less than 98%	Deduction of 2% of the apportioned quarterly AMC charges for every 0.5% or part there of decrease in availability under 98%.

5.8.10 Computation of Availability / Non-availability

The computation of Availability / Non-availability would be rounded up to 2 decimal places on quarterly basis and any deduction in the maintenance charges thereof would be calculated as stated above in aforementioned Section on pro-rata basis.

5.8.11 Contractor's Obligations

In order to optimize and improve the response of the system, the contractor may re-install the program modules in consultation with and after making the Owner / Employer/Utility engineer aware of the consequence (like data loss, database rebuild etc.).

Any modification of Field devices, software/Operating System required to restore functionality due to hardware upgrades, patches, or arising out of a necessity to fix FPRs (Field problem reports), would be done by the contractor at no extra cost to Owner / Employer/Utility.

The contractor will submit FSR (Field Service Report) and the steps taken to solve the problem, along with details of code changes.

5.8.12 Responsibilities of Owner /Employer/Utility

The responsibilities of the owner during the maintenance period are as follows:

(a) Employer/Utility shall ensure that proper Environmental conditions are maintained for the system.

(b) Employer/Utility shall ensure that the System is kept and operated in a proper and prudent manner as described in the system documentation provided by the Contractor and only trained Employer/Utility representatives (or persons under their supervision) are allowed to operate the system.

(c) Employer/Utility shall provide access to the sites of installation for purposes of providing Support Services.

(d) Employer/Utility shall provide the contractor with Space for Office for their maintenance staff and storage for spares.

(d) Responsibility Matrix

The table in this section provides a summary definition of the roles and responsibilities of the contractor and Employer/Utility.

Legend: ● This indicates who has primary responsibility to perform this function.

A This indicates who will provide assistance.

Table 5.5 Responsibility Matrix

Item	Task	Employer/Utility	Contractor
0.0	**PROBLEM IDENTIFICATION**		
0.1	Root cause analysis to determine whether the fault is attributable to Hardware or Software.	----	●
0.2	Resolution of problems involving third party maintainer where there is uncertainty whether the root cause is hardware or software.	----	●
1.0	**SOFTWARE PROBLEM RESOLUTION**		
1.1	Report problem and assist with problem identification	●	A
1.2	Provide or recommend corrections, temporary patches, workarounds or other fixes to system problems	----	●
1.3	Install and test corrections, temporary patches, workarounds or other fixes to system problems	----	●
2.0	**ROUTINE SOFTWARE SUPPORT**		
2.1	Build and maintain database, displays and reports	●	A
2.2	Perform system back-ups	----	●
2.3	Restore or reinstall software from back-ups	----	●
2.4	Monitor system logs (part of remote monitoring service)	----	●

2.5	Maintain system logs	----	●
2.6	Maintain user accounts	●	A
3.0	**HARDWARE PROBLEM RESOLUTION**		
3.1	Report problem and assist with defining problem	●	A
3.2	Troubleshoot problem to diagnose if it is software-related or hardware-related	----	●
3.3	Identify failed component, Replace failed components in online system using parts from spares inventory	----	●
3.4	Restore operation of repaired/replaced equipment	----	●
4.0	**HARDWARE SPARE PARTS**		
4.1	Manage local spares inventory	----	●
4.2	Replenish local spares inventory	----	●
5.0	**INTEGRATION AND DATABASE WORK AT CONTROL CENTRE END**		
5.1	Field device Integration	----	●
5.2	Other system Integration	----	●
6.0	**AUXILIARY POWER SUPPLY SYSTEM**		
6.2	Troubleshoot problem to diagnose	----	●
6.3	Replenish local spares inventory	----	●

7.0	CYBER SECURITY MONITORING		
7.1	Patch Updates	----	●
7.2	Cyber Security Monitoring	●	A
7.3	Annual Audits	----	●
7.4	Implementation of Recommendations during Audit	----	●
7.5	Maintenance of Spares	----	●

5.9 Documentation

The Contractor shall submit a comprehensive list of the documents as applicable for the offered system for Employer/Utility's approval after signing of the contract and the documents shall be finalized as per the approved list. The schedule for submission/approval of documents shall be in line with the overall project schedule.

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Contractor shall submit documentation describing the systems to Employer/Utility for review and approval. Further the Contractor shall also submit the drawings/documents for all the hardware & software required for site installation, testing and commissioning and thereafter operation of the system. The Contractor shall obtain approval of Employer/Utility for the relevant document at each stage before proceeding for purchase, manufacturing, system development, factory testing, erection, site testing, training etc.

Each document shall be identified by a Contractor document number, the Employer/Utility document number, and the Employer/Utility purchase order number. Where a document is revised for any reason, each revision shall be indicated by a number, date, and description in a revision block along with an indication of official approval by the Contractor's project manager. Each revision of a document shall highlight all changes made since the previous revision.

The Contractor shall submit two hard copies of each document/drawing for Employer/Utility's review and approval along with soft copy with each submission. After approval two set of all the documents shall be submitted as final documentation, however, for site specific documents two sets of documents shall be provided for each site. Any changes observed during field implementation shall be incorporated in the as-build drawing and required sets of same shall be

submitted to Employer/Utility. In addition to hard copies all documentation shall be provided in electronic form preferably in pdf format. These documents shall be editable, searchable and printable. For this a web based "Document Management System" (DocMS) software shall be supplied and installed at the Employer/Utility's facility by the contractor along with minimum 100 number of client access licenses. DocMS shall have multiuser capability with user role and privileged management. DocMS shall have complete capability of tracking the documents version, Ownership and editing. This DocMS shall be used as central document repository for the entire lifecycle of the Project for easy managing and referencing of the project documentation. This Document Management System shall have a facility to integrate the Employer/Utility's made documentation for system Operation to be used by Operator. In case any documentation requirement is specified in the relevant section the same shall apply for the equipment /system defined in that section.

The following document shall be submitted in soft(Editable and printable) as well as hard copy as applicable for the subsystem.

(a) Document Plan
(b) Document identification plan
(c) System Description Documents (Overview)
(d) Functional Cross Reference Document
(e) Data Requirement sheets
(f) Data base Documents
(g) Drawings/Documents for manufacturing/Assembly of the equipment/system
(h) Drawings/Documents for installation of the equipment/system at site
(i) Software description/design documents for each module
(j) Factory Test report
(k) Manuals for each equipment
(l) System Configuration Parameter Details
(m) Site Testing documents
(n) System Security Manual
(o) System Maintenance Manual including preventive and breakdown maintenance procedures
(p) Training documents
(q) System Administrator Documents
(r) User guide for Operator
(s) Software Licenses
(t) Type test reports

(u) Sizing calculations

(v) Cable sizing calculations

(w) Inventory of the hardware

(x) Panel General and Internal Arrangement drawing indicating modules, components location etc.

(y) Installation drawing.

(z) Schematic drawing.

(aa) Cable laying & termination schedule details

(bb) Communication Channel Plan

(cc) Firewall and security setup and configuration check list

(dd) Use cases description for all the activities of the pilot

The Contractor shall also supply two sets of User manuals/guides, O&M manuals and manufacturer's catalogues for all the hardware & software supplied under the contract one set each of which shall be at all the locations where the System has been installed. The user manual shall at minimum include the principle of operation, block diagrams, troubleshooting and diagnostic and maintenance procedures. Considering all the components of the project briefly the following documents/drawings shall be required under the project. It is not acceptable to supply user manuals of systems, functions and applications as it exists. The user manuals shall be oriented towards system users and elements & system deployed.

The documentation pertaining to third party or OEM products may be supplied in the format as available from the third party/OEM. If both formats (Paper/electronic) are available then the above mentioned copies of documents shall be supplied in both the formats, however, in exceptional cases where the Contractor is not able to get more copies due to copyright laws restriction & or industry practice, the issue will be mutually agreed upon on case to case basis.

The documents to be submitted shall include the following information:

5.9.1 Software Inventory

An inventory of all software shall be maintained by the Contractor. The Contractor shall submit the following inventory lists: the preliminary inventory list at the time of the FDS approval, an updated inventory list immediately prior to the start of The FAT, and the final inventory list at the time of system commissioning. The inventory shall include the name of each program, a cross reference to pertinent Contractor documents and an indication of whether the program is to be standard, modified, or custom.

5.9.2 Functional Description

Functional description documentation shall be provided for each function described in specifications. It shall include the following information for each function:

(a) Introduction describing the purpose of the function with references to other documentation.

(b) Performance requirements that describe the execution periodicity and the tuning parameters that control or limit the capabilities of the software.

(c) Complete description of the operation, data and logic interfaces.

(d) Sample displays wherever applicable.

5.9.3 Software Design

Software design documentation shall be provided for each function, at least three months before the Factory Acceptance Test. It shall include detailed descriptions of the following items:

(a) The overall organization and structure of the software logic.

(b) Complete description of the algorithms, operation and the data and logic interfaces with other functions.

(c) Data dictionary in which the following (as applicable) information for each data item in tables, file, and array is provided: (1) Name (2) Purpose, (3) Location, (4) Length of data item, and (5) Initialization.

(d) Databases internal and external to the software, along with a description of all inputs required and the output produced by the software modules.

(e) Interfaces with other software modules.

(f) Design limitations such as field length and the maximum quantity of data items that can be processed.

5.9.4 Database Documentation

Database documentation shall describe the structure of the database and Information Model. The documentation shall define the individual elements (files, records, fields, and tables) and their interrelationships. Portions of the database developed specifically for Employer/Utility's systems shall be identified.

Documentation shall also be provided that instructs the user in the preparation of data to be used for the databases, including:

(a) The overall organization of input records

(b) The format of each data record

(c) Each data field and the valid entries pertaining to the fields.

Sufficient database documentation shall be provided to enable the database to be updated or

regenerated when inputs are changed and added, programs are modified, and new programs are added. Database access documentation shall be supplied such that software developed by Employer/Utility may use the same access tools used by the Contractor-supplied software.

5.9.5 User Documentation for Operators

User documentation for Operators shall contain detailed operating instructions and procedures. Information in the documentation shall be presented in terms that are meaningful to users. Each system function of this Specification and all other functions designed for operators use shall be included in this documentation.

Instructions and procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be adjusted, and the effects obtained by varying each parameter. Additionally, the user documentation shall describe:

(a) All user guidance and error messages, along with the steps necessary to recover from errors

(b) The user interface including displays and keyboard operations used to control and review input to and output produced by the function

(c) Alarms and messages issued by the function and the conditions under which they are generated

(d) Procedures to be followed as a result of computer system restarts, failures, and failovers.

Dispatcher documentation shall be customized separately for Employer/Utility's system and shall be based on the delivered systems. It is not acceptable to describe the Contractor's standard system and then identify differences between the standard and delivered systems for operators documentation. The documentation shall not include standard or other descriptions that do not apply to the delivered systems.

5.9.6 System Administration Documentation

System administration documentation shall be provided to guide Employer/Utility personnel in the operation and procedures required to generate and update the systems, including system software, database, application software, and other elements of the systems. System administration documents shall be provided for the following items:

(a) Software management

(b) Network communications management

(c) Processor configuration

(d) System performance monitoring

(e) System restart/failover management and diagnostic procedures

(f) System generation and management

(g) Database generation and management

(h) Report, Display generation and management

(i) Diagnostic programs

(j) Software maintenance

(k) Application software parameters and tuning guides

(l) Other Contractor-supplied system software not included above.

5.9.7 Test Documentation

Documentation for all factory, field, and availability tests (procedures and reports)that apply to Employer/Utility's system shall be provided in accordance with the requirements defined in section 5.6.

5.9.8 Documentation for Auxiliary Power Supply System

The following specific document for items covered under this section shall be submitted which shall be in addition to the applicable general document.

- Data Requirement Sheets (DRS)
- Cable sizing calculations
- Inventory of the hardware
- Panel General arrangement drawing
- Panel Internal General Arrangement drawing indicating modules, major devices/ components location etc.
- Installation drawings
- Schematic drawings
- Type Test reports
- FAT plan & procedure
- SAT plan & procedure
- External cable laying & termination schedule details
- Availability test plan & procedure

5.9.9 Training Documentation

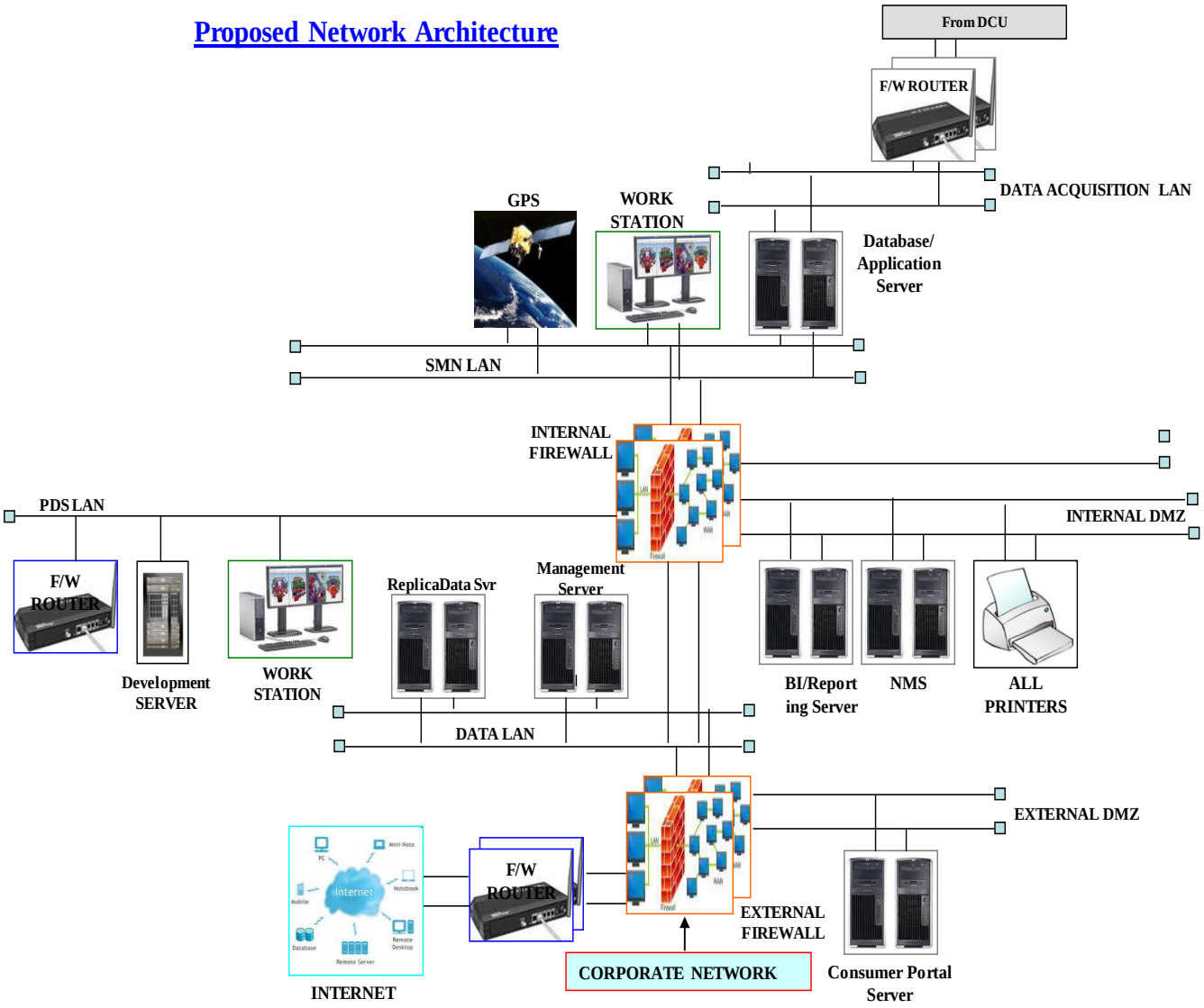
Training documentation shall be provided for all courses in accordance with the requirements defined in specification.

ANNEXURE-I

Suggested List of Standards to be followed:-

S.No.	Activity	Standards
1	CIM Standard CIM Standard for Distribution	IEC 61970 IEC 61968
2	Communication Network for Substation Automation	IEC 61850
3	ICCP	IEC 60870-6
4	Cyber Security Standard	IEC 62351-1-7
5	Electricity Metering; data exchange for metering, tariff and load control	IEC 62056
6	Grid Connectivity	IEEE 1547 MNRE Guidelines

Proposed Network Architecture



ANNEXURE- II

Smart Grid Pilots in India
Technical Specifications

AMI Pilot

Bill of Quantity for Smart Grid Pilots in India*		
S.No.	**Description of Items**	**Qty(Unit)**
A	***AMI Pilot***	
1	**Master Station/Control Centre**	
1.1	***Meter Data Management System***	
1.1.1	**Hardware**	
1.1.1.1	Application Server	As reqd
1.1.1.2	Development Server	As reqd
1.1.1.3	Consumer Portal Server	As reqd
1.1.1.4	Business Intelligence/Analytic/Reporting Server	As reqd
1.1.1.5	Database Server	As reqd
1.1.1.6	Workstations	As reqd
1.1.1.7	Printers	As reqd
1.1.1.8	Routers	As reqd
1.1.2	**Software**	
1.1.2.1	Report Development and Generation Software	
1.1.2.2	Database Application Server	
1.1.2.3	Billing Application based on TOU/CPP	
1.1.2.4	Energy Accounting Application	
1.1.2.5	Load Analysis/Research Application	
1.1.2.6	Portal	
1.1.2.7	Other Custom Applications	
1.1.2.8	Payment Gateway	
1.1.3	**Firewall**	As reqd
1.1.4	**Time Synchronization System**	As reqd
1.1.5	**Back-up System**	LOT
2	***Meter Data Acquisition System***	
2.1	**Hardware**	
2.1.1	Smart Meters-Single Phase/Three Phase/Commercial	As reqd
2.1.2	Data Concentrators	As reqd
2.1.3	Head-end Systems	As reqd
2.2	**Software**	

	Meter Data Acquisition Software	
3	***Communication System***	
3.1	**Network Backbone**	As reqd
3.2	**Communication Equipment for :**	
3.2.1	Interfacing at Data Acquisition End	As reqd
3.2.2	Interfacing at Control Centre End	As reqd
3.2.3	Interfacing at Data Concentrator Unit	As reqd
4	***Network Management System***	
4.1	**Hardware**	As reqd
4.2	**Software**	As reqd
5	***Training***	As specified
6	***Maintenance***	2 Years

Outage Management system

Bill of Quantity for Smart Grid Pilots in India*		
S.No.	**Description of Items**	**Qty(Unit)**
1	***Outage Management system***	
1.1	**Central Computer System**	
1.1.1	**Hardware**	
1.1.1.1	Application Server	As reqd
1.1.1.2	Development Server	As reqd
1.1.1.3	Business Intelligence/Analytic/Reporting Server	As reqd
1.1.1.4	Database Server	As reqd
1.1.1.5	Workstations	As reqd
1.1.1.6	Printers	As reqd
1.1.1.7	Routers	As reqd
1.1.1.8	Other Hardware	As reqd
1.1.2	**Software**	
1.1.2.1	Report Development and Generation Software	As reqd
1.1.2.2	Database Application Server	As reqd
1.1.2.3	GUI Based application for Condition Based Monitoring	As reqd
1.1.2.4	Application for Fault and Outage Management	As reqd
1.1.2.5	Application for Fault Management and System Restoration	As reqd
1.1.2.6	Other Custom Applications	As reqd
1.1.3	**Firewall**	As reqd
1.1.4	**Time Synchronization System**	As reqd
1.1.5	**Backup System**	As reqd
2	***Communication System***	
3.1	**Network Backbone**	As reqd
3.2	**Communication Equipment**	As reqd
3	***Network and Cyber Security Management System***	
4.1	**Hardware**	As reqd
4.2	**Software**	As reqd
4	**Field Equipment- like RTU/Sensors/Intelligent Switch etc.**	As reqd
5	Training	As specified
6	Annual Maintenance Contract	2 years

Peak Load Management system

Bill of Quantity for Smart Grid Pilots in India*		
S.No.	**Description of Items**	**Qty(Unit)**
1	***Peak Load Management system***	
1.1	**Central Computer System**	
1.1.1	**Hardware**	
1.1.1.1	Application Server	As reqd
1.1.1.2	Development Server	As reqd
1.1.1.3	Business Intelligence/Analytic/Reporting Server	As reqd
1.1.1.4	Database Server	As reqd
1.1.1.5	Workstations	As reqd
1.1.1.6	Printers	As reqd
1.1.1.7	Routers	As reqd
1.1.1.8	Other Hardware	As reqd
1.1.2	**Software**	
1.1.2.1	Report Development and Generation Software	As reqd
1.1.2.2	Database Application Server	As reqd
1.1.2.3	GUI Based application for load flow	As reqd
1.1.2.4	Application for Peak Load Management	As reqd
1.1.2.5	Other Custom Applications	As reqd
1.1.3	**Firewall**	As reqd
1.1.4	**Time Synchronization System**	As reqd
1.1.5	**Backup System**	As reqd
2	***Communication System***	
2.1	Network Backbone	As reqd
2.2	Communication Equipment	As reqd
3	***Network and Cyber Security Management System***	
3.1	Hardware	As reqd
3.2	Software	As reqd
4	**Field Equipment- like load curtailment/Cut-off switch etc.**	As reqd
5	Training	As specified
6	Annual Maintenance Contract	2 years

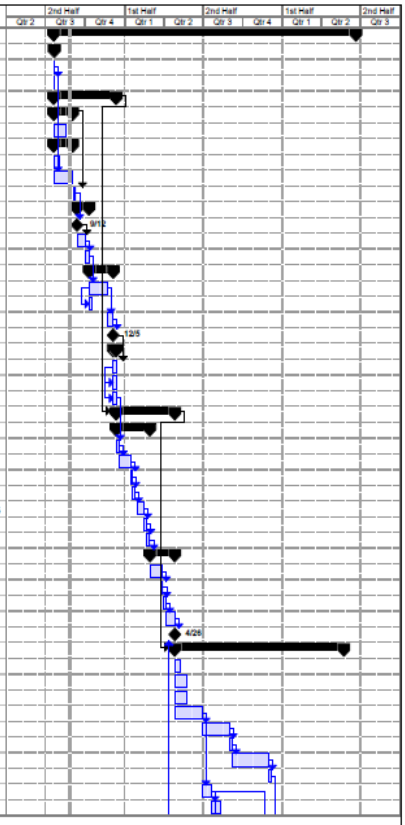
Power Quality Management system

Bill of Quantity for Smart Grid Pilots in India*		
S.No.	**Description of Items**	**Qty(Unit)**
1	***Power Quality Management system***	
1.1	**Central Computer System**	
1.1.1	**Hardware**	
1.1.1.1	Application Server	As reqd
1.1.1.2	Development Server	As reqd
1.1.1.3	Business Intelligence/Analytic/Reporting Server	As reqd
1.1.1.4	Database Server	As reqd
1.1.1.5	Workstations	As reqd
1.1.1.6	Printers	As reqd
1.1.1.7	Routers	As reqd
1.1.1.8	Other Hardware	As reqd
1.1.2	**Software**	
1.1.2.1	Report Development and Generation Software	As reqd
1.1.2.2	Database Application Server	As reqd
1.1.2.3	Voltage/VAR Control (VVC) application	As reqd
1.1.2.4	Load Balancing	As reqd
1.1.2.5	Other Custom Applications	As reqd
1.1.3	**Firewall**	As reqd
1.1.4	**Time Synchronization System**	As reqd
1.1.5	**Backup System**	As reqd
2	***Communication System***	
2.1	Network Backbone	As reqd
2.2	Communication Equipment	As reqd
3	***Network and Cyber Security Management System***	
3.1	Hardware	As reqd
3.2	Software	As reqd
4	**Field Equipment- like quality control devices**	As reqd
5	Training	As specified
6	Annual Maintenance Contract	2 years

ANNEXURE-III

Tentative Project Plan (Page ½)

ID	WBS	Task Name	Duration	Start	Finish	Predecessors
1	**1**	**Smart Grid Pilot Projects**	**501 days**	**Thu 7/21/11**	**Thu 6/20/13**	
2	**1.1**	**Plan for Pilots**	**2 days**	**Thu 7/21/11**	**Fri 7/22/11**	
3	1.1.1	Smart Grid features	1 day	Thu 7/21/11	Thu 7/21/11	
4	1.1.2	Location characteristics	1 day	Fri 7/22/11	Fri 7/22/11	3
5	**1.2**	**Prepare RFPs**	**103 days**	**Thu 7/21/11**	**Mon 12/12/11**	
6	**1.2.1**	**Write RFPs**	**32 days**	**Thu 7/21/11**	**Fri 9/2/11**	
7	1.2.1.1	Volume 1	20 days	Thu 7/21/11	Wed 8/17/11	
8	**1.2.1.2**	**Volume 2**	**32 days**	**Thu 7/21/11**	**Fri 9/2/11**	
9	1.2.1.2.1	Common sections	10 days	Thu 7/21/11	Wed 8/3/11	
10	1.2.1.2.2	Technical sections	31 days	Fri 7/22/11	Fri 9/2/11	3
11	1.2.2	Approval of RFPs	5 days	Mon 9/5/11	Fri 9/9/11	6
12	**1.2.3**	**MOP (Working Group-1 of ISGTF):**	**20 days**	**Mon 9/12/11**	**Mon 10/10/11**	
13	1.2.3.1	Reviews RFP with utilities and vendors	0 days	Mon 9/12/11	Mon 9/12/11	11FS+1 day
14	1.2.3.2	Utilities and vendors comment	15 days	Tue 9/13/11	Mon 10/3/11	13
15	1.2.3.3	POWERGRID makes revisions	5 days	Tue 10/4/11	Mon 10/10/11	14
16	**1.2.4**	**Utilities/prospective franchisee prepare**	**40 days**	**Tue 10/11/11**	**Mon 12/5/11**	
17	1.2.4.1	Detailed Project Report (DPR) for Smart Grid Pilots	30 days	Tue 10/11/11	Mon 11/21/11	15
18	1.2.4.2	MOP appoints nodel agency	5 days	Tue 10/11/11	Mon 10/17/11	17SS
19	1.2.4.3	MOP reviews and approves DPR	10 days	Tue 11/22/11	Mon 12/5/11	17
20	1.2.4.4	MOP awards pilots	0 days	Mon 12/5/11	Mon 12/5/11	19
21	**1.2.5**	**Utilities Customize RFPs**	**5 days**	**Tue 12/6/11**	**Mon 12/12/11**	
22	1.2.5.1	Baseline parameters of KPIs of proposed pilots	5 days	Tue 12/6/11	Mon 12/12/11	20
23	1.2.5.2	Other location-specific details	5 days	Tue 12/6/11	Mon 12/12/11	22SS
24	1.2.5.3	Nodal agency consults and reviews	5 days	Tue 12/6/11	Mon 12/12/11	23SS
25	**1.3**	**Selection of System Integrator (one per pilot)**	**98 days**	**Tue 12/13/11**	**Thu 4/26/12**	5
26	**1.3.1**	**First Stage Bid**	**56 days**	**Tue 12/13/11**	**Tue 2/28/12**	
27	1.3.1.1	Invitation for bids	5 days	Tue 12/13/11	Mon 12/19/11	24
28	1.3.1.2	Preparation of bid	20 days	Tue 12/20/11	Mon 1/16/12	27
29	1.3.1.3	Opening of bid documents	1 day	Tue 1/17/12	Tue 1/17/12	28
30	1.3.1.4	Evaluation	5 days	Wed 1/18/12	Tue 1/24/12	29
31	1.3.1.5	Meeting with Finalists	10 days	Wed 2/1/12	Tue 2/14/12	30FS+5 days
32	1.3.1.6	Preparation of Final Proposal	5 days	Wed 2/15/12	Tue 2/21/12	31
33	1.3.1.7	Approval of First Stage Evaluation	5 days	Wed 2/22/12	Tue 2/28/12	32
34	**1.3.2**	**Second Stage Bid**	**42 days**	**Wed 2/29/12**	**Thu 4/26/12**	**33**
35	1.3.2.1	Preparation of bid	21 days	Wed 2/29/12	Wed 3/28/12	
36	1.3.2.2	Opening of bid documents	1 day	Thu 3/29/12	Thu 3/29/12	35
37	1.3.2.3	Evaluation	5 days	Fri 3/30/12	Thu 4/5/12	36
38	1.3.2.4	Approval of award	15 days	Fri 4/6/12	Thu 4/26/12	37
39	1.3.2.5	System integrator selection (Letter of Award)	0 days	Thu 4/26/12	Thu 4/26/12	38,60
40	**1.4**	**Execution of Pilot (one per pilot)**	**280 days**	**Fri 4/27/12**	**Thu 5/23/13**	25
41	1.4.1	Create detailed project plan for pilot	10 days	Fri 4/27/12	Thu 5/10/12	
42	1.4.2	Assessment of existing environment	20 days	Fri 4/27/12	Thu 5/24/12	
43	1.4.3	Baseline measurements for improvement	20 days	Fri 4/27/12	Thu 5/24/12	
44	1.4.4	Selection of Partners as needed	45 days	Fri 4/27/12	Thu 6/28/12	
45	1.4.5	Procure equipment	45 days	Fri 6/29/12	Thu 8/30/12	44
46	1.4.6	Factory Acceptance Testing	5 days	Fri 8/31/12	Thu 9/6/12	45
47	1.4.7	Install equipment	60 days	Fri 9/7/12	Thu 11/29/12	46
48	1.4.8	Site acceptance testing	5 days	Fri 11/30/12	Thu 12/6/12	47
49	1.4.9	Documentation	15 days	Fri 6/29/12	Thu 7/19/12	44
50	1.4.10	Organization Structure	15 days	Fri 7/20/12	Thu 8/9/12	49

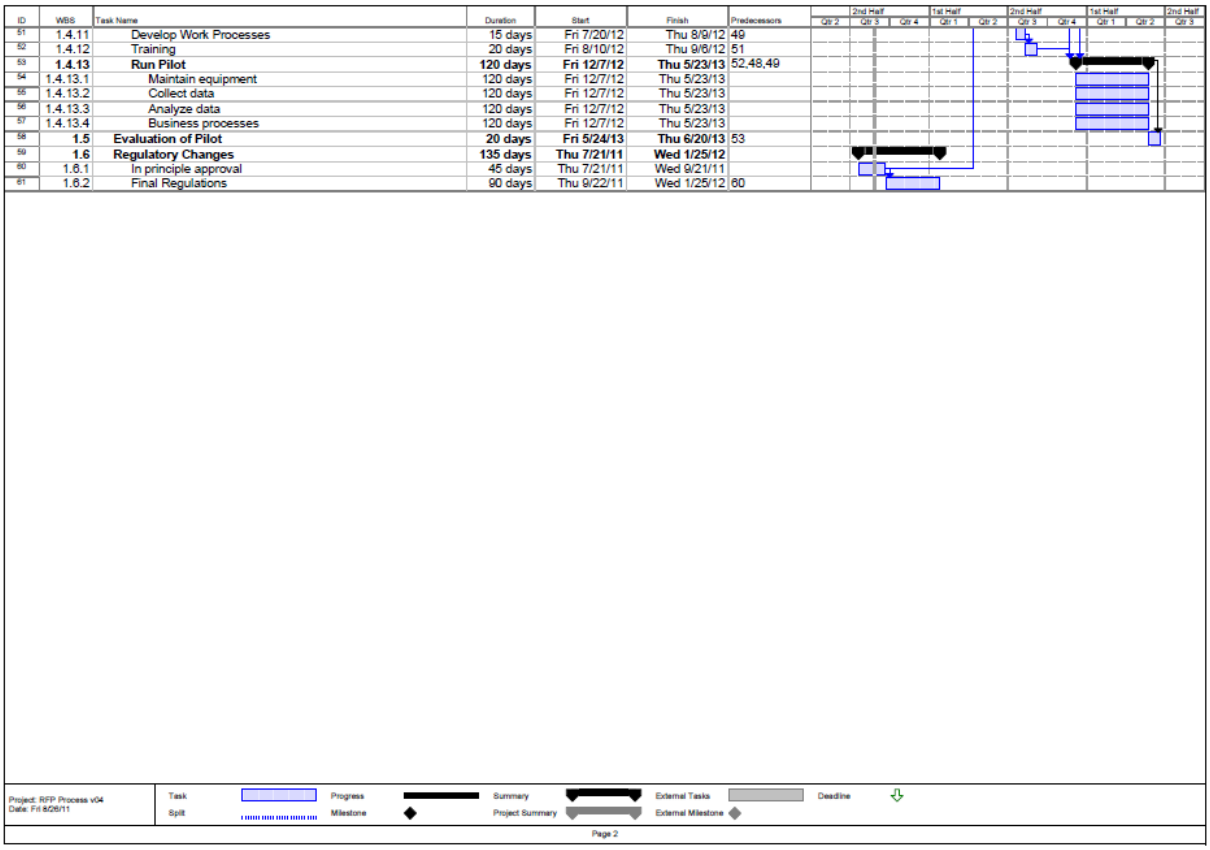


Project: RFP Process v04
Date: Fri 8/26/11

Task · Progress · Summary · External Tasks · Deadline
Split · Milestone · Project Summary · External Milestone

Page 1

Tentative Project Plan (Page 2/2)



ID	WBS	Task Name	Duration	Start	Finish	Predecessors
51	1.4.11	Develop Work Processes	15 days	Fri 7/20/12	Thu 8/9/12	49
52	1.4.12	Training	20 days	Fri 8/10/12	Thu 9/6/12	51
53	**1.4.13**	**Run Pilot**	**120 days**	**Fri 12/7/12**	**Thu 5/23/13**	52,48,49
54	1.4.13.1	Maintain equipment	120 days	Fri 12/7/12	Thu 5/23/13	
55	1.4.13.2	Collect data	120 days	Fri 12/7/12	Thu 5/23/13	
56	1.4.13.3	Analyze data	120 days	Fri 12/7/12	Thu 5/23/13	
57	1.4.13.4	Business processes	120 days	Fri 12/7/12	Thu 5/23/13	
58	**1.5**	**Evaluation of Pilot**	**20 days**	**Fri 5/24/13**	**Thu 6/20/13**	53
59	**1.6**	**Regulatory Changes**	**135 days**	**Thu 7/21/11**	**Wed 1/25/12**	
60	1.6.1	In principle approval	45 days	Thu 7/21/11	Wed 9/21/11	
61	1.6.2	Final Regulations	90 days	Thu 9/22/11	Wed 1/25/12	60

ANNEXURE-IV Glossary

Abbreviation	Expansion
AMC	Annual Maintenance Contract
BEE	Bureau of Energy Efficiency
BI	Business Intelligence
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CERT	Computer Emergency Response Team
CIFS	Common Internet File System
CPP	Critical Peak Pricing
CPRI	Central Power Research Institute
CVE	Common Vulnerabilities and Exposures
DCU	Data Concentrator Unit
DMZ	De Militarized Zone
DTR	Distribution Transformer
FRTU	Feeder Remote Terminal Unit
FTP	File Transfer Protocol
GCC	General Conditions of Contract
GIS	Geographical Information System
ICCP	Inter Control-Centre Communications Protocol
ITU-T	International Telecommunication Union, Telecommunication Standardization Sector
KPI	Key Performance Indicator
LT	Low Tension
NTPC	National Thermal Power Corporation
PDS	Programmer Development Server
PFC	Power Finance Corporation
POWERGRID	Power Grid Corporation of India Limited
RE	Renewable Energy
REC	Rural Electrification Corporation
SCADA	Supervisory Control and Data Acquisition
SMN	Smart Meter Network
SSL	Secured Socket Layer
TMU	Transformer Monitoring Unit
TOU	Time of Use
UPS	Uninterrupted Power Supply

APPENDIX –I

DETAILED FUNCTIONALITIES OF SMART GRID PILOTS

1. Introduction

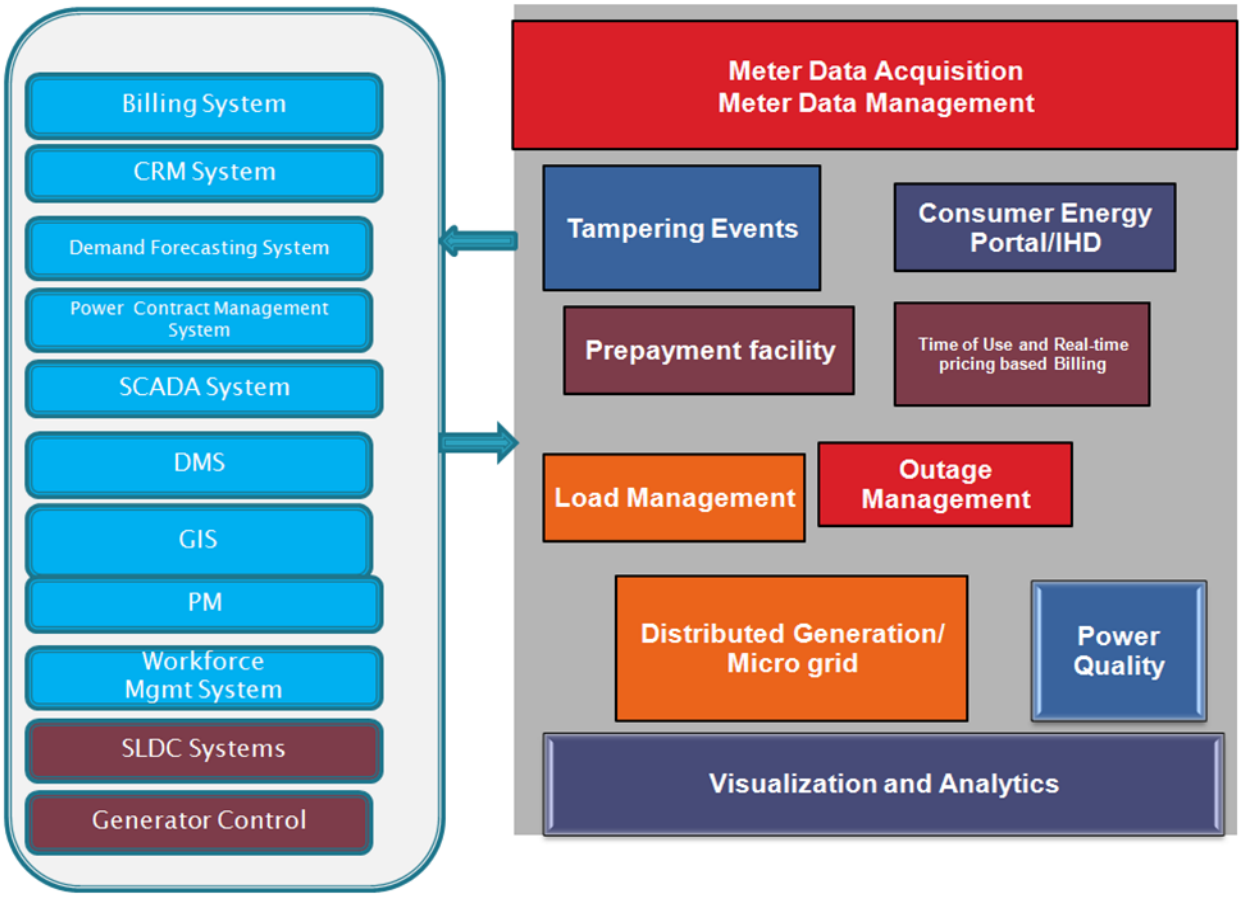
The following are various functionalities being opted as part of the smart grid pilots in India.

- AMI for Residential, Commercial and Industrial
- Peak Load Management
- Outage Management
- Power Quality
- Renewable Integration
- Micro Grids
- Distributed Generation

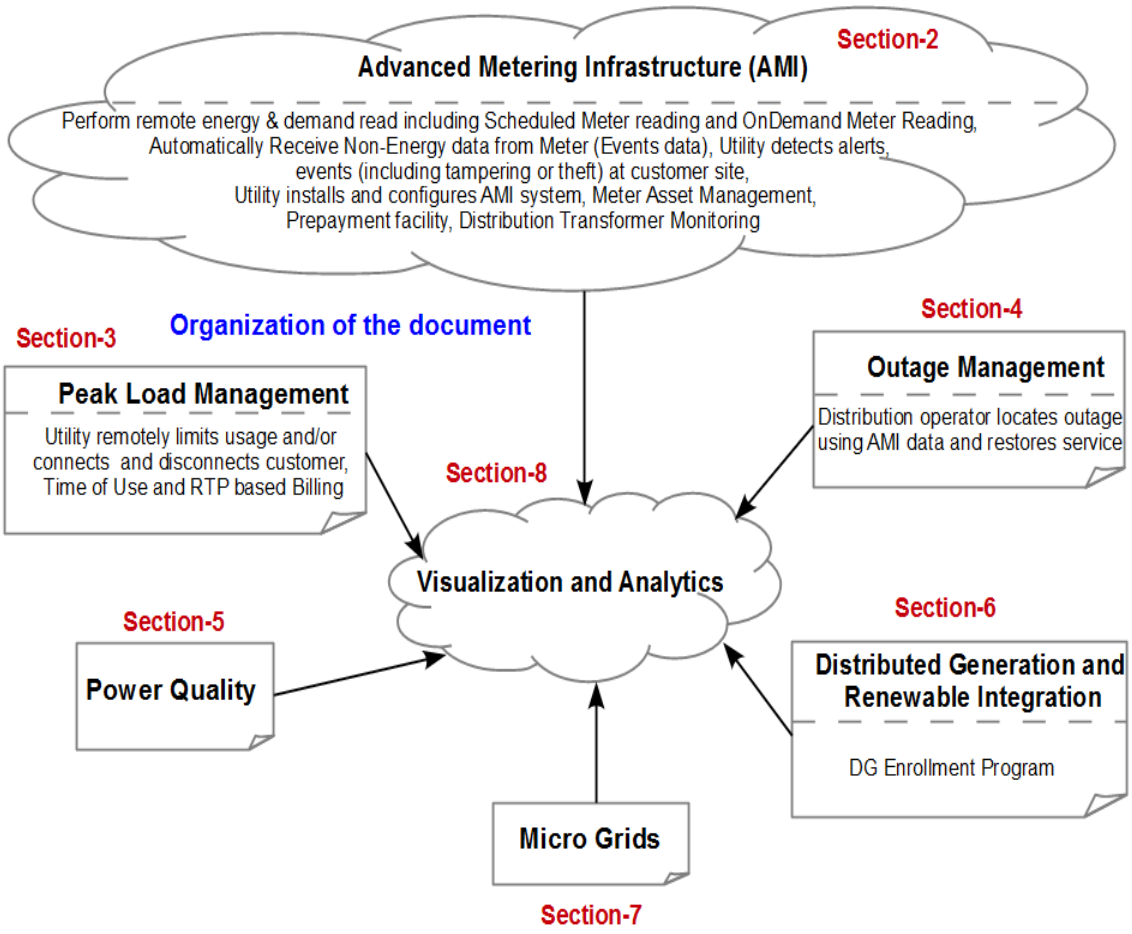
Use Cases are the descriptions of smart grid functionalities that define the important actors, systems and technologies, and their requirements that are part of the smart grid applications. This document presents the key use cases of these functionalities, suggested for including in the Technical requirement documents for the smart grid pilots.

The listed use cases in the document are suggestive and not exhaustive in nature and Utilities need to take final call on the Use Cases to be included in their tender documents.

Fig:- Various functionalities of Smart Grid Pilots -Use Case Categories



The use cases and information exchange needs have been grouped based on functionality and the organization of the document is as shown in the figure below.



2. AMI for Residential, Commercial and Industrial

AMI is a flexible, general-purpose metering and communication system that can be used for many applications – including meter reading, distribution automation, connect/disconnect, and others. AMI systems promise to provide advanced energy monitoring and recording, sophisticated tariff/rate program data collection, and load management command and control capabilities. Additionally, these powerful mechanisms will enable consumers to better manage their energy usage, and allowing the grid to be run more efficiently from both a cost and energy delivery perspective. These advanced capabilities will also allow utilities to provision and configure the advanced meters in the field, offering new rate programs, and energy monitoring and control.

The key points under this section are Meter should record and store energy, load profile, metering and event data and send it to Control center thru appropriate communication technology that can be RF/PLC/GPRS.., . Data from various meters in a subsystem can be collated by DCU that polls meters reporting to it for data aggregation and then sending it to Control Center, Control Center will facilitate data repository with VEE, Synchronization and aggregation as per network hierarchy, Time clock of each node in the system i.e. meter/DCU/ Control center etc should be time synchronized

2.1 Meter Data Management

Data management system at Control center should support following functions:-

Sl No	Functionality	Description
1	Menu driven and web based software	The software should have menu driven functions for automatic data capturing, periodic data uploading, etc. with user friendly web based front end. It should allow user to view energy usage for a specific customer, print or export the tables, view the last data collection timestamp, view the current status of diagnostics flags, perform usage analysis, and view any open Service Requests.
2	Data versioning and auditing	The software should be reliable, flexible, and scalable. The software should provide data management including data versioning and auditing i.e. all data is versioned and stored in the database, including the original values, error flags, estimated or edited data, and re-collected data etc.
3	Data Validation	The software should preferably ensure data validation at both

		ends e.g. at the meter/data logger end before transmission to eliminate possibility of garbage data and the system at the data centre should apply comprehensive data validation before accepting and using meter data like Meter Number, Connected DT, Scheduled Reading date and time, reading parameters (KWh, KVAh, KW,PF etc.), Period for which data needed
4	Service Oriented Architecture	The software should support Service Oriented Architecture (SOA) compliant N-Tier multi-tier, distributed architecture design philosophy with following tiers: a. Client Tier: The client tier will be the interface of the software with the utility's operations/dashboard user. The client tier will provide all the user interfaces for the operational and supervisory activities involved in meter data acquisition, processing and analysis. b. Business logic tier: It service the requests made by the client tier. These requests could be automated, based on user-defined schedules or on demand from the user. c. Database tier: It comprise RDBMS designed to maintain the relationships between meter and network assets, network topology, user privileges, connection point details, customer accounts and other entities. The database tier should be optimally designed to exploit both normalized as well as multidimensional data models. The database should also maintain a time-series repository that stores the data collected and processed from meters, including meter readings, register reads, interval usage data, outage and restoration events and event logs as well as derived or computed data such as billing determinants, aggregations and asset performance indicators like load factor and load duration curves.
5	Core Reporting Functionalities	Software should also support core reporting functionality which includes data collection performance reporting (for example, actual vs. expected by day, by technology type) and exception reporting (for example, meter or communications equipment failures, diagnostic flags, etc.).
6	Data Storage should facilitate storage for	a. Registered Read Data including register reads, daily billing cycle, as well as derived billing determinants (for example, TOU/RTP from interval data). b. Interval Data channels with variable intervals (for example, 5 minutes to 60 minutes) and variable units of measure (kWh, kVARh, kW, kVAR, volts, amps, frequency etc.).

		c. Calculated Data that is derived or computed such as billing determinants and aggregated loads.
7	Data Transfer to other systems	The software should support an interval data transfer service for transferring interval data to external systems on a scheduled frequency for non-billing purposes, including the transfer of the same interval data to multiple systems on different cycles. Data transfers can be scheduled to send data in real-time (as the interval data is received), or on a daily, weekly, or monthly cycle
8	Data Synchronization	The Data Synchronization Engine ensures that any changes in data elements or relationships such as meter changes, rate changes, move-in move-outs, and other changes to customer premise or Service Delivery Point (SDP) information are identified and reflected in MDM. The Synchronization process automatically generates and logs exceptions when attempts to synchronize data cause invalid or erroneous results. **The Data Synchronization Engine should support real-time web services**.

This sub-section covers the requirement on remote meter reading.

2.2 Perform Remote meter Reading

S.No	Requirement	Details of requirement
1	Meter sending the consumption data	Meter at scheduled frequency sends the data to head-end (could be through the DCU if solution is defined so). Consumption details will be programmable time block basis, and data could be incremental to what was sent by meter in the preceding instance
2	Acquiring meter data remotely	Multiple clients in data center will Read Demand and Energy Data Automatically from Customer Premises or will have access to the data if already available in the AMI system –e.g. for regular meter reading, load forecasting, load management etc. Ensure that clients like billing system and load forecasting, load management etc should not be required to initiate separate meter reading requests and meter reading data is validated, synchronized, unified and made available to other systems on request
		Head-end acquiring average/instantaneous data from the

S.No	Requirement	Details of requirement
		meters which then reaches Meter data management system
		The meter data received from DCU/Meter shall also give the data logging (till where data reached etc.)
3.	Requesting meter data remotely	1. MDM requesting average/instantaneous interval and events data of the meters from the Head-end at scheduled intervals i.e. thru programmable data capture frequency; and creating billing profile, portal services to view energy data for various purposes, etc.
4	Set data capture frequency remotely	1. Control center to set data capture frequency remotely of AMI Meter/Device interval data for all consumers and DTs/feeders through MDM and Head-end
		2. The daily capture (capture frequency shall be configurable) of AMI Meter/Device interval data for all consumers and DTs/feeder
5.	Utility can get onDemand Meter reading remotely	1. MDM capturing on Demand energy / Average/Instantaneous data (which means viewing the meter data at any instance on demand) that may include 3p voltages, currents, frequency, PFs, total kW, and kVA and register reads for cumulative kWh, kVArh, KVAh
		The system shall capture on Demand energy data (Three phases voltages, currents, PFs, total kW, and kVA and register reads for cumulative kWh, kVArh, KVAh etc.) for all customers (residential, commercial, and industrial) and DTs/feeders
		The call center/ consumer care center officials (having the required authorization e.g. district manager, customer care group head etc.) should have the ability to perform on Demand requests for residential and C&I customers, including meter status, current month consumption, cumulative energy and voltage (power quality information) or shall have access to the data if already available in the AMI system.
		Call center/ consumer care center officials will have access to the data over a web based portal
		System shall have the ability to keep a log of the on Demand requests
		System shall have the ability to send energy data via e-mail (or another medium) if it exceeds maximum time allowed.
		If either no response was received in a given timeframe or a negative response was received, the requesting party will be notified, and an exception created. This will be recorded as an exception and resolved by the utility within approved TAT by

S.No	Requirement	Details of requirement
		regulation.
6	More than one make of meters communicating to multiple make of DCUs	More than one make of meters to communicate with multiple make of DCUs with synchronizing the various recorded meter interval data
7	Manual Collection of Meter Data	Field Representative collecting data manually from field and upload the same in MDM for meters where energy data was expected but not received, exceptions have to be created by the system and it should be possible to collect
		Field Service Representative (Line man/ meter reader) retrieves data directly from AMI Meter (alternate retrieval of meter data) in a standard format that can be pushed into the main system
8	Validation, Estimation, and Editing (VEE) of data in MDM	MDMS functionality to perform validation, estimation, and editing (VEE) against energy data receiving from Head-end.
		VEE system in MDM should have the capability as applicable on any type of data should be there (instantaneous/energy/load profile/event/meter general parameters like RTC etc.). Different estimation algorithm shall be used for missing data conditions (e.g. missing interval in a one hour gap, missing intervals of an entire billing span, etc.).
	Meter Storage System	Meter stores interval data on 15/30 min basis for at least 15/30 days predefined periodicity along with the load survey, midnight survey, events (tampers) & billing profile
9	Centralized data management	MDM ensures that clients like billing system and load forecasting, load management etc should not be required to initiate separate meter reading requests and meter reading data is validated, synchronized, unified and made available to other systems on request
	Priority Message Generation	Head-end receives priority messages in less than 1 min for 95% of end points and non-critical messages can be pushed periodically (configurable) either at day end/ every 4 hours etc.). Utility configures which messages to be designated as priority through MDM.
	AMI Network monitoring	Graphical interface enables utility to see the possible reasons, root cause analysis of the communication network if possible, logs captured in the devices etc. in case Meter(s) does not communicate remotely during default or non default schedule

S.No	Requirement	Details of requirement
		read. In such situation, events/alerts shall be raised to appropriate utility users e.g. Catastrophic failure scenario (> 10% of meter population failing)
	Meter communication denial	MDM gives the list of Meter that does not communicate remotely during default schedule read and for the meters that communicate intermittently (for xx consecutive days) from head-end
	Remote diagnosis of non-responding devices	Smart grid control center remotely diagnose non-responding devices remotely to reduce field visits and produces a report of non-performing field devices to quantify the system availability
	Voluntary meter reading	Customer providing the meter reading which includes instantaneous meter read (status and data) in case of non availability of data thru remote reading
	Remote maintenance	Firmware Upgrade, Remote programming, which includes user to maintain the AMI system by remotely programming the system parameters like critical events, interval period, etc,. upgrading the system with new firmware
	Billing System	**Register and Interval Billing:** **Register Billing** Register Billing supports billing requirements for monthly billing based on register reads. It includes billing cycle data services that deliver billing determinants via an interface to CIS/Billing on the billing cycle date and on request when special reads are required. A Billing Determinant Calculator provides the flexibility to compute the billing determinant values based on utility defined formulas. Formulas are built around logical and arithmetic operators, and can contain other billing determinants, constants, and customer functions. **Bi-directional** MDM should support bi-directional metering by processing the delivered and received channels for a given meter in two separate channels. **Net Metering** (using Virtual channel) MDM should support net metering by processing the delivered and received channels from the meter/recorder and calculating a net amount. The calculated net will be stored onto a virtual channel. MDM should provide full tracking, management, and storage of usage data related to each data channel. This allows

S.No	Requirement	Details of requirement
		summation of usage data separately for each data channel. **Usage Calculated from Register Reads** MDM can create usage data from register reads received from AMR/AMI systems or gathered manually. MDM will calculate the difference between the current bill period register read and the previous bill period register read, applying the Current Transformer/Potential Transformer ratio (CT/PT) required converting to the correct kWh usage amount. Rollover conditions are also considered when computing usage. The calculated usage is stored in the billing table and accessible to all applications that require the data. **Interval Billing**: The Interval Billing should include all of the functionality offered in the Register Billing in addition to support Advanced Billing Determinants (ABD) calculated from interval reads. As interval data is retrieved by the AMR/AMI systems, the Advanced Billing Determinant (ABD) engine should process the interval reads into daily and billing cycle usage-based billing determinants (as compared to register-based billing). For example, if 15 min interval data is retrieved by the AMR/AMI system , MDM calculates the proper billing determinant which is based on RTP/ Time-of-Use (TOU) tariff, then ABD engine will make this computation based on tariff configuration data in the database. Then it stores this daily data set (RTP/TOU values with usage details for each), along with the interval data in the Metered Usage Data Repository (MUDR). On each billing cycle, the ABD engine will summarize the RTP/TOU and demand data for each period over the requested billing span and deliver these billing determinants to the billing system. By performing the billing determinant summations on a daily basis, MDM support end-user presentation of "month-to-date" information as well as spread computational loads over time (including weekends).
	Interface to consumer portal	Meter data management should provide updated consumption data to the consumer portal which in turn allows consumers to download/VIEW the consumption history
	Customer Interface to MDM for consumer engagement	System through MDM gives periodic updates to the customers and via media (website, SMS, e-mail, meter displays etc.) on various services floated by the utility for consumer engagement

2.3 Automatically Receive Events data /Non-Energy data like frequency voltage etc from Meter

S.No	Requirement	Details of requirement

	Event Collection	MDM receives and stores the complete meter events daily from the head-end
	Critical Event Notification on near real time basis	Meter sends only critical events (priority set by utility) to the head-end as and when occurred.
	Event Management System	MDM thru workflow engine, manage the events instantaneously by routing of events to concerned dept / functions/other systems within utility. MDM further Identify irregular alerts, consumption, alarms, and other abnormal activity and should proactively generate the necessary reports, service orders, or any user defined actions, resulting in operational efficiencies. For eg: Billing System will only receive events which are business process related.
		Utility shall have the option to manage the communication network, diagnose non- responding field devices remotely.

2.4 Tamper Detection

S.No	Requirement	Details of requirement
	Utility detects tampering or theft at customer site	The tamper events captured by meter are sent to head-end which in turn reaches meter data management for further action. Some examples include • Meter not communicating • Meter bypasses detection • Magnet is put on meter • Physical tamper detection • Meter is removed and not reinstalled (due to reasons like Meter damaged/stolen by unauthorized person)

		Notifying utility personnel for immediate site inspection: The meter data management system immediately sends high priority alerts to utility personnel for necessary action as per rules. If any discrepancy is found, a notification shall be created for a utility representative or process to analyze the tampering event and take appropriate action (for example, to create a service order to investigate).
		Disconnecting connection: As soon a valid tamper event or malfunctioning is detected, connection is disconnected.
		Re- Connecting connection: Once the pre-programmed disconnecting tamper event is NORMAL meter shall automatically perform re-connection and send the notification to HES . Re-connecting connection at meter level: Head-end sends the re-connect command to the meter (could be through the DCU if the solution is defined so)
		Invoicing customer based on tamper: Once the tamper event is confirmed after some analysis, customer is invoiced for the tamper/theft. For tamper related details to be available in customer information system
	Analytics in Tamper Detection TDS	TDS uses the data historian of MDM to derive various analytics for theft detection
		If the AMI Meter/Device is removed and re-installed, the usage pattern of the meter shall be compared with the historical usage pattern.

2.5 Customer has access to recent energy usage and cost at their site

S.No	Requirement	Details of requirement
	Display Device at Consumer Premises	Customer views their energy and cost data on the display device at their site . • The meter/in-home display is remotely configured according to the customer's request
	Internet based Customer requests	Customer requests to view energy data and cost data (up to the current hour) for their site using the Internet

	Real-time messages and pricing signals	Customer receives real-time messages and pricing signals/details on the AMI meter and/or in home/business display device and/or through media like SMS, Email, Portal
	Energy Usage Notifications	utility issues notifications on usage and usage restrictions to the consumer's alternative device (via SMS)
	Outage Notifications	Utility notifies the consumers on planned outages in their area (correlating the feeder and consumer data available in GIS)

2.6 SI installs and configures AMI system

S.No	Requirement	Details of requirement
	SI installs and configures AMI Meters/DCUs/Devices	SI shall install and configures AMI Meters/DCUs/ Devices and retrofit devices (includes all devices from the AMI Meter/Device and downstream)
	Automatically discover Meters	Program mesh network to automatically discover Meters in the network, associate the same with electrical network hierarchy (either at feeder voltage or geographical) at defined interval and update Meter ID information to the Central Server
	Cyber Security and Controls	Cyber data security interfaces with controls maintained from the meters to the system head end. All elements of the AMI system configure support for protection of data, confidentiality, data integrity and operational security. Further, AMI system enables creation and maintenance of accounts, passwords and functionality access levels, along with log details
	Communication Network	SI shall install and configures communication network based on the device models and specifications, communication network can be either wireless or powerline.

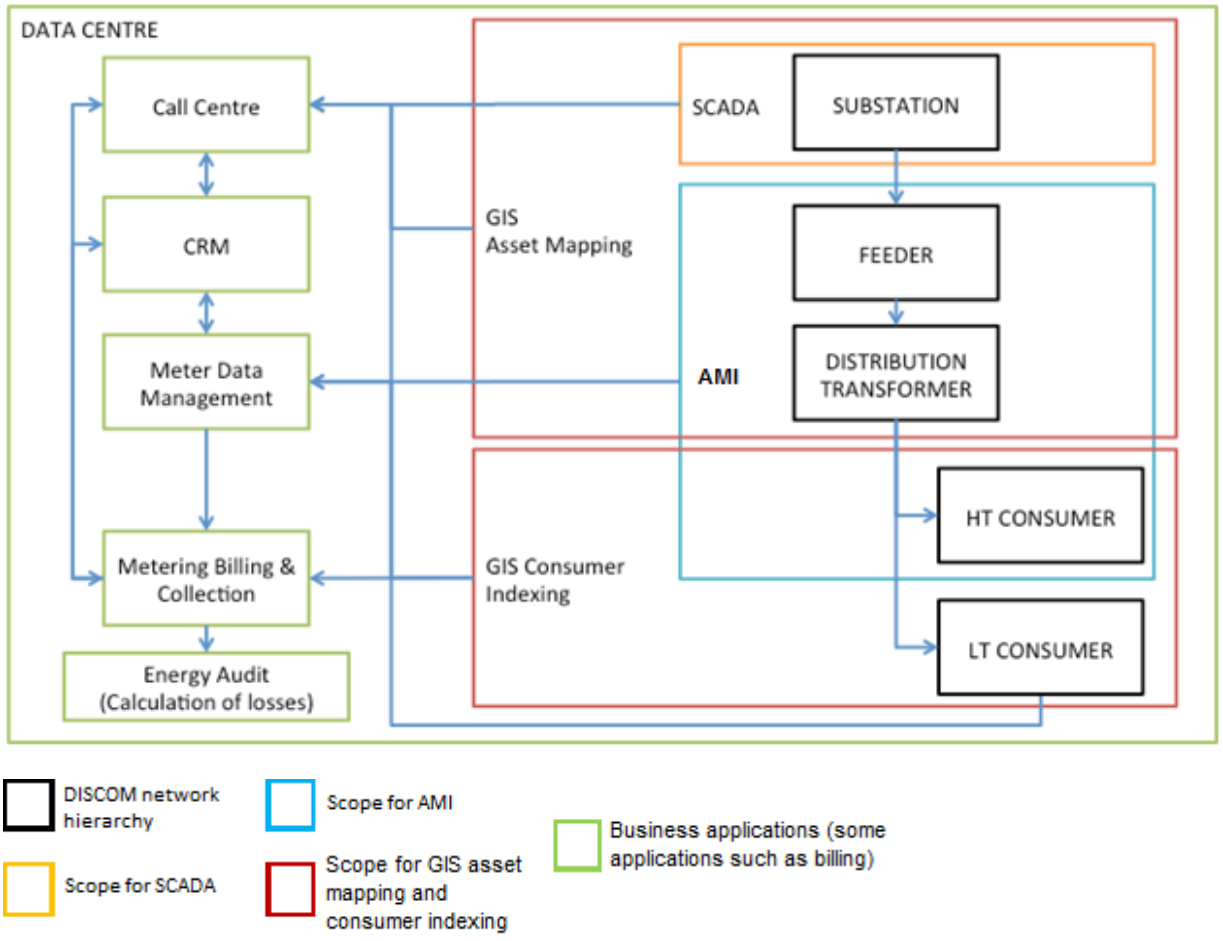
2.7 Meter Asset Management

S.No	Requirement	Details of requirement

	Manage end-to-end life-cycle of the AMI System	SI shall manage end-to-end life-cycle of the AMI system including periodic and condition-based maintenance, Time Synchronisation of AMI Meters/Devices, maintaining internal AMI Meter/Device program ID to support rate changes and load limit threshold value
	Upgradation of AMI System	SI shall upgrade AMI to address future requirements such as Vendor upgrades field component firmware, Vendor upgrades field component software, and AMI System registers customer owned devices for communication on the HAN
	Asset Repository of Meters	SI shall maintain asset repository of meters such as Inventory of the meters, associated assets of meters (SIM cards, modems etc.), Maintenance history and Test results of the meter

2.8 Prepayment Facility

S.No	Requirement	Details of requirement
	Prepaid metering	Utility through the system allows user to enroll for prepaid facility and switch from prepaid to post- paid and vice versa . Scope shall allow for following scenarios • The customer's prepayment balance approaches zero for their site and prepays for additional electricity • The customer's prepayment balance approaches zero for their site and they do not prepay for additional electricity • The customer's prepayment balance approaches zero at his or her site. The customer checks this over the portal or at the display devices. The customer does not prepay for additional electricity service
	Prepayment scheme	Customer prepays for electricity service at his or her site, or owned by the customer (for example, renting to organize an event) for a specific time frame
	Prepayment Alerting System	Utility provides various messages alerting the customer that the prepayment balance on the AMI Meter/Device is low and time remaining before the prepaid account reaches zero. If equipped, this information is passed onto a display device at the event site
	Facilitating Happy Hours	System facilitates happy hours when balance exhausts during holiday, or late night



3 Peak Load Management

The objective of the peak load management iterated for the ongoing smart grid pilots is to optimal utilization of energy resources by uniform distribution of load across the day, to save additional investment in capacity addition within the utility, improved access of power to rural areas, reduction in technical losses, enhanced customer satisfaction by load curtailment in place of load shedding.

3.1 Utility remotely limits usage and/or connects and disconnects customer

S.No	Requirement	Details of requirement
	Load Curtailment event in place of Load Shedding	System will determine based on day ahead schedule for available generation capacity, that a load curtailment is going to take place, advanced notice will be sent to a group of customers affected by this load curtailment. DR system will send the load curtailment command to the MDM. The MDM will forward this command to the appropriate AMI Head-End.
	Sign-up customer	This use case deals with customers signing up for a load curtailment program. Curtailment details are sent to the customers via mail or e-mail. The customer calls the utility or logs on to the utility customer portal to sign up for the program. The customer service representative checks if the customer has the metering device needed for the program and, if not, performs necessary steps for the installation and configuration of these devices. The customer account will be updated to reflect the curtailment program.
	DR Program Commencement	Once the customer is set up with all the devices necessary, the customer details will be sent to DR system. Premium charges for assured power supply with SLA and/or Rebates and incentives can be given to customers who participate in DR programs.
	Load Pattern Forecast	System should be able to aggregate the consumption profiles of multiple customers to find out the total load pattern.
		System shall have a consolidated view of the grid frequency, demand schedule and actual drawal and also estimate the quantum of shortage on near real time basis as well as on day ahead basis. Utility should be able to further drill down to see the list of consumers violating sanctioned / threshold load (at that point in time, historically etc.).Utility shall be able to send a notification to respective load management systems to control the shortage situations thru design of load curtailment program
	Real Time Price Computation	Utility should be able to determine the Daily/weekly ToU Price signals on day ahead/week ahead basis, based on load pattern forecast and Business logics. This ToU price signal can be further redefined to get Real Time Price Signals for next/last interval usage data.
	Real time Pricing	Utility shall be able to send real-time pricing signals to end consumers, using alarms (visual and audio), in home device, mobiles, emails etc.)

	Remote Curtailment Process	The AMI Head-End may update the read frequency of the AMI Meter/Device if required. The curtailment schedule is stored in the HES as well as notified to consumers in advance preferably on day ahead basis, so once the curtailment date/time arrives, the HES will change the load limit of the area meters to say X KW. Once the curtailment end date/time is reached, the HES will again reset the load limit to contract load limit. DR system will forward the curtailment details to Billing System, and Billing System will update the customer account to reflect their curtailment activities. The meter will trip-off for small interval on load curtailment event and reconnect. On repeated occurrence for x no. of times, disconnect meter till load is reduced and manually turned on by customer. The customer shall have the option of manually restoring the supply (with a facility on meter like a push button) after reduction of load .
	Curtailment due to Contract Violation	Utility limits customer's load due to reasons like exceeding contract load
		Alarms (visual and audio) shall be provided in case of load violation (in home device, Email, SMS etc.). The billing system shall be notified of the load violation, and the corresponding charges shall be applied to customer (based on tariff rules).
	Forced Curtailment	Utility shall be able to curtail the load during shortage situations (even when load curtailment event was not planned) with the intent to avoid load shedding and instead opt for load curtailment.
		Customers having segregated wiring for light load and power load, the power load to be disconnected by utility for load curtailment. For customers without this segregation, customers will manually reconnect the meter after reducing the load (or give an option to the utility to reconnect the meter after a gap of x minutes).
	Special provision for Defaulters	System should provide details of the defaulters who are liable for disconnection due to credit or collection cause, disconnects (or limit load to 50W) customer for credit or collection cause, acknowledge the defaulters who made payment against disconnection due to credit or collection cause (can be an integration with existing system if already exists), as well as reconnects (or resumes load to normal contracted level) customer following credit and collection disconnect.(reconnection after making payment)
	Demand side Management	In every 15 minute interval Meter data should be captured , Confirmation of action taken for demand response should be mentioned as well as monitoring of historical Customer Load Profile should be done.

	Load Monitoring at Demand side	Daily Meter Reading, Status and associated details capturing for records of customer consumption data, TOU details, real time trends and Load profile Details. Along with this whenever there is a load violation event recorded in the meter, the information is sent to the control center
	Provision of Re-checking for Automatically generated disconnection or Load limiting commands	Automatic generated disconnection or load limiting commands go through the set of checks and approval (as per business rules), to ensure that no connection should be disconnected due to a mistakenly generated disconnection document.
	On Demand Disconnection / Reconnection	Customer requests routine disconnection / reconnection, by using SMS or AMI device or over Internet.
	Initiate Direct Load Control Event	Utility calls a Direct Load Control Event using the Peak Load Management (PLM) Application and executes through head-end by sending a load control signal to Smart Appliances thru HAN/Smart meter or other means
	Provision of Re-checking for Automatically generated disconnection or Load limiting commands	Automatic generated disconnection or load limiting commands go through the set of checks and approval (as per business rules), to ensure that no connection should be disconnected due to a mistakenly generated disconnection document.
	On Demand Disconnection / Reconnection	Customer requests routine disconnection / reconnection, by using SMS or AMI device or over Internet.
	Initiate Direct Load Control Event	Utility calls a Direct Load Control Event using the Peak Load Management (PLM) Application and executes through head-end by sending a load control signal to Smart Appliances thru HAN/Smart meter or other means

Figure: Different models for Demand Response available to DisComs- For Pilots DISCOM will play the role of DRA/CSP depicted in the center box highlighted in brown colour

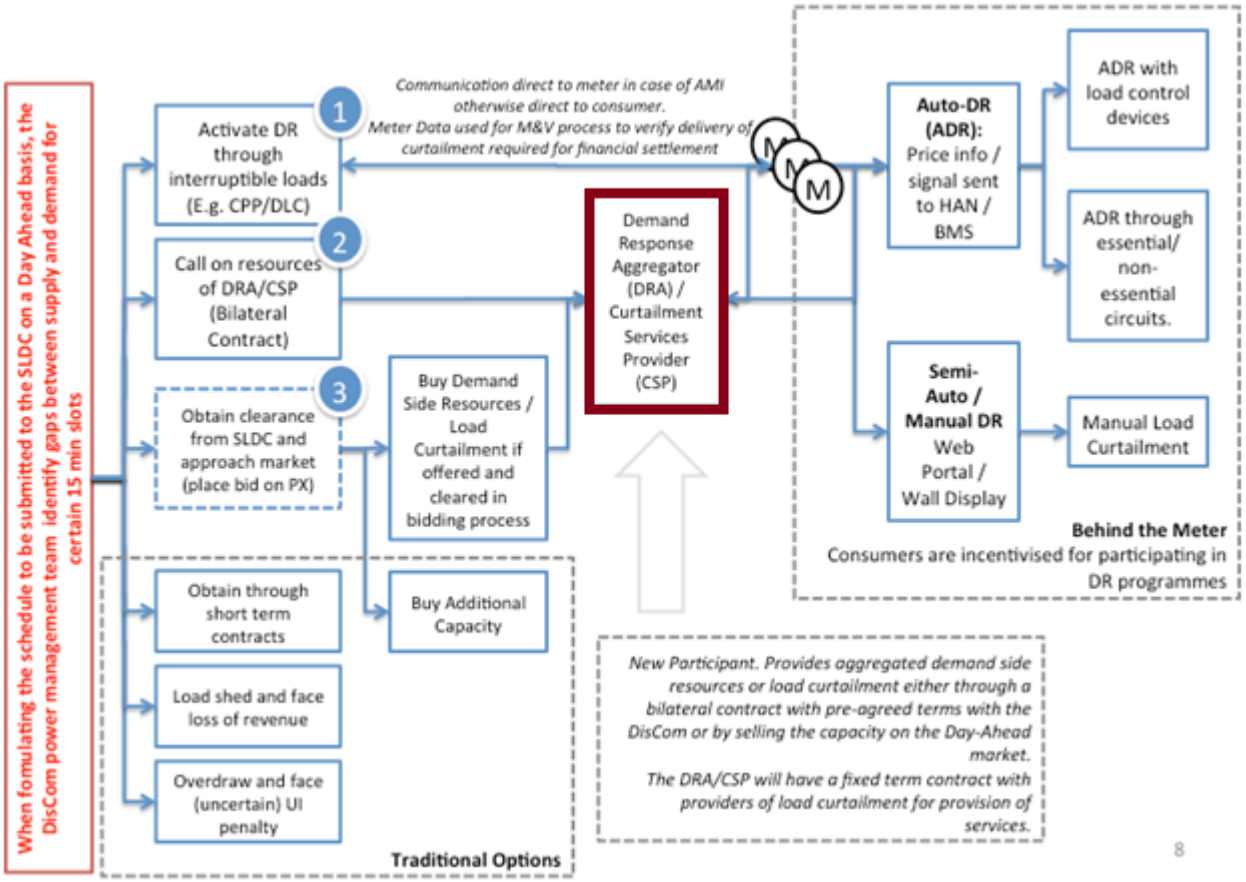
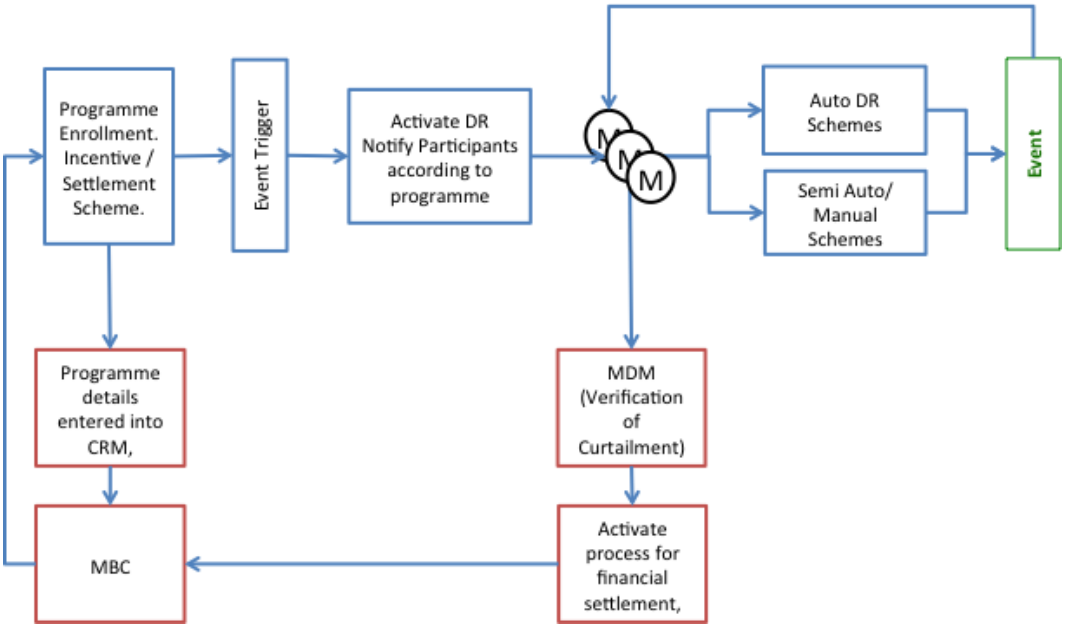


Figure: Process when activating DR through interruptible loads e.g. Critical Peak Pricing (CPP) or Direct Load Control (DLC) programs



4 Outage Management

Outage management is extremely important for the Utilities and the customers they serve. The Utilities will leverage existing OMS (if exists) and utilize the capabilities of AMI and grid automation to improve grid reliability by self-healing and more quickly and accurately identifying the location and magnitude of an outage, resulting in faster restoration.

The objective of the outage management iterated for the ongoing smart grid pilots is to improve availability and reliability, customer satisfaction, proactive maintenance to avoid failures

4.1 Distribution operator locates outage and restores service

S N	Requirement	Details of requirement
1	Power Supply interruption	AMI Meter/Devices shall record outage event. (AMI Meter/Devices detect a power loss after processing preprogrammed checks for false indications.).
		AMI Meter shall notify the outage event to head-end as and when occurred/recorded (even when there is no power at the meter end)

		The head-end system shall record outage information on a meter-by-meter basis.
		System shall receive outage events from the head-end, and generate alarms for genuine outages (system shall have the capability to define the genuineness of the outage – like momentary outages at consumer end will not be treated as outages etc.)
		Metering System will send only that power on/off events to outage management system which is not momentary. Prediction engine shall use this data to identify a potential outage event.
		The utility shall be able to get an option where in the outage events received from meters are correlated with the power availability status at transformer/feeder level to identify whether it is a system level outage or single light out.
		The utility should be able to view the above over a spatial display which could be using the existing GIS system (or alternatively through options like Google maps, Bing, SLD etc. if GIS does not exist)
		System shall request verification of outstanding orders scheduled for that day related to meter reporting loss of power. If there is a result, the message shall be logged but not sent to OMS.
		MDM shall process a loss of power event with a configurable time interval delay to avoid alarming for momentary power drops or voltage sags.
		The normal process for loss of power messages from the meters would be to check Enterprise Asset Management systems for orders under execution and to check OMS for planned outages at the service location. Any hits will be logged for later analysis. If there are no hits, the individual message shall be passed to OMS.
		There will be a configurable counter and a timer so that upon receipt of a loss of power event, MDM will begin aggregating event messages into lists for upload to OMS if the configurable number of events (for example , 500) are recorded in a configurable time period (for example, 5 minutes).
	Customer Care	OMS sharing information about Restoration time, type of Outage, customers affected with customer care system

		Conventional channels of communication, like the call center shall receive calls notifying the utility of an outage.
		The call center/ customer care executive(CSR) shall be able to receive calls regarding the outage and is able to query OMS for available information
		The call center and other sources, such as IVR or a customer portal shall be able begin to produce outage notifications as customers begin to communicate through these channels. The notifications should be passed to OMS through interface with enterprise asset management systems.
	Outage	OMS shall calculate outage location (Utilizing the data from the AMI, GIS, DMS and other system and other sources, OMS shall determine a probable location for the problem)
		Outage order is created and issued (OMS, through its existing interface with Enterprise Asset Management Systems/workforce systems, creates an order for field distribution personnel, and they are dispatched to the selected location.
	Workforce Management	System shall provide the option to plan for crew management and dispatch (to be integrated with existing crew management if available)
		System to assign a service crew for restoration and equipment to crew for repair through Mobile workforce management.
		Field crews restore service. Field crews determine the repairs required to restore service and complete work. (Information systems are required to identify field crews, schedule the field crews, identification of materials should be done through IT systems)
	Outage Priority Mechanism	System shall be capable of aggregating power outage events or indications from individual meters into lists for processing, in order to avoid overloading communication with OMS. System shall be able to prioritize the notifications from feeder/DT/consumer meters, and suppress the events at lower level in the hierarchy (e.g. if outage at feeder, then events from DT/consumer will be suppressed).
	Planned Outage of Electrical equipment	System shall provide an option to maintain the list of planned outages with details like feeder code/name, date and time, duration (or integrate with the systems if already in place which maintain this data).

		MDM shall request verification from OMS of planned outages in the service area relevant to the meter reporting loss of power. If there is a result, the message is logged, but not sent to OMS. If there is no result, the message should be sent to OMS.
		SCADA receives requests for planned outage/restoration from Asset management system and sends this information to OMS for Outage Planning execution / maintenance and restoration of service
		OMS sending the scheduled or unscheduled outage and restoration information to customer care for further dissemination of this information to the concerned customers through telephonic call/Email/SMS
	Outage Restoration	Activities performed for restoring the outage are recorded and updated in the related systems. System shall have the capability of displaying historical activities of similar nature.
		AMI Meters/Devices shall detect restoration of power and record the event and MDM shall be able to receive power restoration events from the meters. The aggregated event data is sent to OMS for processing.
		The AMI system shall record the duration of outage for later statistical analysis and calculation of KPIs like SAIFI, SAIDI etc
		OMS shall request check for non responsive meters. (The outage completion data from the field and the restoration events from the AMI Meter/Devices shall be analyzed by outage management, and a request will be sent to through an interface with the AMI system to verify if a subset of meters are still without power.)
		If outage management determines that outage is not completely over (based on the check for non responsive meters), field crew will be notified for necessary action/ restoration of power for the left out consumers.
		MDM shall check the status of AMI Meters/Devices (MDM shall poll or ping meters to determine their status and reports response or lack of response to OMS. Based on the additional data from the AMI system, outage management may dispatch the field crews to alternate locations to perform additional work to restore power).
		When outage management determines that the outage is over, OMS shall complete the outage order and closes any outstanding notifications related to the outage through its interface with Enterprise Asset Management Systems.
		System shall track outage duration and customer minutes

		out. The system shall track and display the outage duration and customer minutes out for every outage. This information is shall be updated regularly as time passes and as partial restoration steps take place.
		Operator or system shall be able to restore an outage. Operator shall be able to mark customer and secondary outage jobs as restored manually. The system shall automatically determine if all outaged customers part of a transformer, device or higher level outage have been restored. In these cases, the system shall transition the outage job to the 'Restored' state.
	Safety	System shall provide a warning to the operator if a network operation affects a crew. If a Pre-Thermal Warning (PTW) has been issued on any segment of the network and field crew working on this segment, the operator should be warned and any remote network operation is blocked.
	Reports	OMS calculates and send performance indices SAIDI, SAIFI, etc., to SCADA
	OMS Database	OMS database for Distribution Network Model, Consumer data, interconnection system, and Equipment data either using GIS system and/or ERP system and/or direct entry
	Real Time Network status Data for OMS	OMS acquiring real-time status of all Circuit breakers including date & time of tripping, cause of tripping, Expected duration of scheduled outage from SCADA
	Outage Notifications	Utility notifies the consumers on planned outages in their area (correlating the feeder and consumer data available in GIS)
	Switching Operations	SCADA sending network status update i.e, telemetered status change indications from switches, to OMS
	Manual Switching operations	DMS sending manual switching operations for non telemetered points as a part of network status update to OMS
	Outage Prediction	System reports assimilation of outages through MDM to OMS and OMS carry forward the prediction of the affected equipment

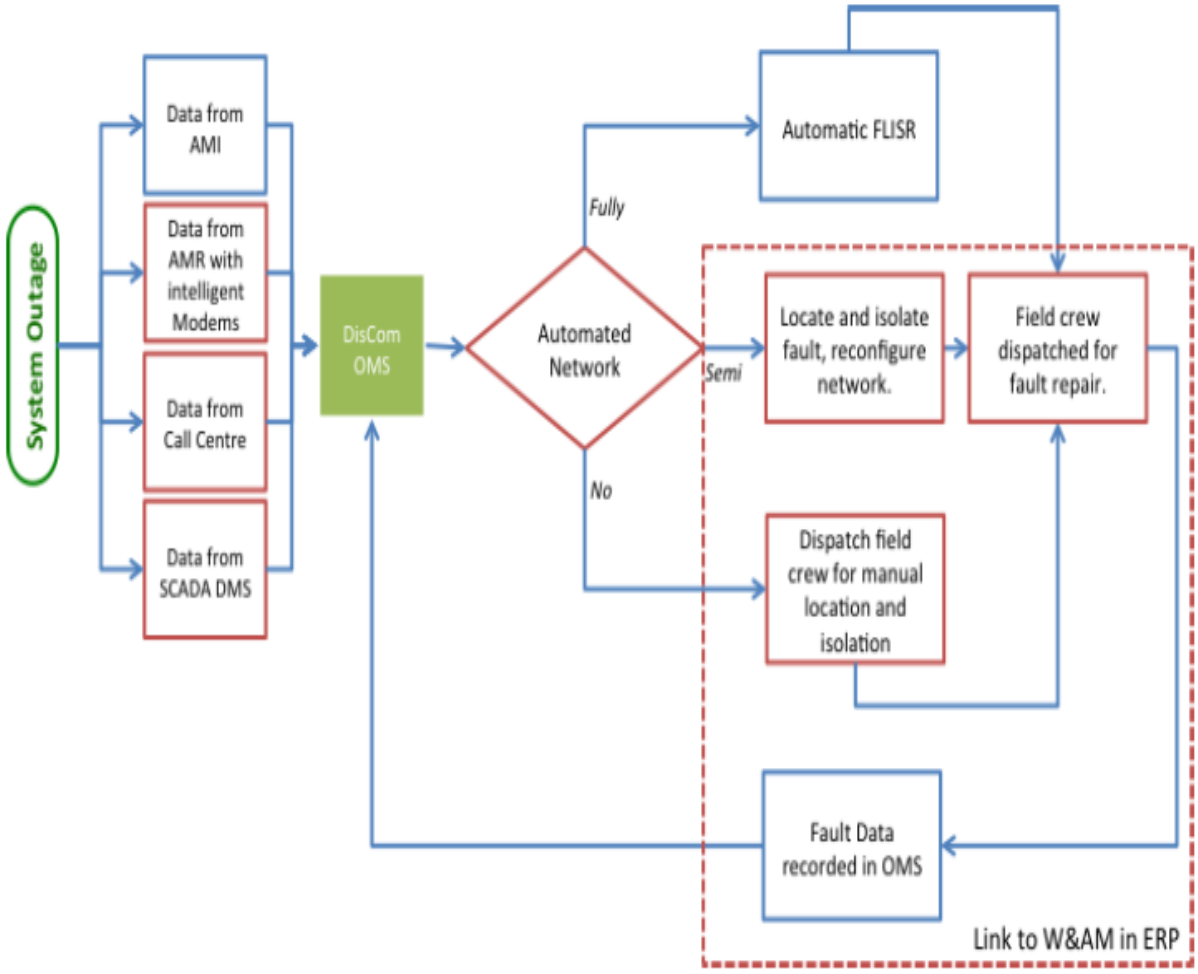
	Storm Management	SCADA updates EHV outage to OMS for management of incoming outage requests
	Cyber-security interfaces	Encryption layer to the data streams emerging IN/OUT from OMS
	Outage Verification	Validating FPI signals received to OMS on outages for any momentary changes in system parameters
	Scheduled or Unscheduled Outages /Restoration notification through customer care	OMS sending the scheduled or unscheduled outage and restoration information to customer care for further dissemination of this information to the concerned customers through telephonic call/Email/SMS
	Fault detection, outage record creation and SERVICE Restoration	SCADA receives requests for planned outage/restoration from Asset management system and sends this information to OMS for Outage Planning execution / maintenance and restoration of service

4.2 Distribution Transformer Monitoring

S.No	Requirement	Details of requirement
	Online monitoring system	Online monitoring system monitors vital parameters of a distribution transformer (oil level, winding temperature, ambient temperature) in real time using sensors/ transformer monitoring unit/ AMI system/ contacts of built in gauges (sensors if not available inbuilt in transformers, need to be retrofitted as part of the solution by service provider) and records data in the MDM database
	Historical Data	Utility should be able to maintain the history related to past maintenance activities done on transformer, Measurement records (received from online condition monitoring, DT meters), corrective actions, any modifications, changes etc&utility should be able to retrieve this whenever required Utility should be able an analysis of the distribution transformer health performance historically (transformers of similar make failing frequently, transformers failing frequently during this month of the season, number of

		failures of the same transformer in the past 12 months, geographical area etc.)	
	Alarm notification system	Alarm notification system generates alarm for abnormal health parameters of the distribution transformer (e.g. load crossing threshold, temperature crossing threshold) for the Utility to initiates a notification to concerned official for immediate action (maintenance action if needed, curtail load of consumers on that transformer if needed etc.)	
	Online Redressal System (ORS)	ORS to trigger a trip off event (to RMU or consumers below) if abnormal health parameter event occurs/persists for certain time duration, or the condition which is crossing next threshold and records the same at MDM	
	Real-time KPIs based monitoring	No of Breakdowns	No of Outages per DT
		Breakdown Duration	Total Outage Duration per DT
		Asset Availability	Ratio of Total Duration for which Asset is Operational to Total Expected duration for which asset should be in Operation
		MTTR/MTBR for Transformers	Mean time to Repair/ Mean Time Between Repair
		Distribution Feeder Load Analysis	List of Overload Feeders per substation , Division, sub division
		Transformer Load Analysis	List of Overload Transformers per Region, Locality
		Transformer Health Check	Transformer winding Temp, Transformer Oil Temp Temperature band in which transformer operates (standard operating value vs. actual curve) along with duration

Figure: Processes and Infrastructure for OMS



5 Time of Use and Real Time Pricing

There are 2 ways of executing time of use and real time pricing

- Billing System sends requests to MDM in order to execute the Time-of-Use formula remotely : Interval/ToU meter readings are stored in MDM
- Billing System execute the Time-of-Use formula directly in the Billing System Energy Data Repository : Interval/ToU meter readings are stored in the Billing System energy data repository

S.No	Requirement	Details of requirement
	Execution of Time of use and Real time Pricing	• Billing System execute the Time-of-Use formula directly in the Billing System Energy Data Repository ○ Formula interface and algorithm is implemented in Billing System ○ Time of use blocks are defined in the Billing System ▪ Each time block is assigned to an Time-of-Use formula ○ Billing process in is executed ▪ Time-of-Use formulas are executed directly ▪ Values are assigned to Real Time Pricing values

		• Billing System sends requests to MDM in order to execute the Time-of-Use formula remotely
		  ○ Formula algorithm is implemented in the MDM system and formula interface is represented in Billing System
		  ○ Time of use blocks are defined in the Billing System
		  ▪ Each time block is assigned to an MDM formula
		  ○ The Billing process in Billing System executes the billing run

6 Power Quality

Managing voltage, frequency etc within certain thresholds etc allows electrical systems to function in their intended manner without significant loss of performance or life. The objective of the Power Quality functionality iterated for the ongoing smart grid pilots is to improve Customer satisfaction, reduction in losses, and increase in Employer Revenue by charging a premium price for specific power quality requirements of the customer if mutually agreed .

S.No	Requirement	Details of requirement
	Power Quality Categories	IT system integrated with MDM stores various power quality records and calculates KPIs in the Utility, Consumer, and Distributed Generation categories/ perspectives considering parameters like Power factor, Total harmonic distortion, Spikes, Impulses, Flicker, Sag (momentary under voltage), Swell (momentary over voltage), Power on/off, Over voltage and under voltage
	Install Voltage / VAR Control (VVC)	System Integrator to install VVC-controllable devices (set to Transformers, capacitor banks, Inductors, etc)and monitor the set of telemetered voltage measurements associated with each . If System detects a limit violation, it advises the corrective control actions.
	Site selection and Installation	For the pilot area SI suggests sites for permanently installed power quality monitors and installs them

	Power Quality Event Capture and Transmittal	Power quality instruments capture and transmit the events and performance monitoring results based on defined baselines to IT system/MDM
	Data Storage, Characterization and Reporting	Based on events recorded in IT System, data is characterized and loaded into a database and reports are generated for the customers
	Real-time Alerts	IT system provides alerts on violation of parameters in real-time and identify the source of power quality disturbance

7 Distributed Generation/ Renewable Integration

Development and implementation of new and innovative technologies for distributed generation includes technology, products, and vendors and solutions evaluation and design of suitable solution for managing renewable integration. Examples are technologies and solutions related to EV/PHEV (Plug-in Hybrid and/or Electric Vehicles), wind, photovoltaic and other distributed generation technologies, systems and solutions supporting flexibility of interaction with customers, energy usage/exchange, demand and losses management, management of transactions, pricing and billing, etc.

Integration of Renewable sources improves reliability of smart grid but poses a variety of issues like dynamic response and advanced protection to take into account the bidirectional flow of power. When Renewable energy sources are connected to the distribution system, the power flow gets altered and this would necessitate a change in the protection system settings. Also, sudden connection or disconnection of renewable energy sources due to faults etc. may result in unacceptable transients in voltages in the distribution system which needs to be addressed. Forecasting of the renewable is another challenge. These and other issues if any shall become part of the solution designed for managing Renewable Integration through the ongoing smart grid pilots.

The objective of "Distributed Generation/ Renewable Integration" functionality iterated for the ongoing smart grid pilots is to ensure sustainable growth, improve power access in rural area, and encourage prosumer enablement.

S.No	Requirement	Details of requirement
	Single Window Clearance for Connecting DGs to Grid	Setting up of DGs on a commercial basis i.e, increased grid- interactive energy will attract (directly/ indirectly) various permissions. Utility encourages Single window clearance for giving necessary approvals and clearances in time bound manner to facilitate DGs penetration into the grid.

	DG Enrollment program	Customer applies for interconnection of distributed generation system (generation capacity, capacity available for grid, customer details etc.). • The customer care system shall provide multiple interfaces to provide single or bulk enrollments to DG programs • The website shall be the point of access to enroll in DG program for all enrollments. • The customer care system shall validate customers for DG programs (service address, account number, name, generator interconnection data). • Each DG will have its own AMI Meter/Device that will act as the gateway. ○ The AMI system shall measure the following per-generator quantities (if present) on an interval or TOU basis: ▪ Watt-hrs generated ▪ VAR-hrs generated ▪ VAR-hrs consumed ▪ All these quantities shall be independent (for example, the VAR-hrsare not "netted" by the AMI Meter/Device). ○ The AMI system shall measure the following quantities at the point of common coupling ▪ Watt-hrs consumed from utility ▪ Watt-hrs generated by customer and sent to utility ▪ Var-hrs generated ▪ Var-hrs consumed ▪ All of these quantities shall be independent (for example, the Watt-hrsare not "netted" by the AMI Meter/Device). ○ The AMI Meter/Device shall be able to be re-programmed remotely to support bi-directional metering. This reprogramming event will be logged in the AMI Meter/Device and sent back with the

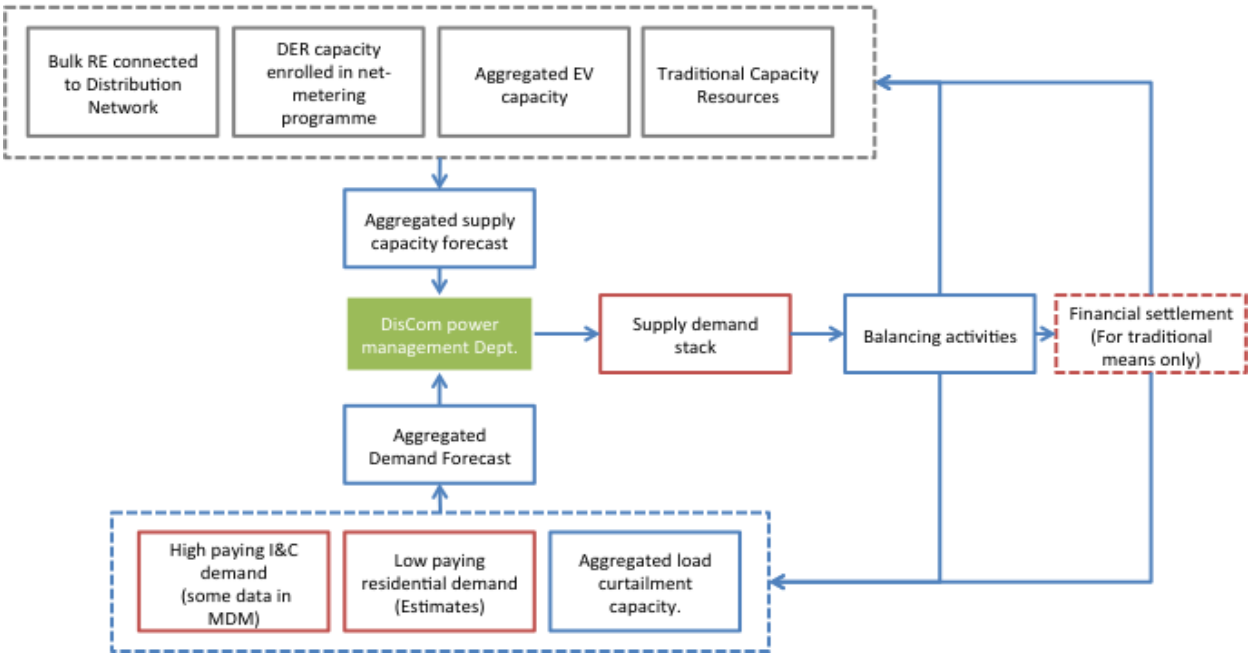
	Interconnection Approval	Utility assesses the application through that system that provides technical transformer capacity and loading, contractual (connected load), harmonics and other considerations. Utility then provides an NOC to the customer for distributed/ renewable generator integration.
	Preparatory Phase for final setup	Once the utility gives an NOC to the customer, the customer will construct the distributed generation system, and then request the utility for its commissioning by providing connectivity or installation/ replacement of meters.) Utility will inspect the installation of the distributed generation system, certify it and commission it.
	Remote Connection/Disconnection	Utility shall be able to connect or disconnect the connectivity of the generation source remotely based on situations like system over load, unexpected back feed, maintenance related work etc.
	Generation forecasting for DG system	System shall give information on generation forecasting of renewable generation/distributed generation sources (e.g. roof top solar) in the area, which can be day ahead/week ahead. This will help the utility assess/estimate the demand vs. generation availability (conventional plus renewable).
	Net-metering model for DG integration	DG system is connected on the customer side of the meter, and the conventional meter is replaced by a bi-directional net-meter. Here coustmer will be billed on net-consumption at the end of billing cycle. If customer is a net –generator at the end of the billing cycle then he will be provided credits towards next billing.
	Gross – metering /feed-in tariff/two-meter model for DG integration	DG system is connected on the DisCom side of the meter.Here, the renewable energy fed into the grid is accounted directly through a dedicated meter, and the customer bills the DisCom based on the feed-in tariff. One meter will be installed at the interconnection point of the generation source. The second meter shall be installed at the consumption point.

	Remote monitoring	Utility remotely monitors the net-meter or gross-meter at a pre-determined interval (15 mins to 24 hrs).
	Billing In case of net-metering	If the consumer is a 'net-consumer' at the end of the billing cycle, then the utility will bill the consumer based on the meter reading itself. Not much changes in terms of meter reading. The appropriate policy/regulation shall be applicable.
		If the consumer is a 'net-generator' at the end of the billing cycle, then the utility will have to reimburse/ credit/ off take the power for free based on a pre-determined rate/ understanding/ policy/ regulation. The appropriate policy/regulation shall be applicable.
	Billing In case of gross-metering	The utility will reimburse the consumer based on a pre-determined feed-in tariff based on the applicable scheme/ policy/ tariff. Further, if the gross-meter is linked to a consumer account, then the energy consumption and the energy generation bills of the consumer could also be merged into one. The appropriate policy/regulation shall be applicable.
	Validation of DG system	Comparison of outputs of nearby distributed generation sources based on GIS proximity / nearby weather monitoring systems and check of irregularities
	Synchronization requirements for Protection Relays	The connection of the DGs shall not cause a voltage fluctuation at the point of common coupling greater than ±5% of the prevailing voltage level of the area power system at that point.
	Area energization requirements for Protection Relays	The DGs shall not energize the area power system if it is de-energized.
	Fault in a circuit with DER connected to healthy section cleared by fast circuit breaker trip and by reverse protection from DER fault injection creating a self-sustainable island	DERMS/DMS receives the scan of SCADA data and historic load data to be checked for changes in topology and loading during the time of repair.

		DERMS/DMS determinesthe sufficiency of the island during thetime of repair and enables FLISR for location of the fault within the de-energized section.
		DERMS/DMS determinesthe insufficiency ofthe island during theportion of time of repair and enables FLISR for location ofthe fault within the de-energized section and solvingrestoration for the customers connectedto the island.
	Fault in a circuitwith DER connected to healthy sectioncleared by fast circuit breaker trip andby reverse protection from DER faultinjection, creatingan insufficient island	DERMS/DMS receives thescan of SCADA data and historic load data to be checked for changes in topologyand loading duringtime of repair.
		DERMS/DMS determines the insufficiency ofthe island during thetime of repair and enables FLIR forlocation of the faultwithin the de-energizedsection and solving restoration for thede-energizedcustomers connectedto the island.
	Fault in a circuitwith DER connectedto faulty sectioncleared by circuitbreaker and by relayProtection of DER.	DERMS receives thescan of SCADA data and historic load data to be checked for changes in topologyand loading duringtime of repair.
		DERMS/DMS determines the after-faulttopology, the loading during the time of repair, andenables FLIR for location of the fault and solving isolation of the fault and restoration for thede-energized customers connected to the healthyportions of the Feeder.
	Gross and Net metering of Generation - Demand and Energy Data Automatically from Prosumer Premises	Requesting instantaneous, interval and events data from the meters and create profile in Billing. Portal services to view energy data
	Contract Management for DG installations (banking, carry over, smart tariffs)	Identifying implication of relevant policies and regulations. Mapping existing and new DG contracts on system
		Generating reports based on transaction information as per defined periodicity Identification of banking, carry forward/lapse information and sending to billing system
	Generation Forecasting System	Forecasting of generation based on DG system availability and weather inputs

	Aggregate demand and net demand forecasting for pilot area	Identification of likely demand in pilot area for identified time periods based on past trends, Weather forecasting and based on immediately preceding periods (week, day, hour)
	Transformer level flow monitoring to detect/predict back-flow. Prioritised remote disconnection for backflow	DG Outage and Restoration Notification
		DG Outage and Restoration Notification
	Power outage management - remote disconnection and reconnection	Power Outage and Restoration Notification (if OMS subscribed for events)
	Visibility of gross and net generation/demand to prosumer	Instantaneous Meter Read (status and data) of gross and net meter

Figure: Processes and infrastructure for RE forecasting, scheduling and settlement



8.0 Micro Grids

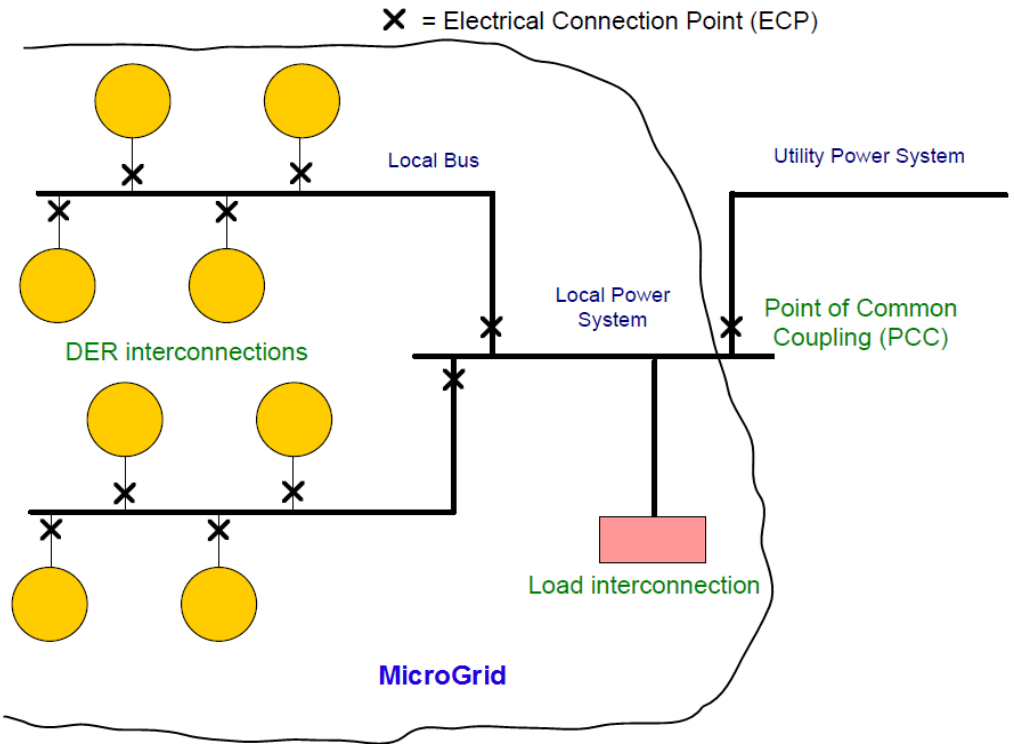
MicroGrids are modern, small-scale versions of the centralized electricity system. They achieve specific local goals, such as reliability, carbon emission reduction, diversification of energy sources, and cost reduction, established by the community being served. Like the bulk power grid, smart MicroGrids

generate, distribute, and regulate the flow of electricity to consumers, but do so locally. Smart MicroGrids are an ideal way to integrate renewable resources on the community level and allow for customer participation in the electricity enterprise.

The objective of MicroGrid functionality iterated for the ongoing smart grid pilots is to tap the potential for renewable resources, Improve power access in rural area, reduced carbon emissions, and test autonomous operation of the grid. Some of the requirements will be common for Distributed Generation and Micro Grids and can be proposed by SI to ensure smooth grid integration of Renewable energy sources.

S.No	Requirement	Details of requirement
	Execute scheduling command	Energy Management System starts development of supply plan in day-ahead
	Acquisition of weekly weather forecast information	EMS acquires weekly weather forecast information
	Acquisition of past demand and output records data	EMS acquires past demand (electricity, heat) and output (PV solar, Wind Turbines) records data.
	PV Solar & Wind Turbine output forecast	EMS forecasts PV Solar & Wind Turbine output based on weekly weather forecast and past output records data.
	Acquisition of remaining fuel level (incase of Biogas, Bio-diesel, diesel, gas plants in the Microgrid)	EMS acquires remaining amount of fuel
	Acquisition of State of Charge (SOC) of battery	EMS acquires SOC of battery
	Development of supply plan	EMS develops supply plan based on electricity demand forecast, remaining fuel level and SOC of battery
	Optimum scheduling command in Real-time	EMS commands optimum scheduling in real-time. It can be selected from minimization of CO2 emission or minimization of cost. The mode is selected by the operator in advance
	Acquisition of real-time information	EMS acquires real-time information of generating sources, loads, voltages, etc.

	Load Frequency Control (LFC) Command [grid connected mode]	EMS provides gas/diesel engine with LFC command and battery with charge / discharge LFC command so that the power flow at the PCC conforms to the purchasing power determined in the supply plan
	Protection Relays in Microgrid	Numerical protection relays with voltage inputs should be provided at the node of connection of distributed generation source with the utility's network. The protection relays must be with selectable protection group settings which could be possible to configure locally or from remote. System power flow studies should be done with the various scenarios of distributed generation in feeds in order to determine the required settings of the protection relays.
	Voltage requirements for Protection Relays	The DGs in Microgrid shall not cause variations in the area electric power system (area EPS) service voltage at other areas.
	Grounding requirements for Protection Relays	The grounding scheme of the DGs interconnection shall not cause overvoltages that exceed the rating of the equipment connected to the area EPS and shall not affect the coordination of the ground fault protection on that area.
	Synchronization requirements for Protection Relays	The connection of the DGs shall not cause a voltage fluctuation at the point of common coupling greater than ±5% of the prevailing voltage level of the area power system at that point.
	Area energization requirements for Protection Relays	The DGs shall not energize the area power system if it is de-energized.



9 Visualization and Analytics

Visualization and analytics are integrated part of the ongoing smart grid pilots for effective realization of the proposed functionalities.

S.No	Requirement	Details of requirement
	Hierarchical Visualization	Utility control center staff acquires the view/visualization of distribution network, AMI based on organizational hierarchy or electrical hierarchy or geographical, with respective authorization

	Integrated real-time and historical views	IT system with MDM creates an integrated real-time and historical views into the incidents & events, in context of functioning, for the purpose of optimizing command center operations (from the metering and grid management systems, KPIs)
	Operational Analytics System	Operational analytics system to analyze vast operational data (voltage, Current, power flow, temp etc) of asset collected over the period of time , to help in identifying the problem areas & bring out actionable intelligence to make better decisions
	Meter level event Routing for visualization and analysis	Utility acquires various events occurring at meter level from MDM to perform subsequent business process and analyze events like error in transferring meter results from the smart meter, malfunction during a smart meter self test, validation error, energy related events and non-energy events, Meter reading outside of the predefined range (overvoltage , under voltage, load violation etc.) and displays summary results in a graphical interface
	Centralized Message Notification Solution (CMNS)	Centralized message notification solution that allows authorized personal and/or business processes to send messages to target audience using multiple communication methods including SMS, Voice, Email for notifications, orders, exception management
	Event Correlation Engine (ECE)	ECE correlate events coming from different sources e..g. outage event coming from a meter/MDM/ other equipment in the network and an outage event coming from the DT /feeder/other equipment s in the network to which the consumer is connected and makes smart decisions for effective grid operation
	Real-time view of energy	SCADA and MDM provide the data to IT system to generate real-time view of energy losses across the network and display poor performing feeders/lines over a geo spatial map, where the operator can further drill down to see the consumers with tamper events, payment defaulters, load pattern on the transformers/feeders, phase imbalance etc. on the poor performing lines/DTs

	Identifying and visualizing poor performing feeder	IT system integrated with MDM and SCADA identifies a feeder/DT as poor performing based on multiple criteria like energy losses, billing efficiency, payment efficiency, outage duration etc. and generates appropriate colour coding (lines with losses above a threshold to be shown in red, and lines with losses in medium range to b shown in light orange etc.) for visualization using SCADA and MDM data, wherever appropriate.
	Customer profiling and segmentation	IT system integrated with MDM analyse multiple customer consumption profiles & generate the consumption pattern for a group of customers (grouped like hostels, hospitals, movie theaters, suspected, residential, commercial, load bucket etc.),used to understand their Consumption behavior
	Market Management System	Market management system integrated with MDM and portfolio management provides consolidated view of the near real-time grid frequency, demand schedule and actual drawal from load dispatch center, and top consumers (considering open access agreements also) contributing to over drawal from AMI. Utility should be able to further drill down to see the list of consumers violating sanctioned load (at that point in time, historically etc.). Based on the information available, decisions regarding load management shall be taken by the utility

	Trend Analysis	System shall compute/source from other systems have an integrated view of all key performance indicators, showing the target value and actual value. In addition to the latest KPI values, the system shall also give trend analysis (based on historical data) • Outage related KPIs ▪ SAIFI, SAIDI [as applicable] ▪ CAIFI, CAIDI [as applicable] ▪ Total number of consumer level interruptions, consumers affected and duration, and corresponding estimated revenue loss ▪ Interruptions reason wise view ▪ MTTR/MTBF • Total contract load vs. total load at that point in time • Average load duration curve vs. actual load duration curve • Reading efficiency (%), Billing efficiency (%) and payment efficiency (%) • Transformer failure rate • Top [five/ten]feeders/DT's loss level wise or outage wise or consumption wise etc. • Current demand raised vs. payment received

Suggested Functional Specifications - Smart Grid Analytics Implementation

1. Analytics for Load Forecasting and Load Research

Load forecasting is required for defining the requirements of the networks transmission capacity, approximating the transmission loss, estimating the existing networks capability to transfer increasing loads and create effective demand response programs.

As part of the Smart Grid initiative DISCOMs are expecting the following to be configured:

- Ability to forecast short term as well as Long term electricity demand is fundamental pre-requisite for the proposed tool.
- Granular level of forecasting must be performed as a hierarchy from system level, feeder level and capability upto meter level so that it help utilities understand which segments of customers are using more electricity versus which segments are using less - there by coming up with the pricing strategy, distribution-asset planning, capacity augmentation etc.
- Create the Decomposition of electricity load Demand into lower granularity of time dimension and geographical dimension.
- In order to facilitate decision making for surplus/shortage, the long term forecast then further need to be decomposed at lower level granularity.
- Annual into seasonal
    - Incorporates the shift effects across season
    - Seasonal into monthly
        - ➔ Incorporates the shift effect across month for any given season
    - Monthly to weekly
        - ➔ Incorporates the shift effect across weeks if any for any given month
    - Weekly to daily
        - ➔ Incorporate shift effect across the days for any given week: for example weekdays are different from the weekly.
    - Daily to hourly load shape.

- ➔ Incorporate shift effect across different hours within a day to incorporate the shifts like peak and off peak hours.

- **Day Ahead Short Term Demand Forecasting:**
  - 1 hour Feeder Level Load Forecasting for the distribution company across 340 sub-stations.
  - Configuration of the load forecasting solution for day ahead 15 mts interval. It should include configuration of the diagnostic process for baseline forecasting and adding effects such as Recency Effect, Calendar (Weekend Effect), Holiday Effect.
  - Configuration of the 2 stage residual modeling with temporal and geographical hierarchy.
  - Configure the error analysis and outlier detection.
  - Configure the scenario planning for changes in events, explanatory variables.
  - Configure the recency effect, holiday effect, weekend effect, special event / festival effects.
  - Configure or Build the medium term and long term load forecasting taking into consideration macro-economic data, weather data. SI to source, collect and build a repository of data from third party service provider if applicable.

- **Position mapping:** To understand the position GAP (i.e. demand and supply if any) so that a long term position mapping strategy can be devised to appropriately optimize on long term and short term power purchase agreement.
  - To understand the likely day ahead position GAP (i.e. Gap between demand and supply) on a granular basis (Load shape), to ensure that the gap is bridged optimally.
  - Create the baseline shape, the seasonal shape and the peak load profiles.
  - Long term demand forecasting should generate the total likely demand for the future years (Peak & off peak)

- **Power Scheduling:**

  The solution should recommend power purchase schedule in an automated fashion. Long and medium term power scheduling form the generators as well as real time scheduling for the day-ahead and hourly/15 minute granularity scheduling is expected by the DISCOMs. While scheduling multiple factors like future demand, PPAs, spot prices from multiple sources as well as other regulatory constraints are to be considered.

- **Load research**

  Load research produces simple models to be used in applications where only available data is monthly / bi-monthly energy consumption and customer class from the billing data. Using the load models the application can estimate the load for one year on hourly basis.

Sample and classification/segment customer using background data and annual energy for estimating load model parameters.

Create Load models based for models for each month, special days, temperature correlation, classification on initial meter data rollouts capturing 15 mts interval data and generalize the load models to the population it to the segmentation of the consumers based

Build load models for each customer class.

Linkage of load models data with the network / feeder total energy measurement with hourly / daily load curves.

Create a repository of load models for customer class, day and time duration.

- **Medium Term and Long Term Forecasting**

  Configure the load forecasting system to forecast for medium term load forecasting and long term load forecasting using explanatory variables including macro-economic factors

  Configure the load forecasting system for scenario modeling for changes in explanatory variables and studying the impact.

2. Analytics for Peak Load Estimation and Customer Segmentation

Peak Load identification is very critical from Grid Stability and Demand Response and Time of Use Offers. Also significant upfront capital investment is required to meet the response of increasing demand at peak hours. However, an intelligent data driven peak-load management system can channelize the peak load demand and thereby significantly

1) Reduce peak demand deficit and forced load shedding
2) Reduce the requirement of capital intensive investment in distribution assets
3) Saves costly power purchase at peak time

The DISCOM expects analytics solution to provide a mechanism to manage the peak load demand. It should have the following functionalities:

- Build / Configure / Customize the analytics platform to anticipate which part of the day (hours) the future load may be high in the near future (may range from a few days ahead / week ahead to month ahead). The forecasting accuracy of the peak is expected to be very high and should be based on advanced mathematical algorithm without the subjective bias. However, it should be flexible enough to incorporate the expert input as when required.
- Build the Clusters for the customer population into smaller meaningful sub-sets with data mining based clusters based on past consumption behavior and pattern.

- Create an analytical process for attractive incentivizing program for optimal TOU pricing**.** Build customer contact program so that during the aforesaid identified peak hour's customers could choose to lower their electricity consumption.
- **Cre**ate an eligible and potential list of customers (likely to accept the program offer) that may adopt or accept to a 'power reward' program. The reward program intends to gives customers or a set of customers (say large housing society or commercial users and industrial users) monetary credits when they reduce their electric usages during critical peak events as notified by the program.
- Draw a baseline of each customer's hourly electric usage needed to be constructed and rewards were calculated based on the differences between customer's actual usage and the projected usage.
- Recommend thevariable pricing for each cluster of customers and calculate the credit amount to be rewarded for the participating customers within a stipulated time after the peak load event.
- Publish the reward program result in the company's website for customers to view their actual usage, baseline usage and calculated reward amount online.
- Identify the additional revenue potential and alert the stakeholders

3. Analytics for Demand Response & Time of Use :

Managing the energy deficit by controlling the demand and matching it to the available supply at the instant of peak is important. The DISCOM wants to adopt analytical methods of attaining this objective and optimize the tariffing mechanism.

- Build demand response program that would allow the residential and industrial consumers to curtail the load when utility demands and to pay on a per- kWh basis. There can be voluntary curtailment of up to certain hours in a year. Alternatively, the load curtailment can be triggered a) when the DISCOM is incurring high cost toward power purchase or b) when the distribution network is congested. This anticipated shift in load presents a beneficial situation for both utility and customer, as the utility will also be saving on account of reduction in purchasing costly power to serve peak loads.

- Leveraging the smart meter level data suggest input in designing an innovative dynamic tariff structures that might in the long term benefit all the stakeholders involved: right from consumer, distribution companies, state governments etc.
- Recommend multiple pricing options based on frequency based tariff component as well as usage based pre-announced Time of Day tariff.
- Build processes to Compare load profiles of different consumers within or across the same industry segment. It should be able to bring out pattern out of variations in the load profiles that is not visible in a spreadsheet environment. The analysis should be capable of executing in multiple levels of distribution chains: like Distribution Transformer, Feeder etc.
- Configure / Customize the solution to detect the change in behavior of a consumer. Based on the changed behavior, it should identify potential consumers for targeting the demand Demand Response Program.
- Identify consumers having individual consumption pattern similar to aggregate Consumption pattern. Prepare the load profiles in a visual and easy to understand manner and should provide good insight of consumption patterns of consumers. Configure the analytics engine to identify consumers with -
  - Similar load patterns to the Aggregate load curve
  - Non-similar load pattern to Aggregate load curve.

  Also provide flexibility to set tolerance limits for deviation between consumer load pattern and Aggregate load curve.
- Build the solution on the consumer level meter data, to address business problems like: "Who are the customers with the possession of equipment like Central A/C, Multiple Air-conditioners, Water pumps, Room heaters that consume more energy levels. The system should be able to identify the penetration level of such customers by substation/ feeder.
- It would be ideal to create a predictive model to score all customers with a probability of having these type of equipments based on sample surveys of households/consumers. To deliver the above analysis the system is expected to seamlessly access applications / data bases from customer information, billing system, GIS management and weather data.

4. Analytics for Outage & Asset Management

- Create Visualization of changes in outage information available real-time, alarms and events by integrating AMI data, GIS data, Asset Management Data and Historian Data.
- Create Visualization of asset reliability metrics across the network
- Create and configure the system to give the following additional visualization
    - Time of day segmentation analysis of events & alarms
    - Event Frequency Trend analysis
    - Multi-variate correlation analysis of events/trends with weather, network, feeder
    - Statistical Process Control charts on events/alarms/outages

- Create classification, segmentation and predictive models for the following:-
    - Network / Feeder / Distribution Transformer Mix of Alarms/Events
    - Data Driven Event Correlation Analysis of alarms for alarm suppression and fault development early warnings and root cause analysis with decision trees.
    - Predictive models for accurate prediction of outages with variables having significant impact on the outages.
    - GIS integrated output to understand the impact of outages.
    - Distribution analysis of fault restoration.
- Integrate operational data such as Workforce data, maintenance planning data, real time fault event/alarms prioritization data, asset location data, spares data, route data for optimization of the workforce allocation. Build a workforce optimization model using linear programming, mixed integer linear programming or non-linear programming.
- Proactively real time monitoring of the distribution network to assess the load and voltage condition to identify problem areas and recommend corrective action.
- Combine geospatial visualization with predictive analytics, the predictive enterprise utility can shorten outages from weather events and identify weak points in the electrical distribution system thus preventing future outages in transformers / cable.
- Create transformer segments/clusters across the network based on transformer attributes such as type, rating, age, failure history, failure type, consumption history, meter's -growth history, inspection history.
- Create transformer overload models for early warnings using transformer voltage, current, power factors, number of meters connected, consumption data, transformer attributes, surges at the primary and secondary sides of a single-phase / 3-phase distribution transformer.

- The transformer overload early warning models should be built on integrated analytics approach using statistical process controls, statistical analysis, data mining techniques and advanced visualization techniques.
- The data driven predictive models should be applicable to diagnostics of cable failures Number of failures in the past Size of cable (cross section), Nature of size: Yes and NO , Type of the insulation – XLPE, PILC,XLPE+PILC, Nature of section: UG, composite, Joint of cable: XLPE, PILC, Transition, Differential size etc, Loading: Max, Max-min difference, average, Duration of the over load, Voltage surges: voltage violation from the operation, External factors : Damage by agencies (Y or N), Weather: It contributes to loading (temperature, humidity etc), Fault in the run: insulation wear-off (Y and N), Vulnerability to water ingress: High, medium, low, None Termination failure: Y& N, Vulnerability to chemical reaction: High, medium, low, None, Age of cable, Make / manufacturer of the cable
- Create dashboards for assessment of risks of each individual asset, feeders and the overall system providing a top to bottom understanding of the power system and the revenue required to optimally manage risk coupled with the transformer survival models.

5. Analytics for Energy Accounting and Leakage.

Energy Accounting is highly data-intensive exercise .Hence mapping of each consumer has to be clearly identified for energy accounting purpose. The solution should be able to calculate Energy Loss at feeder-level or distribution-transformer level or at both. It involves preparation of accounts of the energy flow to various segments and its consumption. To calculate energy loss at a particular network element, say for e.g. At Feeder level, the difference between the sent-out units (inflow units) and sold-out units (out-flow units) is to be calculated. Example of calculation is given below:-

Net energy calculation (E): e(t)= $M\_(n-1)\ (t) - M\_n\ (t) - \sum 1\_k \llbracket m\_k\ (t) \rrbracket - L\_n\ (t)$

$where e(t) = netenergy$

$M\_(n-1)\ (t) = (Integrated)\ energyfromtheupstreamfeedermeter$

$M\_n\ (t) = (Integrated)\ energyfromthedownstreamfeedermeter$

$m\_k\ (t) = Energyusagefrom\ (orsuppliedthrough)\ meterk, canbe + or -$

$L\_n\ (t) = linelossesandunmeteredloads$

- **Visualization capability**: For proactive or early intervention to reduce technical and commercial losses, the utilities need have capability of generating different kinds of reports like:
  - Loss analysis for different groups and categories of consumers

- Accounting and auditing at Feeder level, Distribution Transformer level and DCU level.
- Given the voltage and energy information for already deployed or planned deployment of smart meters, the software solution should be able to identify the meters with stolen energy
- Given the GIS map of a secondary distribution network, the solution should be overlay the identified meter ids of the accounts (stealing power). It should also be able to estimate many indicative figures like : average hourly power stolen etc.
- Perform error management like : Missed reads and Intermittent meter reads
- Measure off-peak, mid-peak, min-max and average voltage and also use the advance statistical process control like Shewhart analysis etc to identify mechanical diversion.

- Configure the system to effectively visualize consumption trends, identify unusual patterns, and visualize load analysis to understand which assets are being over utilized.
- Implement a proper energy accounting framework. It should enable quantification of losses in different segments of the system and would provide the means to identify the areas of leakage, wastage or inefficient use.
- Build a troubleshoot energy problems and billing errors process by consistently tracking energy use. It should identify an unexplained increase in consumption, triggering for an investigation for the cause. For example, a correlation plot should be revealing the strength of relationship between consumption and other factors like area, weather, income etc.
- Configure smart meter data combined with enhanced line sensors enable tighter tracking of power delivery – from the point of distribution all the way to the home or business. To detect fraud or collusion, utilities must have a comprehensive understanding of a customer's behavior and associated drivers (weather, special events, seasonal use of property, etc.).
- Enable and empower the business users to act and make data-driven decisions quickly by creating self service reports.
- Configure the visualization layer to create own data visualizations through a wizard driven interface.
- **Alert potential fraudulent energy use:** Build Alerts to identify occurrence of diverting, bypassing, or tampering with power connections or meters results in higher rates and potentially unsafe conditions. Such mal-practices are wide spread that costs an average utility

companies and valid customers millions annually. The need is to access the customer level usage and demographic data by leveraging data mining to stay one step ahead of the perpetrators by:-

- analyze data to identify new patterns of transmission versus usage
- set fraud alert engines
- manage potential fraud cases efficiently, from detection through notification of the authorities

6. Analytics for Capacitor Bank Planning and Volt Var Optimization

The Volt VAR optimization helps improve the technical loss, reduce electricity demand and promote a self-healing grid and enables widespread deployment Optimal control of the switching of capacitors, voltage regulators and transformer load tap changers in order to minimize the power drawn from source while maintaining acceptable voltage levels. Implementation of Conservation Voltage Reduction as many electrical devices operates more efficiently (use less power) at reduced voltage.

The volt var optimization and capacity bank planning system should involve the following analytics work:-

1. Build optimal models using linear and non-linear programming and advanced solvers for multiple objective models for minimizing losses; minimize power drawn while maintaining acceptable voltage levels, conservative voltage reduction.
2. Model should recommend actions such as optimal tap position; optimally identify capacitor banks for switching.
3. Create scenario planning which would aid decision support system for optimal switching plan such as where to locate the capacitor banks for the desired reduction in power loss or desired level of reduced voltage or power factor needs.
4. The modeling should take into consideration the following constraints such as real power in bus, reactive power in bus, capacity of the reactive power, bus voltage, and angles between bus voltages.
5. Integrate the transformer and regulator taps, capacitor banks, voltage and status, bus voltage, bus admittance matrix, voltage data and accurate load forecasts.

7. Visual in-memory Analytics

Real Time analytics can help facilitate through in-memory computing to analysis massive quantities of data in local memory so that the results of complex analysis and transactions are available at and business decisions can be executed without any delay. The same analysis built in the system should provide mobility by enabling access through mobile devices such as ipad's.

The following visualization dashboards and performance metrics are envisaged in the analytics component:-

1. ***Program Outcome - Meter Rollout out***
    a. Outcome considering pre and post smart meter consumption comparison, customer complaints etc.
    b. Rollout progress status planned versus actuals, costs per engineer, logistics cost, service cost etc.
    c. Service complaints related to pre and post unit consumption increase, service related issues, meter related issues across various categories of customers, meter types.

2. ***Load Forecasting and Load Research***
    a. Load forecasting accuracy measurement across the network hierarchy considering the system level, feeder level, DT level and meter level.
    b. Various Monthly/Hourly Load profiles across various customer class depicting forecasted load models
    c. Time of day patterns of load consumptions across customer segments and load characteristics on transformers with ability to filter data dynamically.

3. ***Peak Load Estimation and Customer Segmentation***
    a. Customer Segments and Peak Load along with linked trend charts.
    b. Additional Revenue collection by peak load analysis and savings to the Utilities and Consumers.
    c. Customer class and load estimations
    d. Mean Absolute Errors in Daily Peak, Monthly Peak, Annual Peak
    e. Peak Load Savings for Utilities and Customer.

4. ***Outage and Asset Management***
    a. Reliability indicators in electric distribution utilities such as SAIFI, CAIDI, CAIFI, MAIFI, ASAI, ALII, ACCI, ASCI, Feeder outage number, feeder outage duration etc.
    b. Asset (Distribution Transformer) reliability figures such as MTBF, MTTR(Restoration), Frequency of failures, trends with geo-mapping of DT network
    c. Additional Revenue collection by peak load analysis and savings to the Utilities and Consumers.

d. Alarm & Events Occurrence and Patterns across time segment such as time of day, geo segment, season including linkage with load patterns and weather events.
e. Transformer Load and Consumption analysis indicating linked drilldown facility of overload across network/feeder/distribution transformer

5. ***Complete Energy Accounting and loss/leakage metrics system to the meter level***
    a. Near Real time Energy accounting system across the network to the DT level.
    b. Risk Maps with tile charts on the feeder/DT having higher losses
6. ***Data Management***

The system should be able to integrate data from SAP, Oracle, GIS, Excel / Flat Files, MS SQL and Historian preferably with native connectors. The data management system should be able to exchange data in XML format with XML Mapper.

Suggestive Use cases and integration interfaces for Smart Grid Pilot Projects

The smart grid pilot projects planned to be taken up in India are targeted to address various challenges ranging from AT&C loss reduction to peak load management and improved outage management. With the intent to give a strong support to this initiative, member organizations of India Smart Grid Forum from all domains of a smart grid – metering, grid management, load management, renewables etc. drafted an exhaustive set of use cases and integration interfaces. These use cases and integration interfaces were developed by leveraging the global experience member organizations carry and also by referring to the globally available resources like

- NIST Framework and Roadmap for Smart Grid Interoperability Standards

  http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/IKBUseCases

  http://www.nist.gov/smartgrid/framework-022812.cfm
- Use cases from Southern California Edison

  https://www.sce.com/wps/portal/home/customer-service/my-account/smart-meters/use-case-license-agreement
- Gridwise Architecture Council

  http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf

The approach followed in these global resources, for example NIST, is to define the functional use cases along with the requisite information exchange needs. These resources cover the aspects like use case, primary actor, use case description, information source, information receiver, information exchanged and the industry standards which can be referred to.

By adopting the similar approach, ISGF has developed some of the integration interfaces for use cases and the same is at Appendix-II for reference of utilities and venders. However, Bidder/ system Integrator has to apply their own due diligence for development of these functionalities.

APPENDIX-II

INTEGRATION INTERFACES OF SOME OF THE USE CASES DEVELOPED BY INDIA SMART GRID FORUM