ENERGY UTILIZATION AND MANAGEMENT PLATFORM

PART 1. GENERAL

1.1. DEFINITIONS

A. Real time data as defined in this specification refers to an update rate not to exceed 5 seconds from data change occurrence.

B. Where the term “unlimited” is used, it is meant to refer to a limit which cannot be encountered in “normal” operation of the system. For example, it is possible to have a thousand users, but not possible to have a million users in normal operation; it is possible to have a hundred thousand points, but not possible to have a hundred billion points.

C. Performance requirements are given assuming the use of a device with “normal” capabilities and a suitable network connection. For example, a requirement for speed performance assumes that the device being used to access the software is capable of that level of performance.

D. A node or gateway, as defined in this specification refers to a small IoT device or a lightweight computer to be placed on-site, with an outgoing network connection (either wired, wireless, or via modem).

1.2. SYSTEM SUMMARY AND INTENDED SCOPE OF SERVICES TO BE PROVIDED

A. Owner requires installation of an enterprise Cloud Based Energy Utilization and Management Platform. Energy Utilization and Management Platform shall be initiated on an as requested per project basis and shall utilize and be an expansion of originally provided system platform.

B. Original provided system shall be capable of expansion and must be shown to be highly scalable. All software upgrades and associated costs of maintenance, upgrade, patching, and service to the cloud-based servers shall be borne by the selected contractor/vendor for the life of the contract at no cost to the owner for the duration of the contract(s).

C. Should the selected contractor/vendor need to provide site-based upgrades inclusive of firmware and functional software upgrades, the owner shall be notified prior to upgrade. The site-based software upgrade shall be implemented without interruption to the monitoring and operational functions of the system. The owner also reserves the right to refuse software upgrades unless the upgrade provides a viable fix to identifiable software/hardware discrepancies or “Bugs”.

D. Each new project shall be delivered as determined by facility management on an as needed basis and shall require contractor/vendor to provide itemized pricing for each project inclusive of system monitoring devices, material and installation cost breakouts for each project. Software and associated hosting services shall also be included in each proposal. Each new project shall be a seamless expansion to the original installed system. All installation and provision of monitoring devices and system devices shall be designed, engineered and supervised by the selected manufacturer or their qualified representative. Installation of new, or expansion of existing metering, shall be by a licensed electrician and/or coordinated with the facility management.

E. Selected contractor/vendor shall provide an expandable system capable of providing monitoring and analytical services system wide, including but not limited to consumption and production of:

   i. Electricity

   ii. Natural gas

   iii. Renewable energy sources, including solar, wind, and hydroelectric systems

   iv. Domestic and irrigation water metering

   v. Building chilled water (BTU) consumption and monitoring

F. All new and existing projects provided shall have the capability of being monitored through the Internet without utilization of specific mobile or desktop applications or software being installed on any device. No system functions inclusive of configuration, system architecture, programming monitoring or analytical services shall require the installation of a custom application on any interface device. All installed systems shall be accessible on a single platform with a single set of login credentials allowing access to all owner resources and their associated data.

G. Selected contractor/vendor software shall allow owner to add, delete and change metering structure as system expands within each building having an energy management platform gateway installed. Owner shall be given administrative-level access to the platform and will be able to create user accounts and profiles without contractor/vendor involvement. Should the owner or authorized employee decide to do so, full access to dashboards inclusive to creation, alteration or deletion shall be allowed per user and/or group of users at the owner's discretion.

PART 2. ENERGY PLATFORM SERVICES AND FUNCTIONS

2.1. CLOUD BASED ANALYTICS AND VIEWABLE DATA

A. At least 30 default preconfigured energy dashboards/views shall be provided for each site at time of install. Each approved owner's representative shall have the ability to customize or alter dashboards and analytics as desired.

B. It must be possible for the owner to create an unlimited number of dashboards/views without the involvement of the contractor/vendor.

C. Software must be capable of providing real-time monitoring and graphical updates as defined in 1.1.A above. Real-time display inclusive of graphical depictions shall be capable of continuous update while data is being viewed.

D. All data screens and access must be automatically resized to fit the viewing area of the device being used to view data. Site must be capable of showing live real-time data on mobile screens as small as a cellular phone.

E. Data acquisition and analytics capabilities shall include as a minimum:

   i. The software will have the ability to compare multiple points on a live graph displaying real-time data. It must be possible to compare at least 25 points on the same screen while receiving live updates.

ii. Live graphs must be interactive, showing the value and time at each point on the line in response to owner navigation with the mouse. It must be possible to hide or show a line on the graph interactively by selecting or clicking on a simple option, without navigating away from the graph or changing report parameters.

iii. Maximum time to display one year's data with high-resolution should be less than 10 seconds from the time the request is first sent to the time that the graph is displayed (cold-start / pre-cached speed), and less than 3 seconds if the data has already been displayed recently (cached speed). Selecting a time range by clicking and dragging over the graph will result in the graph being updated to the new time range in less than one second.

iv. The software must have the ability to predict energy usage for the current day and the current month based on historical consumption data.

v. The software must have the ability to show the expected power usage profile for the current day based on historical power usage and climate information (such as current outdoor temperature, heat index, precipitation, expected high- and low-temperatures, etc.).

vi. The software must be able to show any point values in a "heat map" view, where the value of the point at different points in time is reflected by the choice of color in a two-dimensional "map".

vii. The software must be able to produce time staggered plots, where different date-time ranges can be overlaid on same graph.

viii. The software must provide a financial analytics dashboard which can show savings as they have accrued for each day since some arbitrary point in time. The financial dashboard must be able to show real-time savings, including energy saved up until the current date and hour.

ix. The software must be able to issue notifications that a predefined consumption threshold is about to be exceeded. This threshold can be defined in terms of percentage-of-peak-demand.

x. The software shall record degree day information and local weather including precipitation, temperature and humidity on an hourly basis.

xi. The software must show live visualization of 30 day peak demand as compared to current demand utilizing real time data.

xii. The software must have a visualization which summarizes the daily mean, min, max, 25th-percentile, and 75th-percentile values in a box-plot graph.

xiii. The software must include green energy reporting capabilities, where the amount of emissions created is shown in lbs-of-CO_2 as well as number of trees-equivalent.

xiv. The software must include an interactive data-exploration tool, which allows at least 10 points to be plotted on a single graph, along with at least 10 functions on those points.

    a. The functions are specified using a simple mathematical notation. For example: (A + sqrt(B+C) / D) if D>0 else 0

b. The functions must include simple mathematical operations such as “+”, “-”, “*”, “sqrt”, etc., as well as boolean logic (such as the if-qualifier shown above).

xv. It must be possible for the operator to design their own dashboards / views using a simplified dashboard-construction language or drag-and-drop customization.

a. Such dashboard elements include: images such as 3-dimensional mechanical drawings or floor plans, rewind-bar or similar mechanism which allows historical data to be displayed in-place, line- and bar-graphs, visual indicators which change color or image when a point value changes, tables of live point values.

F. The software must allow the programming of custom fault detection rules by the owner and display the combined results of multiple rules for multiple points in a single visualization.

G. Using a single action (such as a button click), the software must be able to produce static URL routes which link to a particular point and optionally, time range. Navigating to the URL will first request authorization if the operator is not logged in, and then show the operator the specified point at the specified time range.

i. It must also be possible to produce a static URL for particular views and dashboards with their meter configuration.

H. The software must allow the production of public dashboards or views, where data is selected to be open to public consumption with a particular visualization.

i. The public dashboards may be embedded in another website or navigated to using a QR-code mechanism which is provided by the software. The QR-code to link to a particular public dashboard is produced by the software.

2.2. METERING AND DATA ACQUISITION

A. Owner reserves the right to add metering and/or request the selected contractor/vendor to provide pricing and installation of additional meters and metering functions.

B. Preconfigured meters may be added without having to add meter points, registers, and common point features such as alarms or calculations.

i. Preconfigured meters shall be selectable through a pull down menu during the initial meter creation process.

ii. Each meter type shall have a base point mapping reflective of the meter type and applied metered media.

iii. Selected contractor/vendor software shall provide the owner with a list which shall reflect the common types of meters contained in libraries within the software.

C. It shall be possible to create custom meters or controllers with custom point maps.

2.3. DATA MANIPULATION

A. Virtual Metering shall allow the system to combine like meters within a facility into a software based virtual meter providing combined energy data, current, demand, and other registers as if it were a hardware meter. The system shall have no virtual meter limitation. Virtual meters shall be configurable through a software wizard which allows

combining meters or portions of meters (for example, meterA + half of meterB – meterC).

B. The following data-manipulation resources shall be available for each point:

i. Integrator / Differentiator, where the integral of the point value is calculated (for example, to convert a flow rate to a consumption or visa versa).

ii. Runtime calculator, where a minimum on-value is used to compute runtime (for example, if the current exceeds 0.2 Amps, then start accumulating runtime).

iii. Accumulator, where the point status increases without rolling over, so that the accumulated point may be used instead of the raw meter consumption, which might roll over after it reaches some value.

iv. Schedule, where the point value can change based on the time of day or week.

v. Lookup table, where a point value can be mapped using an arbitrary nonlinear lookup table (for example, to convert resistance on a thermistor to temperature).

2.4. US ENVIRONMENTAL PROTECTION AGENCY ENERGY STAR FUNCTIONS

A. The software shall have the ability to interface directly with the owners EPA Energy Star Portfolio, and must be accessible to the user within the on-line Energy Star tool, Portfolio Manager.

B. The software shall have the ability to automatically create meters and other structural elements within the Energy Star owner portfolio which reflect the meters and other structural elements programmed into the software.

C. The software must automatically synchronize consumption data with the owner's Energy Star database no less frequently than once a day.

i. Daily, weekly, or monthly reports (at the owners discretion) must be automatically issued via email which summarize the Energy Star software synchronization state in such a way that it is obvious if data has been lost due to the Energy Star database being temporarily down or inaccessible due to network traffic, processor load, or some other reason.

2.5. ALARMING

A. Fixed threshold system alarming shall be available for each monitored and virtual point within the system. The alarming notification function shall include record-only, e-mailing, text message or any combination as determined by the operator.

i. Fixed threshold alarm limit notification shall include any selected point as determined by the owner.

ii. Should the selected point value exceed or fall below, or deviate from some range by more than an entered threshold, for a specified duration, alarming shall occur.

iii. Typical alarming shall include Amperage, kW, kWh, BTU, GPM, and MCF of CNG threshold limits.

B. Variable threshold system alarming issues a notification based on a calculation of one or more point values.

C. Demand-response alarming, which is a specialized case of variable-threshold alarming, shall include predictive warnings based upon current demand and provide early alarming notification of impending high demand conditions.

   i. It must be possible to specify the alarm demand-response threshold to be either a fixed value, or a time-varying value which is calculated using peak-demand calculation methodology similar to the registered energy provider.

D. All alarms will have the following customizable attributes:

   i. Multiple recipients, identified by either the group or by individual user account.

   ii. A true-time, which specifies a minimum time which an alarm condition must be true before a notification is issued.

   iii. An reissue time, where an alarm will reissue a notification after a specified period of time if the alarm condition has been continually valid since the last notification.

   iv. A maximum rate of alarm, which is specifiable on a per alarm basis such that no number of alarms on a particular point shall cause notifications from that point (such as text messaging or e-mails) to be sent out faster than the configured rate.

2.6. FAULT DETECTION

A. The software will allow the creation of fault-detection rules which allow the combination of an arbitrary number of point-criteria using AND- or OR-logic.

   i. It must also be possible to tie rule activation to schedules and minimum true-time. For example, only activate a rule if the current-draw on an air-handler is greater than 1 Amp for more than 1 minute during the “building unoccupied” schedule.

   ii. It must be possible to attach a cost to the rule (either as a static value or as a calculation referencing one or more point values), where a total cost for a particular rule on a point can be calculated by multiplying the cost by the duration for which a rule was activated.

   iii. Rules must be specifiable in a general manner, so that a single rule may applied without change to any number of points / meters / controllers. For example, if a rule identifies when heating and cooling are running simultaneously on an air-handling unit, then the rule will be defined once, and may applied without change to all air-handlers in the system.

B. The results of all fault detection rules must be viewable in a single visualization, where the activation of any rule on any point for which rules have been applied can be seen and inspected for at least 30-days.

   i. Filtered views of the rules must also be possible, where only a subset of point or rules are displayed.

   ii. Clicking on a particular point in the visualization must provide detailed information on that particular rule in a separate screen (hereafter referred to as the Detailed Rules view), including the breakdown of when and for how long each rule for that point was activated.

iii. The Detailed Rules view will show all points related to the rule and allow the operator to view history on all the points in the same graph at the times for which the rule was activated.

2.7. BILLING

A. The software will allow data collected from meters to be used to bill tenants of the property.

B. Bills must be presented in an aesthetically pleasing itemized invoice with consumption visualizations such as consumption-per-month over the last twelve months and a pie-chart of relative consumption for all meters serving a particular tenant.

C. It must be possible to specify a different rate for electrical, water, and gas for each tenant.

D. It must be possible to specify time varying rates such that a billing cycle which runs from the first of a month to the first of the next month may use a different rate for any day or range of days. For example, if the electrical utility bill runs until the 17th of the month, then a bill which runs from the 1st will use one rate for 1st-17th and a different rate for the 18th-31st.

E. It must be possible to specify utility allowances for each tenant.

i. These allowance must be customizable on a per-tenant and per-utility-type basis.

2.8. SAVED REPORTS

A. It shall be possible to save reports to an operator “briefcase”, with a separate briefcase for each operator.

i. The information saved must include the set of points used in the report as well as all configured parameters, filters, and selections for the report.

ii. It must be possible to specify time for reports in relative terms. This way, a saved report which displays the relative consumption of different building for the month may be run at any time and will show the relative consumption for the current month, not the month in which the report was first run and saved.

a. Examples of relative time may include: “last month”, “from the beginning of this month until now”, or “from 3pm on the 12th of seven months ago until midnight on the 8th of last month”.

B. Any report which has been saved may be automatically scheduled to run daily, weekly, or monthly. The results of the report will be e-mailed to any of the users or groups specified by the operator.

i. The hour at which a daily report runs must be configurable, as must the day on which weekly or monthly reports run.

2.9. INTEGRATION

A. HVAC integration

B. Modbus server at gateway or cloud level

C. It must be possible, at the owners discretion, to pull in building controls points via BACnet or Modbus in such a way that they are treated as native to the platform, meaning that they may be used interchangeably with other points in reports, calculations, and alarms.

   i. In the case of a BACnet integration, automatic point importing must be supported if the BACnet devices or server support this feature.

D. Manual data entry

2.10. MODELING

A. The software must provide facilities to produce power / load models (showing energy demand by time of day), as well as energy consumption models.

   i. Models must be automatically generated based on historical data at the option of the operator, but also allow for manual model specification.

B. The modeling wizard must make use of climate data, and optionally use occupancy data if available. Day-of-week and possibly seasonal data may also be used by the modeling algorithms.

   i. A model-correlation graph must be produced by the modeling wizard which measures the accuracy of the model when used to predict data which it was not trained on.

   ii. The modeling wizard must produce a weather-performance visualization, where the daily consumption is shown compared to the mean 24-hour temperature for each day in the training and testing period.

C. It must be possible to provide a manual override for historical anomalies via uploading a spreadsheet or text file. For example, if the modeling algorithms should skip a particular date range since the site was closed for construction, or if a particular time span was not indicative of normal operation.

D. It must be possible to train a model with as little as 30-days of historical data.

E. The consumption model must have a resolution of a single day, meaning that consumption for each day is predicted individually, rather than a single prediction of the consumption for the whole month.

   i. The software must have a visualization where the predicted energy is compared to the measured energy for each day in the specified time range.

PART 3. DATA ACQUISITION, INTEGRITY, AND ARCHIVAL STRUCTURE

3.1. PLATFORM ARCHITECTURE AND STORAGE REQUIREMENTS

A. Cloud Based Software Provisions and Guidelines

   i. Cloud Based Services shall include storage and access to all previous and current collected data for the period of the contract and shall be the responsibility of the selected contractor/vendor. All data shall be transferable to owner should the owner contractor/vendor discontinue contracted services.

ii. Data shall be accessible by an approved representative of the owner on an on-demand, as needed basis, at any time with the exception of normal scheduled service and maintenance required by contractor/vendor.

iii. The expansion of the original system and addition of each site or monitoring device which is added to the system shall have the initial setup provided by the selected contractor/vendor. An approved owner representative or administrator shall have the ability to customize the data views as desired to fit the chosen application.

iv. It shall be within the owners capability of adding additional gateways or monitoring without the intervention of the selected contractor/vendor.

v. A cloud-based server shall monitor all site nodes' communication frequencies. Should a site node not update data for a determined amount of time the owner and service provider shall be notified as to the communications failure.

B. Gateway Devices:

i. Each site shall be provided with one or more gateway devices (herein interchangeably referred to as nodes) which shall have the capability of communicating with up to 31 networked energy monitoring devices, each with out point limitation.

ii. Each gateway shall be pre-configured to connect to a cloud-based server by the contractor/vendor prior to installation. Gateways shall have the ability to automatically connect and register upon connection to the Internet. Nodes shall have the ability to store up to 30 GB of data should the Cloud Server be unreachable, which will be synchronized with the Cloud Server upon reconnection.

iii. Each gateway shall feature a warranty for the life of the provided service contract.

iv. Each gateway shall have the ability to communicate to energy monitoring devices via the following protocols:

a. ModbusRTU

b. ModbusASCII

c. ModbusTCP

d. BACnetIP

e. BACnet MS/TP

f. Niagara oBIX

v. The system shall allow live monitoring of every gateway, channel or meter communications. Such communications will include error messages, performance indications and point read statistics.

a. Such monitoring may be restricted to a single gateway, or may be open to receive all messages from every gateway registered to the site.

3.2. DATA INTEGRITY

A. Gateways located on-site must retain a copy of their historical point value data for at least one year or 256-million samples, whichever is less.

B. If a gateway is disconnected from the cloud (due to network outage, for example), it must be able to feed (backfill) the cloud server the last year of activity or 256-million samples, whichever is less.

   i. If some data is lost due to restoration from a backup, then the data may be automatically synchronized by pulling it from the nodes.

C. A copy of all site configuration must be backed up once a day. At least one year worth of daily configuration snapshot must be saved by the contractor/vendor.

D. Snapshots of all history must be made at least once a week. At least one year worth of history snapshots must be saved by the contractor/vendor.

   i. Each snapshot will include all history saved in the system since it was first installed.

E. The amount of history stored by the contractor/vendor is unlimited, but may reduce in resolution after some time. For example, recent history from 3 months ago may be saved at a rate of 1-sample per 5- or 15-seconds, while older history from 10-years ago might be saved at 1-sample per 5-minutes.

3.3. SECURITY AND NETWORKING

A. If passwords are used for gateways, then all gateway devices must have strong, unique, random computer-generated passwords.

   i. Strong passwords must be at least 10-characters long and include mixed-case, numbers, and punctuation.

   ii. Passwords are only required during gateway manufacture and upgrade and are not intended to be used during normal operation.

B. It should be possible to specify static or dynamic DHCP-addresses for the gateways.

   i. Normal operation should require no network configuration and obtain network parameters such as IP address, subnet mask, and DNS servers from the DHCP server (or router).

C. Gateway operation must not require port-forwarding / NAT, or exposing internal network devices to the outside world.

   i. Connection to the cloud must be initiated by gateway, and cannot be initiated by the cloud server.

D. Communications between the gateway and the cloud-server must be encrypted.

   i. TLS (Transport Layer Security) v1.2 or higher must be used for communications, with at least 128-bits of symmetric and 1024-bit of asymmetric encryption during handshake.

E. It must be possible to lock out or allow IP address ranges using a Whitelist / Blacklist mechanism where everyone from the blacklist if forbidden access to the system unless the also appear on the whitelist.

F. It must be possible to lock access to the software for certain privileged users unless they also have a second factor of authentication.

i. This second factor of authentication will be a program installed on a mobile device which generates a continually changing series of pin numbers using a cryptographically secure pseudo-random number generator.

ii. After the privileged user logs in normally, the software will then require the entry of the pin code for that user and particular time of day.

G. The software must allow field-configuration of WiFi parameters (SSID and password) on the gateway via a file generated on the platform via the web-browser interface.