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METER DATA MANAGEMENT (MDM) PROJECT IMPLEMENTATION PLAN

SUSTAINABLE ENERGY FOR PAKISTAN (SEP) PROJECT

OCTOBER 15, 2020

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ACRONYMS

AEB	Area Electricity Board (former name for a DISCO)
AEDB	Alternative Energy Development Board
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
API	Application Programming Interface
APMS	Assets Performance Management System
AT&C	Aggregate Technical and Commercial
B2B	Business-to-Business
BI	Business Intelligence
CE (Ops)	Chief Engineer Operations
CE (P&E)	Chief Engineer Planning and Engineering
CIM	Common Interface Model
CIS	Customer Information System
COP	Chief of Party
CP	Commercial Procedures
CSD	Customer Service Director
CT	Current Transformer
D&S	Design & Standards
DBMS	Data Base Management System
DISCO	State-owned Electricity Distribution Company
ETL	Extract, Transform and Load
FESCO	Faisalabad Electric Supply Company Limited
FY	Financial year
GEPCO	Gujranwala Electric Power Company Limited
GIS	Geographic Information System
GoP	Government of Pakistan
HE	Head End System
HESCO	Hyderabad Electric Supply Company Limited
HT	High Tension, or High Voltage Level
IESCO	Islamabad Electric Supply Company Limited
KPIs	Key Performance Indicators
kWh	Kilo Watt Hour
LDI	USAID's Load Data Improvement Project
LESCO	Lahore Electric Supply Company Limited
LT	Low Tension, or Low Voltage Level
M&E	Monitoring and Evaluation
MDC	Meter Data Collector
MDM	Meter Data Management
MEPCO	Multan Electric Power Company Limited
MoE	Ministry of Energy

MW	Megawatt
NEPRA	National Electric Power Regulatory Authority
NPCC	National Power Control Center
NTDC	National Transmission and Dispatch Company
OSAT	On Site Acceptance Testing
PDC	Power Distribution Control Center
PEPCO	Pakistan Electric Power Company Limited
PESCO	Peshawar Electric Supply Company Limited
PITC	Pakistan Information Technology Company
QESCO	Quetta Electric Supply Company Limited
RO	Revenue Officer
S&S	Standards & Specification Department under PEPCO (formerly D&S department)
SCO	Service Commission Order
SDO	Sub Divisional Officer
SE	Superintending Engineer
SEP	USAID's Sustainable Energy for Pakistan Project
SEPCO	Sukkur Electric Power Company Limited
SGITL	Smart Grid Integration and Testing Lab
SPV	System Performance Verification
SQL	Structured Query Language
TC	SEP Technical Component
TESCO	Trible Area Electric Supply Company Limited
UDIL	Universal Data Integration Layer
USAID	United States Agency for International Development
VEE	Validation Editing and Estimation
WAPDA	Water and Power Development Authority
XEN	Executive Engineer

1. EXECUTIVE SUMMARY

1.1 PROJECT OVERVIEW

1.1.1 BACKGROUND

As part of USAID's Power Distribution Program (PDP), smart meters were installed on feeders at grid stations across all DISCOs in Pakistan. The project consisted of three main components:

- the provision of smart meters;
- the installation of headend applications;
- the development of a web-based portal for monitoring of the installed smart meters.

The meters were installed to support DISCOs in recording load profiles and conducting real-time monitoring of power dispatch. PDP was further extended to provide support to three DISCOs (MEPCO, PESCO and HESCO) with smart meters installation at the customer level. Customers for smart-meter installation were selected on the basis on certain parameters, such as high load profiles and agricultural context (tube-wells). Initially, the solution was designed to support integration of all types and makes of smart meters, however due to a lack of understanding and technical capacity, the Advanced Metering Infrastructure (AMI) project remained confined to a single vendor specific solution. This resulted in a "vendor lock" situation and in turn, prevented the DISCOs from further expanding AMI solution at both grid and consumer levels. In order to level the playing field for all meter manufacturers and enable the DISCOs to procure smart meters competitively, it was essential to enable the existing solution to support meters from various manufacturers.

USAID's Sustainable Energy for Pakistan Project (SEP) aimed to fill this gap by implementing a Meter Data Management (MDM) solution along with built-in Business Intelligence (BI) tool to expose multiple vendor Head Ends (HEs) in common AMI landscape and provide structured information through analytics over dashboards enabling DISCOs to access near real-time information for prudent decision making. This plug-and-play arrangement, independent from smart meter manufacturers, will allow DISCOs to procure smart meters through competitive bidding leading to the more cost-effective AMI deployment.

Pakistan has seen a significant increase in generation capacity during the last few years resulting in the narrowing of the demand and supply gap. However, despite projected surplus generation, the country's power sector continues to face many risks and constraints which impact the continued development and sustainable supply of electricity. The most significant of the challenges facing the power sector is the accumulating circular debt resulting from the DISCOs' high technical and commercial losses. Cash-starved DISCOs are unable to invest in the infrastructure required to support the transmission and distribution of increased supply of power and ensure grid reliability.

Furthermore, the high commercial and technical losses incurred by the DISCOs consume a significant chunk of the country's total generation, putting excessive financial burden on the entire distribution sector and impeding economic growth. DISCOs in Pakistan remain heavily reliant on manual processes and outdated technology which results in errors and creates potential for manipulation of results. The limited capacity of DISCOs to adopt latest technology and the inability to deal with growing challenges further compromises the performance of DISCOs. These factors combine with outdated policies and procedures, poor systems of governance and inefficient practices to become an impediment to government efforts to attract private investment for DISCOs.

1.1.2 SEP SCOPE OF WORK

The SEP project is working to reduce the constraints Pakistan's energy sector is facing throughout the energy value chain, enable private sector investment in Renewable Energy (RE) projects, reform

policies, and enhance grid reliability for the transmission and distribution sectors—all of which advance SEP's goals. SEP activities span all segments of the clean energy domain, including generation, transmission, distribution, commercialization, and sector governance and regulation. The Project's objectives are to help Pakistan:

- Create a creditworthy business environment that attracts private sector investors in a fair, competitive, and transparent energy market that is accessible to all stakeholders.
- Support the development of investment opportunities and expand the capacity within the Government of Pakistan (GoP) to bring projects to financial close.
- Transform the transmission system operator (NTDC) into an entity capable of managing and expanding the national grid while ensuring reliable, efficient, and stable transmission and dispatch services.
- Support the market operator and regulator (CPPA-G and NEPRA, respectively) in transitioning to an open wholesale market.
- Contribute to performance improvements at electricity distribution companies.
- Overcome barriers to RE investment through suitable policy, regulatory, or legislative amendments and procurement measures.

Based on SEP's approved work plan for TC3, the Ministry of Energy (MOE) proposed to USAID to undertake a list of tasks under SEP mainly aimed at reduction of AT&C losses and improve the DISCOs' operational efficiency.

Given the limited resources available for commodity support under SEP, USAID and SEP teams agreed to remain focused on selected priority tasks which could improve the financial and operational efficiency of selected DISCOs. The SEP team, together with USAID, reviewed the list of tasks shared by the MOE to identify those which align with SEP's scope and TORs. Successive consultation meetings were held with Pakistan Electric Power Company (PEPCO) and PESCO to develop a suitable technical assistance strategy.

Keeping in view the earlier selection of PESCO and MEPCO as turnaround DISCOs under the previous USAID Power Distribution Program (PDP), where considerable technical and commodity assistance had already been provided, detailed discussions were held with the senior management of both DISCOs. This led to the selection of the following short-listed tasks for immediate technical assistance:

- Preparation of plans for further upgrades and enhanced utilization of the Load Data Improvement Project (LDIP).
- Gap analysis and selected upgrading of installed AMR/AMI projects.
- Installation of Aerial Bundled Conductor (ABC) in congested areas.
- Specific gap analysis of ERP implementation.

1.2 AMI GAP ANALYSIS

DISCOs in Pakistan fail to meet their regulator-mandated technical, operational and financial performance goals. This is due to various factors such as the inefficient power distribution network infrastructure, lack of efficient system planning, high technical as well as commercial losses, financial mismanagement, and gaps in standards and specifications. Similarly, in the absence of latest technology, DISCOs are unable to effectively operate and maintain their respective distribution networks. Commercial meter-to-cash operations at DISCOs are carried out using outdated procedures and

processes, which rely on legacy metering technologies. This results in deficient billing systems which contribute to direct cash collection losses.

To address these challenges, USAID under PDP implemented Advanced Metering Infrastructure (AMI) system at PESCO, MEPCO and HESCO employing smart AMR meters, hardware / software for Meter Data Collection (MDC), end-user interface and commissioning of an integrated Advanced Metering Infrastructure (AMI). This initiative was aimed at introducing a fully automated metering system which would lead to a reduction in losses, enhance load management controls, provide access to real-time customer load profiles, improve billing quality and revenue. This would result in fewer billing complaints, improved operational efficiency, reduced operating costs and optimize the DISCOs' metering and billing operations. The AMI head-end systems were installed at PITC Data Centre / NOC at WAPDA House Lahore and DISCOs field users were provided with remote access through secure private physical and logical VPN links. DISCOs were given access to a meter data repository through web-based applications to use meter readings for billing and analyses purpose while sub-divisions, divisions and revenue offices were connected over the IP cloud to perform day-to-day operational and other commercial activities.

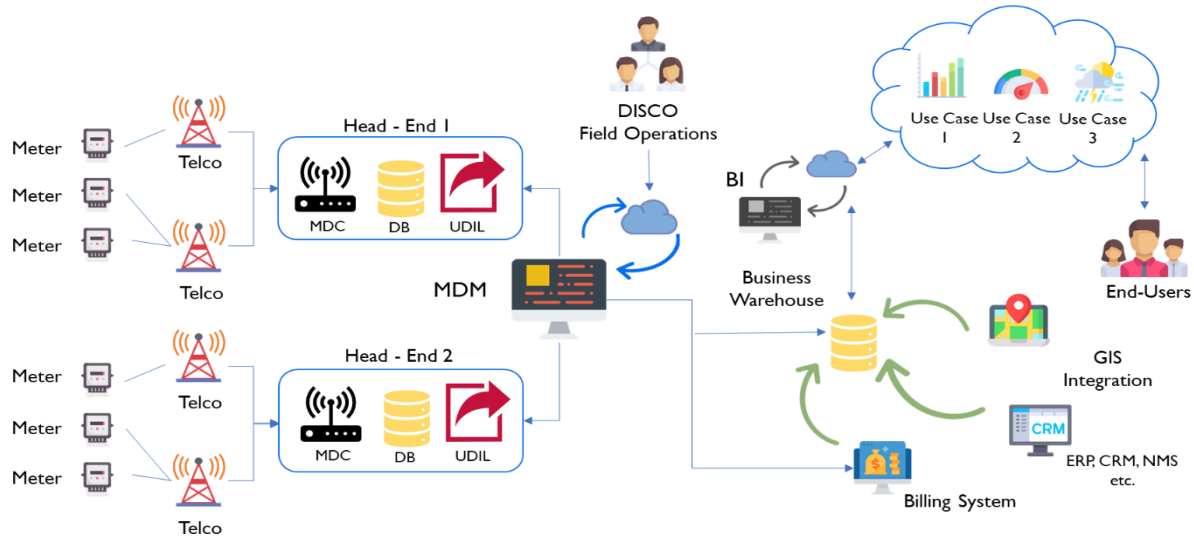
As a result of the AMI rollout, DISCOs accrued net benefit of USD 175 million in savings in energy sales and improvement in revenue collection, in addition to other benefits such as reduction in technical energy losses and improved system reliability. The AMI initiative also allowed DISCOs to improve customer service, reduce the number of billing complaints, increase operational efficiency, demand side-load management, reduce operating costs and fully automate electricity metering and billing operation.

However, a major impediment to the expansion of smart meter installation is that the existing AMI system does not support the integration of meters from multiple vendors, creating a monopoly which favors a single vendor. Another major obstacle in expanding AMI activities is the absence of standards and specifications to promote standardized multivendor compliant AMI platform. Furthermore, it would have been useful to develop a solution in consultation with various stakeholders such as National Transmission and Dispatch Company (NTDC)'s design department who is custodian of the technical specifications, PITC which is responsible for extending IT services to DISCOs, AMR meter manufacturers and AMI integrators.

2. OPEN ARCHITECTURE-BASED AMI LANDSCAPE

Automated meter-to-cash processes are proven to be the most efficient and cost-effective means through which distribution operations can be streamlined. These processes, which combine data measurements with continuous remote communication, can result in timely billing, improved billing accuracy, more flexible billing cycles and easier energy theft detection. Automated processes also allow DISCOs to develop customer energy profiles which can be used to launch energy efficiency and demand response programs. Across the world, power utilities are now using data for more than just bill calculations and utilizing the information collected to improve customer service, utility asset management, timely outage management as well as effective system planning.

In order to support DISCOs in gaining the benefits of a fully automated system, SEP developed and implemented an open architecture based multi-vendor compliant Advanced Metering Infrastructure (AMI) for DISCOs. This included the procurement of Meter Data Management (MDM) Software with a built-in BI (business intelligence) tool along with smart meters and associated communication headend systems for PESCO and MEPCO. The diagram below shows the design of the AMI enterprise landscape developed by SEP, under which MDM plays a pivotal role in transforming data into information while serving multiple operational entities:



This document contains a detailed implementation plan for the MDM software application configured to meet the DISCOs' commercial requirements while supporting end-to-end solution for successful operation of the multivendor compliant AMI platform. The platform employs integrated middleware layer and standardized Universal Data Integration Layer (UDIL) to aggregate data received from various brands of smart meter, through individual Meter Data Collector / Head-End (MDCs/HEs) systems and integration with the DISCO billing system.

3. SCOPE OF WORK

The MDM system will be commissioned at the PITC Data Center / NOC developed by USAID at the WAPDA House in Lahore, Pakistan. The centrally hosted MDM system with built-in BI capabilities will provide infrastructure and services to DISCOs without any user limitations. In order to meet the design requirements, the MDM system will retrieve data from multiple Headend(s)/MDCs/Interfaces/Drivers, process commands as well as expose the master and transaction data to business warehouse for reporting, data analytics and interfacing with the billing systems over secured networks. Similarly, the MDM system will allow two-way communication between MDM and multiple Headend(s)/MDCs/Interfaces/ Drivers to facilitate the DISCO operational functions. Hardware and software to be procured and installed under USAID's SEP is listed below:

Table 1: MDM Hardware and Software List

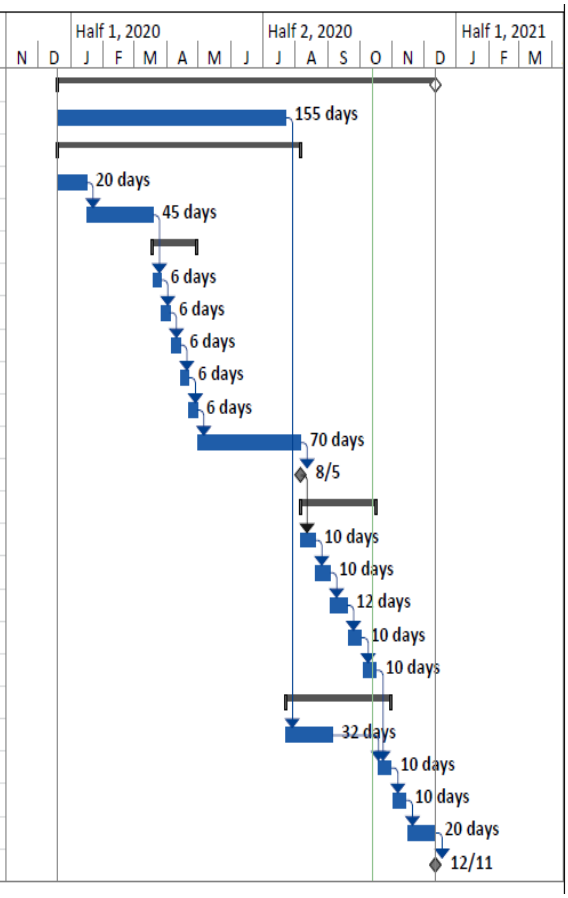
No.	Description	Unit	Quantity
1.	Supply, installation, testing & commissioning of Meter Data Management system fully functional as specified in the RFP, at PITC Data Centre Lahore.	Each	1
2.	My SQL Database Server - Dell PowerEdge R740 Xeon Gold 6252 2.1G 24C/48T, 10.4GT/s 35.7M Cache, 256GB (4x64GB RDIMM) 2933MT/s, Dual Rank, 480GB SSD SATA Read Intensive 6Gbps 512 2.5in Hot-plug AG Drive,3.5in HYB CARR, 1 DWPD, 876 TBW.	Each	4
3.	Web Server - Dell PowerEdge R740 Intel Xeon Gold 6252 2.1G 24C/48T, 10.4GT/s 35.7M Cache, 64GB (2x32GB RDIMM) 2933MT/s, Broadcom 5720 Quad Port 1GBE Base, rNDC network adapter as per proposal.	Each	1
4.	Smart Integration Gateway Server - Dell PowerEdge R440 - Intel Xeon Silver 4116 2.1G, 12 C/24T, 9.6GT/s, 16M Cache, Turbo, HT (85W) DDR4-2400, 32 GB (2X16 GB RDIMM), 2666 MT/dual Rank, 480GB SATE 6Gbps with DVD ROM, SATA Internal Optical Drive, Dual Hot-plug redundant Power Supply as per proposal.	Each	4
5.	Oracle MySQL Enterprise server 5.7 License - Database System	Lot	4
6.	Network Firewall - CISCO ASA 5512 with 4 GB Memory, 4 GB Flash supporting 100,000 concurrent connections - Rack 1U type with high availability as per proposal.	Each	1
7.	Network Switch CISCO SG110-24 with 128 MB DRAM and 128 MB Flash Memory	Each	2
8.	SMS Modem - 3G HSPA/HSUPA/HSDPA/UMTS, 7.2 Mbps Downlink and 5.76 Uplink speeds USB 2.0 interface as proposed.	Each	6
9.	10 kVA UPS with 30 Minutes backup time as proposed.	Each	2
10.	Rack APC AR3100 42U Tower PDU APC AP7551 230 V 50/60 Hz 16 Amps and KVM Switch	Lot	2
11.	Web Application Front-End – COSMOS	Each	2
12.	Smart Analytics Software	Each	2
13.	Bulk SMS & Email Software	Each	4
14.	Smart Integration Gateway Software	Each	6

No.	Description	Unit	Quantity
15.	iRedMail 0.9.9	Each	2
16.	Business Intelligence Reporting Tool (BIRT)	Each	4
17.	Apache Tomcat 9.0.12 Reporting Server	Each	4
18.	Nginx 1.14 Web Server	Each	4
19.	VSFTPD 3.0 FTP Server	Each	1
20.	Ubuntu Server 18.04.2 LTS Operating System	Each	15

4. PROJECT IMPLEMENTATION SCHEDULE

In accordance with the subcontract agreement, the supply, installation, testing and commissioning of MDM system will be carried out over 257 days. The following diagram shows the schedule of activities:

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Subcontract # 154-SEP-1617-004 (Lot-I)**	**257 days**	**Dec 19 '19**	**Dec 11 '20**	
2	Hw & System Sw Procurement	155 days	Dec 19 '19	Jul 22 '20	
3	**System Design & Development**	**165 days**	**Dec 19 '19**	**Aug 5 '20**	
4	System Planning	20 days	Dec 19 '19	Jan 15 '20	
5	Requirement Gathering & Analysis	45 days	Jan 16 '20	Mar 18 '20	4
6	**Blueprint Design**	**30 days**	**Mar 19 '20**	**Apr 29 '20**	
7	Smart Integration Gateway	6 days	Mar 19 '20	Mar 26 '20	5
8	Metering Data Organization	6 days	Mar 27 '20	Apr 3 '20	7
9	Web Based Interface	6 days	Apr 6 '20	Apr 13 '20	8
10	Subdivision Automation	6 days	Apr 14 '20	Apr 21 '20	9
11	MDM Analytics	6 days	Apr 22 '20	Apr 29 '20	10
12	App. Development & Customization	70 days	Apr 30 '20	Aug 5 '20	11
13	Software Release	0 days	Aug 5 '20	Aug 5 '20	12
14	**Op. & Func. Performance Verification**	**52 days**	**Aug 6 '20**	**Oct 16 '20**	
15	Prototype Release	10 days	Aug 6 '20	Aug 19 '20	13
16	Alpha Release	10 days	Aug 20 '20	Sep 2 '20	15
17	Beta Release	12 days	Sep 3 '20	Sep 18 '20	16
18	Release Candidate	10 days	Sep 21 '20	Oct 2 '20	17
19	Performance Regression Testing	10 days	Oct 5 '20	Oct 16 '20	18
20	**System Commissioning & Configuration**	**72 days**	**Jul 23 '20**	**Oct 30 '20**	
21	Hardware Commissioning	32 days	Jul 23 '20	Sep 4 '20	2
22	Software Configuration	10 days	Oct 19 '20	Oct 30 '20	21,19
23	End User Deployment	10 days	Nov 2 '20	Nov 13 '20	22
24	User Training	20 days	Nov 16 '20	Dec 11 '20	23
25	User Acceptance & Go Live	0 days	Dec 11 '20	Dec 11 '20	24



5. PROJECT IMPLEMENTATION

5.1 MDM HARDWARE PROCUREMENT

The timely procurement of IT hardware and software for the management of the MDM solution is the most important element, in ensuring the execution of the MDM project according to the schedule. To ensure that the project is completed within the stipulated time-period, all activities including solicitation of quotations, negotiations, issuance of a purchase order and delivery of IT hardware and software, will be carried out with 217 days of the signing of the subcontract agreement.

5.2 MDM SYSTEM DESIGN & DEVELOPMENT

To support the storage and management of the large volume of data generated by the metering system, the MDM application system will also include an appropriately scaled data warehouse. The MDM system will retrieve data from multiple Headend(s)/Meter Data Collectors/Interfaces/Drivers, process command as well expose the master and transaction data to business warehouse for reporting and data analytics and communicate with the billing system in use at DISCOs for data sharing. Similarly, MDM will also allow two-way communication between MDM and multiple Headend(s)/MDCs/Interfaces/Drivers. In addition to the core MDM functions such as extraction of data from multiple MDCs, bill-determinants calculations, estimation and editing validation, and data storage and management, the solution will provide value added functionality required for overall program success. Such value-added functionality will include revenue protection, advanced customer data presentation via a portal, outage management etc.

The MDM application software will be customized and deployed to meet all requirements, by providing through web access to the end users based on access levels defined in the security policy.

The SEP team has organized the activities required for the design, development and implementation of a state-of-the-art customized meter data management system into the following categories:

1. System Planning
2. User Requirement Collection & Analysis
3. Blueprint Design
4. Application Development & Customization
5. Functional Verification & Testing
6. In-house Commissioning
7. Configuration
8. System Performance Verification (SPV)
9. On Site Acceptance Testing (OSAT)
10. User Training

All activities will be organized and scheduled to fully develop and commission the MDM solution within **205** days, including but not limited to:

- Accessing system integration requirements
- Energy consumption interval data management
- Versioned data storage
- Data validation, estimation and editing
- Calculation of billing determinants
- Two-way communication between AMI and CIS
- Revenue protection and theft analysis
- Customized reporting
- End customer analysis
- Interface with various software used by the utility e.g. customer billing services, customer complaints, demand response, outage management system etc.

5.2.1 SYSTEM PLANNING

Planning is the first stage in the software development process. This stage involves identifying the business problem, studying the processes and outlining the intended software solution. As part of this first stage, the SEP team developed a detailed project plan including budget, resources, timeline, technical and operational specifications for the MDM. This plan was shared it with the subcontractor as part of the Request for Proposals (RFP). This phase of the project will be completed within **20** days of signing the subcontract agreement by the subcontractor.

5.2.2 COLLECTING USER REQUIREMENTS & ANALYSIS

Identification and analysis of user operational requirements is a vital step in the development of an MDM system. For successful field operation and acceptance, an MDM system must meet all key requirements, supporting operational processes and procedures and addressing the needs of the end-user. While many technical, functional, operational, security and integration requirements have already been described in the subcontract agreement, some details need to be determined.

The SEP team will assist and guide the subcontractor in gathering the required information from PITC and the DISCOs to understand their prevalent commercial procedures, processes and expectations. SEP will organize joint meetings between the subcontractor, SEP's technical experts, PITC and DISCO AMI Cell. During these meetings, software and system requirements will be analyzed, documented, validated and managed with the aim of achieving the following objectives:

- Data capturing and synchronization techniques from multiple sources and MDC Servers using multiple communication methods, strategies & protocols.
- Workflow functionality support including New Application, New Connection Order (SCO), Meter Change Order (MCO), Change of Attributes (COA), Temporary Disconnection Order (TDCO), Permanent Disconnection Order (PDCO), Transfer Consumers and Complaints Management.
- Billing Integration API's with the support of estimated billing.

- Automated Validation, Estimation & Editing (VEE) processes.
- Automated data synchronization across DISCO systems.
- Consolidated interface for data management.
- Embedded and configurable business processes based on industry standards.
- Smart analytics for timely forecasting, perfect planning and smooth execution of DISCO operations.
- Provide the system information and functional views to the software development team and operators.
- Finalizing MDM software application architecture.

Once these requirements are clearly understood, the subcontractor will further ensure that the stated requirements are clear, actionable and complete for the development of MDM software application. The identification and analysis of requirements will be completed and documented as a Software Requirements Specification (SRS) within **45** days of the contract award.

5.2.3 BLUEPRINT DESIGN

During this phase, requirements gathered in the Software Requirements Specification (SRS) document will be used as an input and used to draw out the software architecture for implementing system development. During the development of the blueprint, the existing and proposed AMI landscape will also be critically evaluated.

The SEP team, along with the subcontractors, will carry out an individual evaluation for each existing MDC system that needs to communicate with the MDM. A strategy would be drafted, on the basis of this analysis, to establish a communication link using UDIL standards. To ensure a smooth transition from a manual to an automated digital system, all wireframes, including commercial processes, will be evaluated for their execution by the MDM in accordance with prevalent processes and procedures. MDM software application will mainly consist of the following modules:

1. Smart Integration Gateway
2. Metering Data Management
3. Sub-Division Automation
4. MDM Analytics

5.2.3.1 SMART INTEGRATION GATEWAY

MDM will offer both conventional and exclusive integration methods to facilitate seamless integration with other systems used by DISCOs for customer energy consumption, energy accounting, billing data and smart grid devices.

1. MDCs & MDM Integration using:
   - CIM, Multi-Speak
   - UDIL
   - Web-Services
   - Database Tables/Views
   - FTP/SFTP

2. Billing Integration with existing WAPDA systems in use at MEPCO and PESCO:

- COBOL Based Billing System
- ORACLE (IBS) – Oracle based Integrated Billing System
- Smart Gird Devices – Assets Performance Management System (APMS)

5.2.3.2 METERING DATA ORGANIZATION

MDM application software will organize and manage metering data along with automated Validation Editing and Estimation (VEE) and Business Intelligence (BI) processes comprising of:

- Daily and monthly billing data
- Events and critical alarms management
- Instantaneous data and load profile data
- Prepaid, postpaid and bi-directional meters data management
- On demand operations (remote connect/disconnect)
- Data export (web services, FTP/SFTP, DOCX, PDF, Excel, SVG, etc.)

5.2.3.3 WEB-BASED INTERFACE

The MDM application software will provide a web-based interface to DISCO end users as per prevalent commercial procedure enabling them to carry out regular Business Unit (BU) functions such as but not limited to the followings with minimum two-level security checks:

- Maintain hierarchy of meters (admin and network both)
- Process changes in the hierarchy such as transfer of consumers
- Process Service (New) Connection Order (SCO) with installation of meter
- Meter Change Order (MCO)
- Meter Disconnection Order (DCO)
- Meter Reconnection Order (RCO)
- Change of attributes in the meter such as sanctioned load etc. (COA)
- Other functions as described in the prevalent commercial procedure or as required by SEP during system configuration.

The above web-based interface will also be capable of managing the metering functions (read & write) as described in the UDIL document. Some basic functionalities are as follow:

- Relay operation - disconnect/reconnect meter.
- Time synchronization of meter with head-end.
- Relay operation on the basis of sanctioned load.
- Creating group of Customers/meters for Load Management actions

- Transmittal of Load Management/shedding schedule for individual or group of customers defined above.
- Time of use changes.
- Register configuration for Import & Export (Net-metering), Peak & Off Peak etc.
- IP/Port update
- Meter Load Profile sampling interval update etc.
- MDI interval setting.

5.2.3.4 SUBDIVISION AUTOMATION

MDM application software will offer a unique facility to automate sub-division processes without changing existing workflows for:

- Online Application management for new electricity connection
- Consumer Information System
- Workflow Functionality
- Complaint Management
- Smart Meter Communication Management
- Demand Side Load Management
- Field Deployment Management
- Smart Device (APMS) Data & Communication Management

5.2.3.5 MDM ANALYTICS

MDM analytics empowers utilities to analyze, forecast, plan and execute day-to-day affairs in efficient and timely manner incorporating:

- Energy Consumption & Demand Analysis
- Energy Auditing
- Power Quality Analysis
- Theft & Tampering Analysis
- Procurement Planning Analysis
- Infrastructure Up-gradations Analysis
- Demand Side Load Management
- Smart Device Operational Analysis
- Readings with Exceptions
- Analysis to show the total number of Readings that resulted into exceptions.

- Analysis to show the number of meters that were sending measurement data and then stopped sending for some reason. (mute meters)
- Analysis to show a summary of new devices have not sent measurements since their installation.
- Meters not in contact (Mute) - Meters that could not be contacted since last N days.
- Meter change orders processed during the current billing month.

All design schematics are intended to be completed and distributed among the development teams within **30** days of the finalization of the SRS document.

5.2.4 APPLICATION DEVELOPMENT & CUSTOMIZATION

Following the finalization of the MDM application design, software development will begin with the development of a web-based application, smart integration gateway and database for serving end user requirements as described above. The software development team will be working in independent groups, each responsible for their own tasks. However, all teams will be working in close coordination each other to ensure smooth integration of interrelated tasks and interlaced processes. The application software will be customized to meet end-user requirements by incorporating subdivision automation mentioned above and generating the following reports in accordance with the DISCO's existing commercial procedures to support the following functional and operation requirements:

- Customer Billing record as per prevalent commercial procedure.
- CP – 10 Meter Reading List (General Consumers).
- CP – 11 Meter Reading Record.
- CP – 13 Consumer Statistics.
- CP – 15 Temporary Disconnection Order List.
- CP – 17 Disconnection Orders.
- CP – 17A Register of Permanently Disconnection Defaulters.
- CP – 19 Reconnection Orders.
- CP – 34 Meter Reading List (MDI Consumers).
- CP – 61 Permanent Disconnected Defaulters.
- CP – xx List of MCOs
- CP – xx List of New Connections

All the development and customization activity will be completed within **110** days of finalization of the design.

5.2.5 SOFTWARE RELEASE

Following the completion of source code development, all teams shall regroup to release the first version of the MDM application software and offer it for compliance.

5.3 OPERATIONAL & FUNCTIONAL PERFORMANCE VERIFICATION

Following the development stage, MDM software code testing is the next task which needs to be completed. In this phase, the entire coding structure is checked and optimized. In addition to code testing, operational and functional compliance is also examined during this stage.

Quality assurance of MDM application software, flow of coding, scalability for future customizations, defects, etc. are checked and compared with the requirement chart or documentation. Using software or manual techniques, software test engineers ensure that all MDM application goals are met, and developers fix any errors reported by the software testing team. The developers also ensure all changes required for performance compliance are met. Upon completion of the software coding, the modules as well as integrated application will be released for testing. During this phase, the developed and customized MDM software application will be thoroughly tested for any system errors, defects, bugs or non-compliance. Developers will work to address any issued identified and reoffer the application for testing. The activities below shall be completed within 60 days of the first release of the MDM software application:

5.3.1 PROTOTYPE RELEASE

The first-time user release will offer the broad level functionalities of required MDM application software. Software test engineers will be the first-time users of the newly developed and customized MDM. At this stage, the software will be evaluated based on the basic functional requirements. Initially, it will be ensured that all the developed modules are accessible and available in the system as intended. All features will be tested for operational performance and following the completion of the first round of testing changes and the MDM software will be reoffered for incremental testing. The process will continue until a stable version complaint with all functional requirements as per SRS and schematic design is released.

5.3.2 ALPHA RELEASE

Once a successful prototype version of the MDM application software has been released, it will be offered to the performance verification group for detailed evaluation and conformance with technical and operational specifications. Each module of the MDM software will be subject to simulated filed environment. Any module or function which does meet the with the specification will be reported to the software development team and reoffered for testing until it passes the test. Once the MDM application software passes the test to the satisfaction of performance verification engineers, it will qualify for next phase of evaluation and testing. All functional tests and incorporation of required code changes will be completed within **15** days.

5.3.3 BETA RELEASE

Subsequent to ALPHA release, where the MDM application software has been initially tested for SRS and schematic design compliance and bugs have been fixed, a BETA release will be offered to Quality Assurance (Q/A) which will test the software from an end-users' perspective. Q/A will ensure that all operational as well as functional specifications have been properly met. Any ambiguity will be addressed by the development team and reoffered for testing. All modules and functions shall be subject to rigorous stress testing by being operated in real time and field conditions for **15** days.

5.3.4 RELEASE CANDIDATE

Once the MDM has passed the BETA test successfully, it will be offered to selected officials of SEP/PITC, for preview. These officials will test the MDM application as per subcontract's technical, functional and operational requirements. This will allow the software to be evaluated for any serious faults which may surface and be fixed before the field deployment and operation. All suggestions and reported bugs will be incorporated in the release within **30** days.

Following the incorporation of SEP/PITC findings, the system will be offered to MEPCO and PESCO for review and feedback. All suggestions and feedback from the DISCOs will be incorporated within **40** days.

5.3.5 PERFORMANCE REGRESSION TESTING

A dedicated team of team of engineers and developers continue to conduct internal testing throughout the execution phase and O&M period in order to further refine and enhance the MDM application, based on the user experience and feedback. Any minor bugs that still show up at this stage will be addressed immediately. The feedback from the field end-users is very imported and will be addressed at this stage of the software development life cycle process.

5.4 SYSTEM COMMISSIONING & CONFIGURATION

Following diagnosis, the complete MDM system including hardware and software will finally reach a state of equilibrium, i.e., a stable software platform and ready for configuration and commissioning. The software development life cycle meets the final software release state after completing the pre-stages successfully.

5.4.1 COMMISSIONING OF HARDWARE RESOURCES

Once all necessary hardware resources have been received from the supplier, it will be tested and commissioned in the following two phases:

1. Testing and commissioning at the subcontractors' facilities
2. Testing and formal commissioning at PITC Data Center

All hardware items shall be individually inspected and commissioned at the subcontractor's facilities for initial testing and performance evaluation. Once the system has been tested to the satisfaction for a period of **30** days, it will be delivered to PITC data center and commissioned as per requirements within **15** days. All required hardware configurations, Operating System (OS) installation and third-party software shall be completed at PITC data center within 10 days and will be subjected to testing for **15** days. At this stage, the system will be made ready for the commissioning of MDM application software.

5.4.2 SOFTWARE CONFIGURATION

Initially, the system will be configured at subcontractor's facilities for testing and evaluation purposes. Once the release candidate has been finalized, and hardware installed at PITC data center, the MDM application software is ready for commissioning and will be installed and configured for operation.

5.5 END USER & DEPLOYMENT

Following the competition of hardware and software configurations, the system will be subjected to a dry run with actual data being retrieved from multiple head-ends. Virtual Private Networks with both MEPCO and PESCO will be established and access levels will be defined for the AMI Cells and end users. This activity will take **10** day to complete.

5.6 OPERATION & MAINTENANCE

The system will be liable for all the operational and maintenance support as stipulated in the subcontract contract agreement. All critical issues will be resolved on solid footings and periodic maintenance releases will be offered according to evolving standards and specifications. The subcontractor will maintain dedicated MDMS development, integration, maintenance and installation

team. These teams will include experienced industry experts and will be equipped with state-of-the-art tools and equipment to execute the project and provide required support and services. Details of support services during O&M period of 2.5 years are listed below:

Nature	Hours of Attention/Response Time	Technical Support Details
On-call/Electronic Technical Support	Immediate	Dedicated Local Support Team
On-site Technical Support	2-8 Hours (Location Dependent)	Dedicated Local Support Team
Technical Issue Resolution	1st Response within 1 BD	Dedicated Local and Foreign Support Team

5.7 TRAINING

Within two weeks of installation and configuration of the MDM application software, a comprehensive training session of SEP, PITC and DISCO officials will be conducted. Training sessions will include the technical and administrative knowledge of the MDM system for day to day operations. Training sessions will be based on the plans made in consultation with SEP.

A complete set of training materials will be provided to each participant to support them in making the best use of customizations, features and functions offered by MDM. Following the completion of the training, users will be able to manage, maintain, monitor optimize and perform the general troubleshooting of the system. This activity will last for **30** days.

5.8 USER ACCEPTANCE & GO-LIVE

Following the successful commissioning and training on the MDM system for end-users, the subcontractor will request SEP for issuance of user acceptance certificate. Once the user acceptance has been issued, the system will be made live and user access shall be provided to all DISCO officials and field formations.