1. ENERGY AND POWER MANAGEMENT SOFTWARE—GENERAL

A. The Energy and Power Management Software (EPMS) platform shall facilitate applications in the broad categories of (a) energy performance, (b) power availability, quality and reliability, and (c) sustainability performance. At a high level, the feature-set shall provide functions in:
   1. Real-time monitoring.
   2. Alarming and event management.
   4. Energy, power, and sustainability data analytics and visualization.

B. The software platform shall be certified for use as a part of an ISO50001 program and verifiably support compliance. In addition, the functionality shall support ongoing ISO50001 programs per the following areas of Section 4 of the ISO standard:
   1. Energy review.
   2. Energy baseline.
   4. Monitoring, measurement, and analysis.
   5. Input to management review.

C. The EPMS shall verifiably support compliance with EN 16247-1 for energy audits.

D. The EPMS shall include Modular, licensable optional applications to expand the basic functionalities of the core platform.

2. ENERGY AND POWER MANAGEMENT SOFTWARE—REAL TIME MONITORING

A. The EPMS shall provide a graphical monitoring and analysis application for power users (trained administrators, power system engineers, energy managers, facility managers, technicians, etc.) that provide a rich set of tools for WAGES energy analysis, Power Quality analysis, power system monitoring and control.

B. The graphical monitoring and analysis application shall be able to create a comprehensive set of linked hierarchical graphical diagrams showing all devices and their associated device specific diagrams in the power monitoring network WITH A SINGLE MOUSE CLICK (auto-diagram creation).

C. The graphical monitoring and analysis application shall support custom graphics/images and provide the ability to create graphical diagrams of the Power Monitoring system, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.

D. The graphical monitoring and analysis application shall be capable of writing to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.

E. The graphical monitoring and analysis application shall allow application and HMI design engineers to create custom diagrams with linkages to device registers even if the devices are offline / disabled.

F. Web-enabled real-time tables: The system shall have the following capabilities for interactive side-by-side visualization of real-time measurements:
1. Display a tabular view to compare device readings from multiple meters in the power monitoring network quickly.
2. Permit users to create, modify, view and share table views through a browser without the need for a separate software application.
3. Have built-in functions that allow users to easily and instantly filter out measurements when viewing a table.
4. Support both physical and virtual devices defined in the system.
5. Support exporting real time tabular data into Excel formats.

G. Power monitoring trending: The EPMS shall include graphical charts for real-time trending of power usage (kW, Volt, Amp, and kWh) or any measurement supported by metered equipment such as generators and MV/LV switchgear. These trends shall include the capability to:
1. Trend up to 14 measurements on the same chart (limit may be increased if desired).
2. Customize attributes such as color, line thickness, overlays, display name, and display units for each data series.
3. View the trend using an auto-scaling or manual chart axis.
4. Adjust the desired time viewing window for the trend.
5. Inspect the trend by zooming and panning to focus in on key areas of the trend.
6. Provide drill-down detail for the highlighted trend data point to help identify root causes of concern.
7. Trend measurements with different units on the same chart using two different axes.
8. Provide calculated values of minimum, maximum, and average values for a trend.
9. Configure a target threshold line for comparison against actual measurements.
10. Configure up to two target bands with visual indicators to identify when a measurement is outside specified limits.
11. Display real-time data and/or historical data per data series, with optional back-filling of the real-time data using historical data.
12. Export trend data to .CSV/Excel format.
13. Access trend data from a web browser or mobile environment.
15. Share trends with other users or restrict use.
16. Simultaneously view multiple trend charts, or alternatively maximize a selected trend to display it in full screen mode.

3. ENERGY AND POWER MANAGEMENT SOFTWARE—ALARM AND EVENT ANALYSIS AND NOTIFICATION

A. The EPMS shall provide alarm and event annunciation features that include the following:
1. An alarm viewer that provides a summary of the active alarms shall be provided. The viewer shall:
   a. Be visible in any screen when logged into the web interface of the system.
   b. Display the total number of unacknowledged alarms, and the breakdown of how many of those alarms are high priority, medium priority and low priority.
   c. Provide an audible alarm and a simple means for muting the alarm.
   d. Allow a simple mechanism to acknowledge alarms for users with appropriate user privileges.
   e. Allow a mechanism to sort and group alarms.
   f. Allow a mechanism to set configurable alarm thresholds, for example, high, medium, and low.
   g. Allow a mechanism to create user defined alarm views that fit user defined criteria.
   h. Provide an active alarms view to show alarms currently in the active state.
B. The EPMS shall provide an alarm notification system.
   1. The alarm evaluation and notification system shall ensure that appropriate staff members are notified of power system events. The system shall collect data, evaluate alarm conditions, and annunciate the alarms to specified users through email or SMS text messages.
   2. The alarm evaluation and notification system shall include:
      a. An alarm evaluation engine.
      b. An alarm notification/annunciation engine that supports annunciation through email and SMS text message.
      c. Flexible alarm scheduling capabilities.
      d. Web-based configuration tools for notification configuration, log viewing, and filtering.
      e. The ability to control alarm flooding by intelligent aggregation through alarm filtering and consolidation.
      f. Message delivery mechanisms such as:
         1) Electronic mail (Email)
         2) Text messaging for cell phones (GSM Modem)
         3) Simple Network Management Protocol (SNMP)

4. ENERGY AND POWER MANAGEMENT SOFTWARE—DATA ANALYTICS AND VISUALIZATION

A. The EPMS shall provide web-enabled dashboards.
   1. The system shall have a web client interface that presents interactive auto-updating dashboard views that may contain water, air, gas, electric, and steam (WAGES) energy summary data, historical data trends, images, and content from any accessible URL address.
   2. Users shall be able to create, modify, view, and share their dashboards (including graphics, labels, scaling, measurements, date ranges, etc.) using only a browser and without a separate software application.
   3. Users shall be able to create with configurable drag and drop gadgets to show the following data:
      a. Images from any web-based content
      b. Energy consumption
      c. Energy cost
      d. Energy comparison
      e. Energy savings
      f. Emissions
      g. Trends
   4. The system shall facilitate kiosk displays by assigning individual dashboards to slideshows to run in unattended mode, scrolling through designated dashboards at a configurable time interval.
   5. The system shall permit users to create, save, and share an unlimited number of dashboards and slideshows.

B. The system shall provide a web-enabled reporting platform.
   1. The system shall provide a web-enabled reporting tool to view historical data in pre-formatted or user-defined report templates.
   2. The system shall support reporting on all supported physical devices and virtual (or calculated) meters as defined in the device hierarchy.
   3. Users shall be able to create, modify, view and share their reports in the web reports interface.
   4. The reporting tool shall provide standard pre-formatted report templates for:
      a. Energy cost
      b. Load profile
      c. System-wide interactive power quality with CBEMA/ITIC evaluation.
d. EN50160 compliance
e. EN50160 Edition 4 compliance
f. Harmonics compliance (IEEE519-1992)
g. IEC61000-4-30
h. 100 ms. power quality
i. Energy Usage: period-over-period, by shift, single and multi-device comparison
j. Tabular, trend and multi-trend
k. Alarm and event history
l. System configuration
m. Hourly usage report
n. Single and multi-device usage reports

5. The reporting tool shall support exporting to the following output formats: .HTML, .PDF, .TIFF, .Excel, and .XML.

6. The reporting tool shall be capable of subscriptions to facilitate automatic distribution of reports according to a configurable schedule by saving to network locations, email, or print.

7. The system shall support the ability to trigger the generation and delivery of a pre-configured report based on pre-specified event criteria. The system shall be capable of configuring event monitoring detection filters criteria.

8. The reporting tool shall have a framework to support:
   a. Simple customizations to reports such as colors, image inclusions, turning report sections on/off, and logo changes without programming.
   b. Additional more complex report customization through a programming kit.

9. The reporting tool shall be capable of subscriptions to facilitate automatic distribution of reports according to a configurable schedule by saving to network locations, email, or print.

10. The system shall include features to enhance energy awareness and drive energy conservation and sustainability programs. The features must facilitate the following functions.
   a. Profiling and trending energy use for all electrical and piped utilities (WAGES)
   b. Establishing energy baselines
   c. Comparing and ranking energy use with different entities (buildings, departments etc.)
   d. Energy monitoring against user-configurable targets

11. The system will facilitate energy awareness through the following capabilities.
   a. Display energy usage using trend, graph, bar, dial dashboard visualizations.
   b. Rank selected energy consumption entities or loads in descending order.
   c. Convert various energy measurements to a common unit.
   d. Normalize energy usage by typical measurements like area, and compare normalized data visually.
   e. Display energy profiles according to time of use (time of day, week day, holidays, season, etc.) with overlaid energy target lines from other dynamic sources or fixed limits.

12. The system shall include the following user-configurable report templates to facilitate energy awareness.
   a. Energy Usage
      1) Organize and overlay energy usage data from multiple entities (such as load type, departments etc.) in the same graph through common visual cues such as column, bar, pie chart etc.
      2) Organize and overlay energy usage data from multiple entities vs. common time intervals such as daily, weekly, monthly etc.
   b. Consumption Ranking: Visually rank different entities (such as buildings, floor, departments etc.) by energy usage
   c. Energy Comparison: Visually
      1) categorize energy usage by load type to find opportunities for savings
2) compare energy performance across entities such as buildings, departments for benchmarking purposes
d. Energy Usage by Time-of-use: Aggregate energy usage by time-of-use periods and highlight any exceeded thresholds (targets)

13. The system energy awareness report templates will include the following general capabilities.
a. Normalize consumption data by a static scalar
b. Set different aggregation intervals
c. Configure different time periods
d. Set upper and lower target lines
e. Display data through common visual cues such as column, line, pie chart, gauges etc.
f. Display warnings for missing data points

5. APPLICATIONS—POWER QUALITY MONITORING, COMPLIANCE AND ANALYSIS

A. Power Quality Monitoring: The EPMS shall provide power quality specific screens and reports as follows.

1. Device Level Power quality summary screen—the data collected by any compliant PQ-capable metering device shall be summarized to show:
a. Voltage disturbances, including the date and time of the last disturbance, the count of the number of transient events, and the count of the number of sag/swell events.
b. Harmonic measurements, including a link to the harmonics log for the particular device. Additionally, there shall be a link to another screen that shall show the real-time Total Harmonic Distortion (THD) content and the maximum THD.
c. Flicker measurements.
d. Logged events, including a link to the event log for the particular device.
e. Waveform logs, including a link for waveforms captured during transients and sag/swell events.
f. Further detailed waveform analysis using a tool shall be provided.

2. System Level Power Quality summary screen—the power quality report shall display all power quality events collected in the EPMS for one or more measuring points for a given period of time.
a. The report shall show a summary table of all the events in a given time period and provide the means to see further details (power quality details report) for any given event.
b. The summary report shall contain a plot of the Information Technology Industry Council (ITI) (also known as ITIC or CBEMA) curve that displays the worst disturbance from each event listed in the summary table. The summary table shall contain the following components for each event:
1) Event identifier.
2) Source.
3) Event timestamp.
4) Phase identifier for the worst disturbance during this event (ex., "V1").
5) Voltage magnitude for the worst disturbance during this event in % of nominal (for example, "68.80%")
6) Voltage magnitude maximum and minimum on phases V1, V2 and V3 for the worst disturbance during this event in % of nominal.
7) Duration for the worst disturbance during this event in seconds (for example, "0.084s").
8) Disturbance type for the worst disturbance during this event (for example, "sag").
9) ITI (ITIC, CBEMA) tolerance curve violations (for example, "outside tolerance").
10) Link to the details report for this event.
11) Link to waveform report for the worst disturbance during this event.

c. Each entry in the summary table shall include a link that provides further details for the given event. The details to be shown are:
   1) Disturbance event timestamp.
   2) Phase identifier.
   3) Voltage magnitude in % of nominal (for example, "68.80%")
   4) Voltage magnitude maximum and minimum on phase V1, V2 and V3 in percentage of nominal.
   5) Duration in seconds.
   6) Disturbance type.
   7) ITI (CBEMA) tolerance curve violations (for example, "outside tolerance").
   8) Link to waveform report.

d. Each entry in the summary table shall include a link that shows the waveforms of the given event (if any exist). The waveforms shown shall be for both the voltage and current readings of the measuring point.

3. One hundred (100)-millisecond Power Quality Report
   a. This report shall display data recorded at 100 millisecond intervals, with a data table for the measured point and selected measurement containing columns labeled: Timestamp, Source Label, Measurement Label, Measurement Unit, and Data Value.

4. IEEE1159.3 Power Quality Data Interchange Format (PQDIF) Support
   The system shall provide a mechanism to export power quality data to the non-proprietary standard PQDIF format with support for the following default templates:
   a. Flicker: Short-term and long-term flicker disturbance data on the voltage inputs.
   b. Sag/Swell: Sag/swell disturbance data for voltage inputs, including minimum, maximum and average values.
   c. Sag/Swell Waveforms: Waveform data for voltage sag/swell.
   e. Steady-state Waveforms: Waveform data for steady-state data.

5. Disturbance Direction Detection
   a. For power quality compliant devices, the system will indicate the direction of the disturbance within the electrical distribution system in event logs, with associated confidence or certainty rating (for example, "Upstream: Confidence Rating - High", or "Downstream: Confidence Rating – Medium" etc.).

B. Power Quality Compliance Reporting
   1. EN50160 Edition 4 compliance report
      a. The EN50160 voltage characteristics of public distribution systems compliance report shall display a summary of EN50160 compliance for a set of measuring points in the system for a given time period for the following components:
         1) Power frequency.
         2) Supply voltage variations.
         3) Flicker severity.
         4) Supply voltage unbalance.
         5) Harmonic voltage.
         6) Inter-harmonic voltages.
         7) Mains signaling voltages.
         8) Interruptions of supply voltage.
         9) Supply voltage dips and swells.
      b. Additionally, the report shall allow for detailed drill-down for a given measuring point and measurement period.

2. IEC61000-4-30 report
The IEC61000-4-30 compliance report shall display a summary of the IEC61000-4-30 compliance for a set of measuring points in the system for a given period. The report shall:

a. Include the following IEC61000-4-30 components: frequency, supply voltage magnitude, flicker, supply voltage unbalance and supply voltage THD.

b. Provide a means to manually enter a baseline value for each component.

c. Display a series of trends for each component listed with each component’s manually entered baseline.

d. Include a data table that displays all the power quality-related events for the given report period including voltage dips, voltage swells, and voltage interruptions.

3. IEEE 519 Harmonics Compliance report

The IEEE519 harmonics compliance report shall have the following capabilities:

a. Provide a mechanism to report on IEEE519 limits.

b. Provide a mechanism to report on user defined limits.

c. Ability to determine voltage and \( I_{	ext{sc}}/I_{\text{l}} \) ratio directly from the device, where \( I_{\text{sc}} \) is the maximum short circuit current at the point of common coupling (PCC), and the \( I_{\text{l}} \) is the maximum fundamental frequency demand current.

4. For both individual and total harmonic voltage distortion, display the following:

a. The allowable IEEE519 limits.

b. The % time out of compliance.

c. The number of non-compliant three-second intervals.

d. The number of total measured intervals.

e. Number of missing or invalid intervals.

f. Compliance levels of Warning, Out of compliance, or Compliant.

g. A maximum value with a time-stamp of when that distortion was measured.

5. For both individual and total harmonic distortion for current, display all the values specified in the previous section for every range of harmonic orders.

6. For each phase, voltage, and current provide a graphical plot of THD versus time stamp. On the same plot, plot the allowable limit to allow for visual comparison of compliance.

7. Provide a graphical plot of “average value of voltage per harmonic” and “average value of current per harmonic” as a percentage of fundamental frequency, versus harmonic order to allow for visual identification of the worst harmonic problems.

8. For each phase voltage and current, provide a graphical plot of harmonic content versus time stamp with simultaneous plot lines for a set of harmonic orders (for example, \( h \leq 11 \)). This allows the user to identify the harmonic orders associated with the worst problems to enable mitigation measures such as active filtering.

C. Integration with Power Quality Mitigation Equipment

1. The system shall natively support interfaces with power quality mitigation equipment for power factor correction, harmonic filtering, voltage sag mitigation (UPS), and transient protection to provide end-to-end solutions for monitoring, correction and optimization of power quality.

6. ENERGY AND POWER MANAGEMENT SOFTWARE—TECHNICAL INFRASTRUCTURE

A. The EPMS shall provide the following operating system and browser support:

1. All associated core components of the EPMS software operate as Windows operating system services.

2. The web client interface shall support multiple browsers.

B. The EPMS shall provide the following data management support:

1. Microsoft SQL Server database engine per supported configurations.
2. All network configuration settings relating to device routing and addressing, communication gateways, distributed I/O servers, and load-distributing application servers shall be stored in the EPMS databases.

3. Archiving, trimming, and on-demand or scheduled capabilities shall be supported.

4. The capability to view historical data from archived databases shall be included.

5. The EPMS shall be capable of retrieving data from devices in the monitoring network and provide the following abilities:
   a. Interrogate and download logs of interval, waveform, and alarm data stored onboard metering devices and related circuit breaker trip units.
   b. Interrogate and download logs of interval data generated by the software system (software-based logging).
   c. Interrogate and download logs of alarm and event data generated by the software system (software-based alarming).
   d. Automatically re-arm the waveform recorders upon upload of information.
   e. Detect unknown measurement quantities provided by devices in the network, and automatically generate appropriate database references for those quantities without user intervention.

C. The EPMS system shall include an Administrative interface with the following management functions:
   1. Security: administer groups and user accounts with role based privileges.
   2. Database: initiate backup, archiving, and trimming tasks.
   3. Devices: Add or rename devices, map measurements, and communication settings.
   5. Events: View and manage software system events.

D. The EPMS system shall function without disruptions (including communications, logging, and alarming) and shall remain online during all system administration functions such as adding, modifying, or removing devices in the system; creating, modifying, or removing graphical diagrams, dashboards, tables, and reports; creating, modifying, or removing application logic programs in the application logic engine.

E. The EPMS shall support the following device support and management features:
   1. The system shall include factory-tested native driver support for at least 75 electrical distribution devices (energy and power meters, protection relays, circuit breakers, PLCs, etc.).
   2. Native comprehensive device support shall include:
      a. Pre-engineered, interactive graphical display screens for viewing and analyzing real-time and historical device data.
      b. All registers pre-mapped to standard measurement names without additional mapping of internal device registers.
      c. Automatic upload of time-stamped onboard data logs, event strings, and waveform captures without additional configuration.
      d. Automatic time synchronization.
   3. The system shall support integration with other third party intelligent electronic devices (IEDs) not directly supported natively.
   4. The system shall support logical device definitions for user-friendly device and measurement names for inputs/outputs or channels on devices that represent a downstream device (in the case of PLCs and auxiliary inputs) or an individual circuit (in the case of multi-circuit devices). Bulk-import capability to create large numbers of logical devices without manual single-device configuration shall be supported.
   5. The system shall support the concept of hierarchies to organize devices structurally into various levels. Examples include Tenants/Racks/Circuits, PDUs/RPPs/Panels, or Buildings/Floors/Roofs. The system shall include the ability to:
      a. Aggregate data at any location in the hierarchy.
b. Track hierarchy configuration changes over time.
c. Allow administrators to update names in a given hierarchy at any time (even in the past) to ensure accurate reporting of associated data points (for example, report on energy consumption for a Tenant who has re-located, expanded, added, or removed circuits during the billing period).
d. Export the hierarchy structure to Excel format.
e. Bulk-import capability to create and edit large hierarchies without manual per-device setup.

F. The system shall support extensibility in the following ways:
1. Provide a graphical, object-oriented application logic engine to create system-wide logic modules with arithmetic, XML data import, PC-based alarming, and logging capabilities.
2. The application logic engine shall have a comprehensive set of functions to create customized applications programs for functions such as weather or real-time price import, KPI calculations, energy units conversion, data aggregation, data normalization, data comparison, power loss calculations, power factor control, load shedding, etc.

G. The EPMS system shall support system integration in the following ways:
1. Device-level Modbus interoperability.
   a. The system shall be capable of supporting Modbus communicating devices and be capable of functioning as a Modbus master to read/write registers in Modbus devices for monitoring and control applications.
   b. The system shall be capable of Modbus device definition (device drivers) creation to enable integration of third-party Modbus protocol devices.
2. System-level OPC interoperability.
   a. The system shall be OPC DA 2.0.1 compliant (as per the OPC Foundation Compliance Testing process) for OPC Server and OPC Client data sharing applications amongst OPC compliant systems.
   b. The system shall provide default OPC Server tag mappings for all natively supported device types without the need to select, configure, or program the mapping of device registers to OPC tags.
   c. The system shall provide a flexible means to add or change OPC mappings and shall support the ability to add custom measurements.
3. Data-level interoperability.
   a. The system shall support the Extract, Transform, and Load (ETL) data log file transfer mechanism to import and export data log files to integrate functions such as manual data entry, offline device data import, push data to the cloud, or to other systems.
   b. The system shall include a mapping application for specifying log data file import-export mappings and import schedules to facilitate import/export in formats such as .CSV, .XML, etc.
4. Web application level integration.
   a. The system shall include:
      1) The capability to integrate other web applications into its web interface through the use of pluggable web content widgets.
      2) The capability to supply content such as dashboards, reports, trends and diagrams to other external web applications through addressable URLs.
5. Web services integration.
   a. The system shall include web services integration capabilities for machine-to-machine interactions with other application software systems with the following characteristics:
      1) Based on SOAP (Simple Object Access Protocol) protocol specification.
      2) Provide a Web Services Description Language (WSDL), machine-readable description.
3) Allow access to real-time, historical (i.e., time stamped), and alarm/event type data.
4) Provide the ability to acknowledge alarms by authenticated and authorized clients.
5) Provide digest authentication functionality.
6) Provide the ability to be enabled or disabled.

H. The system shall support internationalization and regional settings for localization. The languages supported by default are: Chinese (Simplified), Chinese (Traditional), English, French, German, Italian, Russian, Spanish, Polish, Czech, and Japanese.

I. The EPMS shall support system configuration and advanced analysis tools in the following ways:
1. The system shall include a monitoring and analysis application with a rich set of power tools for water, air, gas, electric, and steam (WAGES) energy analysis, power quality analysis, power system monitoring and control, and include the following capabilities:
   a. Auto-diagram creation capability to create a comprehensive set of linked hierarchical graphical diagrams showing devices and their associated device specific diagrams in the network.
   b. Ability to import custom graphics or images to create electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.
   c. Support for power quality analysis.
      1) Plot PQ events on an ITIC/CBEMA curve or SEMI F47 curve.
      2) Manual waveform capture.
      3) Visualization or analysis tools for sinusoidal electrical waveforms including waveform overlay, zooming, and calculations for RMS, peak, delta, harmonics spectrum bar charts, and phasor diagrams.
   2. Ability to write to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.
   3. Ability to develop custom graphics screens and application logic programs with the devices being offline or disabled to allow for project development in disconnected mode.

J. The system communications infrastructure shall support the following:
1. Multiple communications network topologies including Ethernet/TCP, serial RS-485/RS-232, and Modem dial-up connections.
2. IPv4 and IPv6 addressing for Ethernet communications
3. The capability to provide time-synchronization signals over an Ethernet network with 16ms accuracy or better.
4. The capability to communicate simultaneously with multiple devices, including devices on different physical communications channels.
5. Scalability to greater than a thousand devices.
6. The ability to automatically retrieve logged data (interval data, event data, and waveform data) from natively supported devices without additional configuration.
7. The ability to accept or reject duplicate data entries into the database.
8. The ability to schedule connection times for specific time-periods to conserve bandwidth.
9. The ability to automatically disconnect modem connections when all device data is database-synchronized (used to minimize long distance phone charges).
10. Support for modem pooling and assignment of communication sites to specific modems for communications optimization.