ENERGYICT

ENERGY INFORMATION AND COMMUNICATION TECHNOLOGIES

EIServer

ENERGY MONITORING & MANAGEMENT

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1. INTRODUCTION TO ENERGYICT

EnergyICT Pty. Ltd. is a wholly owned subsidiary of EnergyICT NV, based in Belgium. Founded in 1991 by Stefan Grosjean, EICT employs approximately 150 people from offices located in Belgium, The Netherlands, The United Kingdom, France, Germany, Australia, and the United States. EICT personnel have deployed over 400 systems throughout the world to help a wide range of customers manage and control their energy requirements. EICT manufactures and offers their complete line of fully integrated hardware and software products, in conjunction with a wide range of data and project management services.

EICT's two primary lines of business are:

1) Advance utility monitoring and control solutions
2) Meter data collection and management systems

The systems delivered include interval meter data collection and processing systems; sub-metering solutions for real-time monitoring and control; Meter Data Management (MDM) systems for Automated Metering Infrastructure (AMI)/Automatic Meter Reading (AMR); data collection devices for load studies; complex billing engines; smaller scale load balancing systems and many other retail, commercial and government applications.

These systems include some of the largest systems ever deployed, such as Wal-Mart (more than 30,000 channels of sub-meter and load data), IMServ (150,000 meter data channels) and DTE (20,000 C&I electric meters). The EICT product has also been selected for use in the largest AMI/AMR/MDM system in the world, Électricité de France (EDF), which will encompass 34 million meters.

2. EIServer® Architecture

EICT is proposing its flagship meter data collection and management software EIServer® running as a Hosted ASP (Application Service Provider) platform in the EnergyICT Secure Data Center. EICT's EIServer® is designed for the future with an open architecture to provide a highly scalable meter data warehouse and data collection system. The core objectives integrated into the design of EIServer® are flexibility, performance and traceability.

The best way to describe the EIServer® architecture is in terms of a series of layers built upon a core module as shown in **Figure 1: EIServer Architecture**.

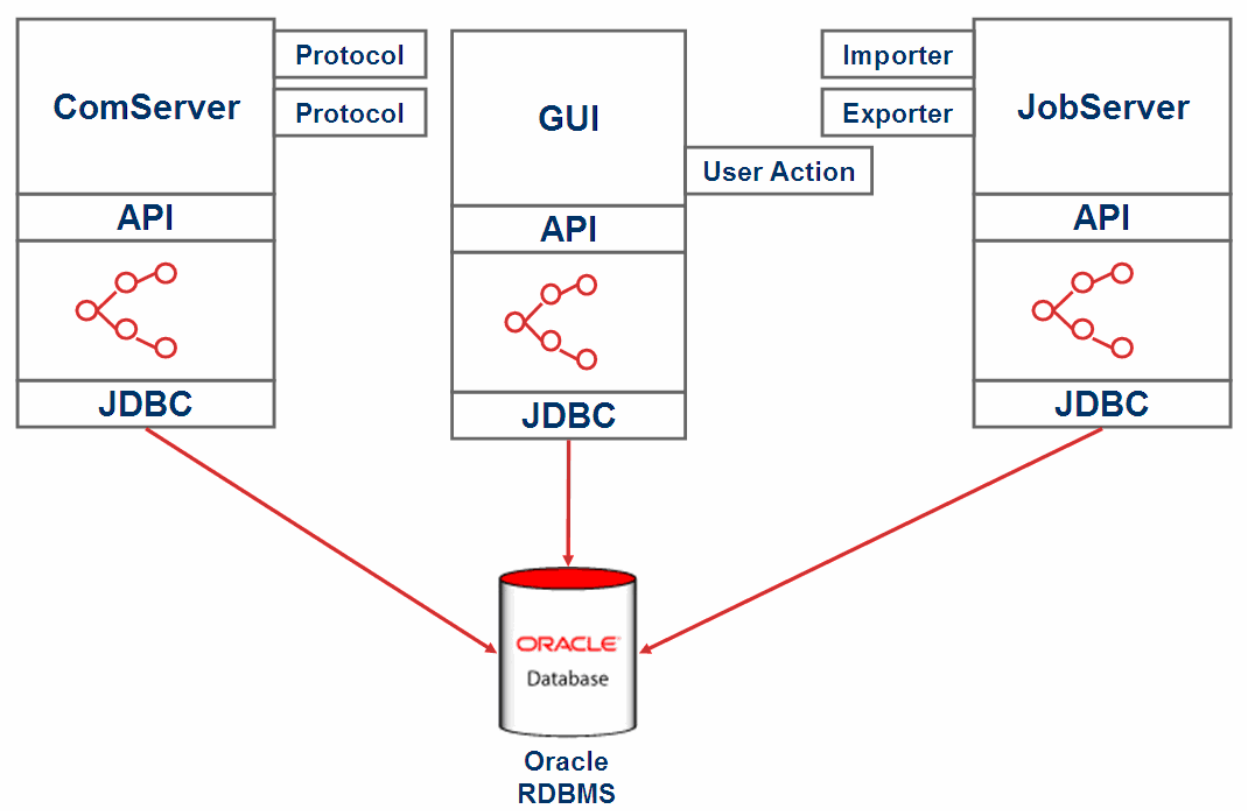

Figure 1: EIServer Architecture

An Oracle® database is at the base of this design, which provides outstanding performance with proven scalability. By choosing Oracle®, EIServer® is deployable on a wide range of hardware, from a laptop computer to a cluster of UNIX servers, depending on the needs of the system. Stored procedures provide advanced performance-oriented functionality, such as validation.

A data access layer sits above the database utilizing the same JDBC methods across EIServer® components. On top of the data access layer sits the EIServer® business logic layer. Utilizing the object model available in the Java language, a business logic layer exists that uses these objects for the storage and retrieval of data. Through our long experience in all segments of the energy market, we created an object model with elements that

accurately and completely reflect the business logic encountered in the energy management market.

EICT has also developed a number of functional components that expose the objects of the business logic layer and through them, the data warehouse. These are comprised of the recognizable features of EIServer® available in its powerful toolset, such as, report generation, VEE (Validation, Estimation & Editing), and EISpector® functionality. These features have been implemented using EICT's own Application Program Interface (API). Using the extensive API, other programs and systems can work directly with the EIServer® data warehouse.

Integration with third party business software (e.g., CIS billing or CRM systems), as well as other EICT products, is made easy. The EIServer® client application that is used to operate and administer any EIServer® system utilizes EICT's own API entirely and exclusively, meaning the full set of functionality within EIServer® is accessible to external systems through the API. Furthermore, the API provides a layer of abstraction, shielding applications from changes that may occur to the underlying business logic layer.

Additionally, EIServer® provides a communication layer that allows for the exchange of data across remote locations. Among the essential services that the communication layer makes possible are:

- Data collection via the EIServer® COMServerJ® Module, as well as, web-enabled data logging equipment, manufactured by EICT, which effortlessly transfer remote meter readings to the hosted centralized data warehouse
- Use of the EIWebClient functional component which provides Web client functionality to users via a standard Internet browser
- Integration of third party applications that remotely interact with the EIServer® API via Web Services

An overview of the EIServer® open architecture is provided in Figure 2: EIServer® Open Architecture. A key element of this open architecture is the use of pluggable classes to extend existing functionality with customer specific logic. Pluggable classes, written in Java and packaged as compressed JAR files, provide full access to the Java and EIServer® API. More importantly, the use of pluggable classes is the standard means by which core functionality is implemented in EIServer®, meaning that customer-specific logic is being implemented in exactly the same fashion as the standard functionality that ships with EIServer®.

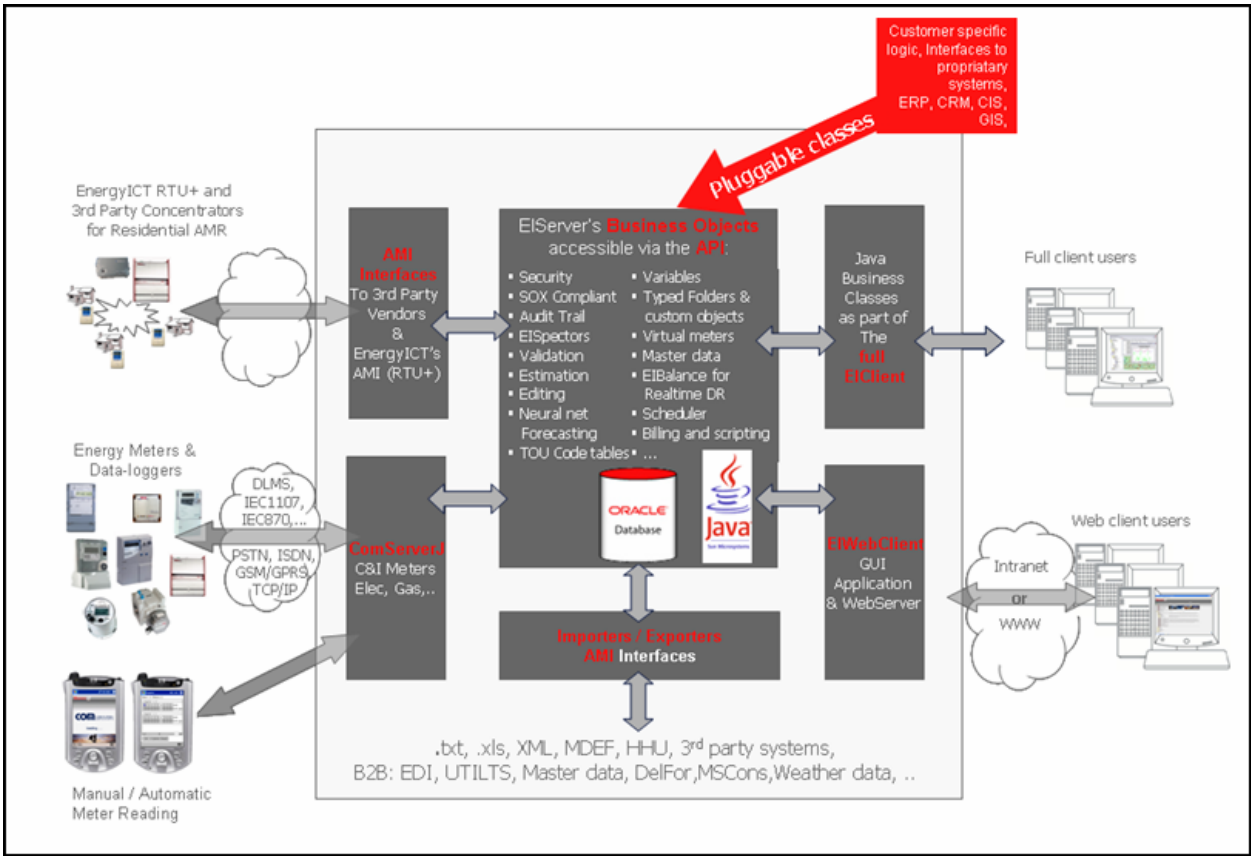

Figure 2: EIServer® Open Architecture

In addition to the extensibility provided by pluggable classes, EIServer® also provides "Typed Folders", which allow for the creation of fully versioned user-defined entities, and attributes that can be used to track and store information that is not available through other EIServer® objects.

Figure 3: Typed Folders illustrates a meter asset defined as a Typed Folder.

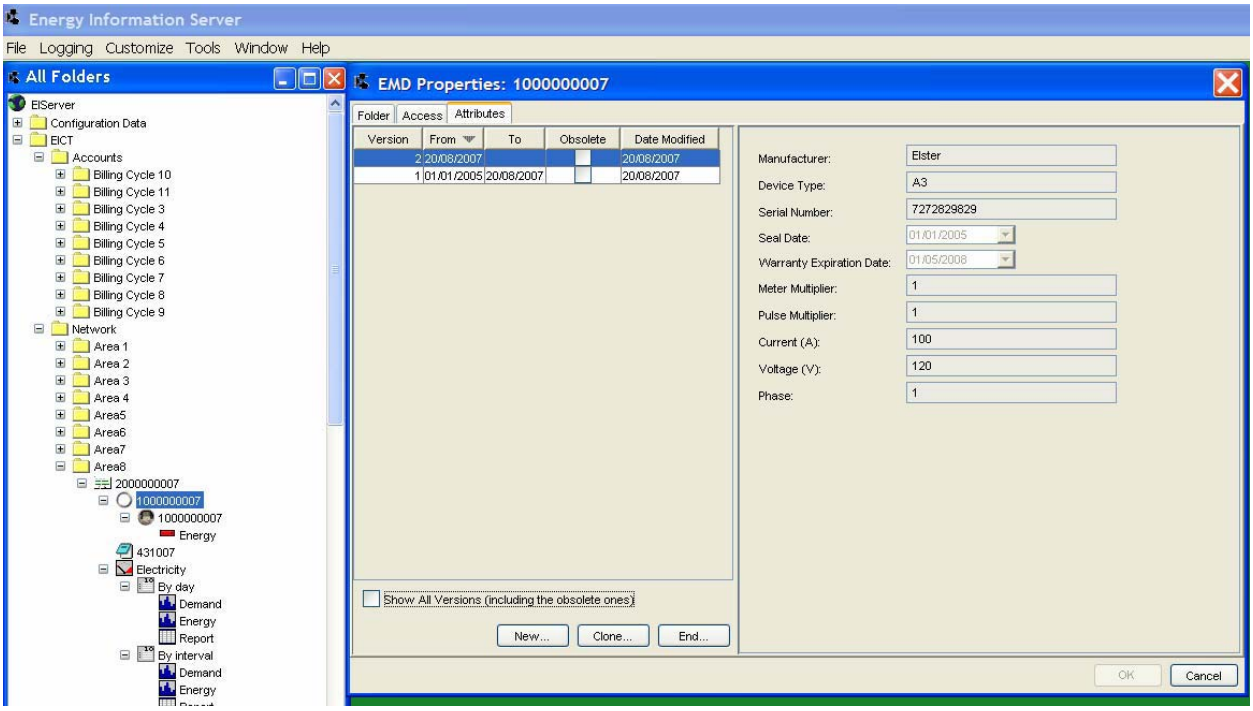

Figure 3: Typed Folders

It is important to note that, once defined; a "Type Folder" is fully versioned and accessible via EIServer®'s API.

Integration with third party or legacy systems is accomplished by means of Web Services (Service Oriented Architectures). Depending on the type of performance service, various technical interface techniques ranging over asynchronous or synchronous file and/or messaging interfaces and/or publish/subscribe type of interfaces can be used.

2.1 Proposed Architecture

Figure 4 illustrates a high-level schematic of the proposed system. As the exhibit illustrates, EIServer® will fulfill the following functions:

- A meter data collection engine for all utility meter data
    - Data collected and supplied by the Meter Data Agent (MDA) will be exported from the MDA's MV-90 System via a file format supported by both EIServer® and MV-90 (i.e.; MV90, MDEF or HHF) and imported into EIServer® on a defined, agreed upon frequency that is technologically feasible
- Serve as the corporate meter data repository and distribution system for all interval meter data
    - perform all meter data validation, estimation, and editing

- Provide internal business users with a secure and flexible web based interface to access facility meter data

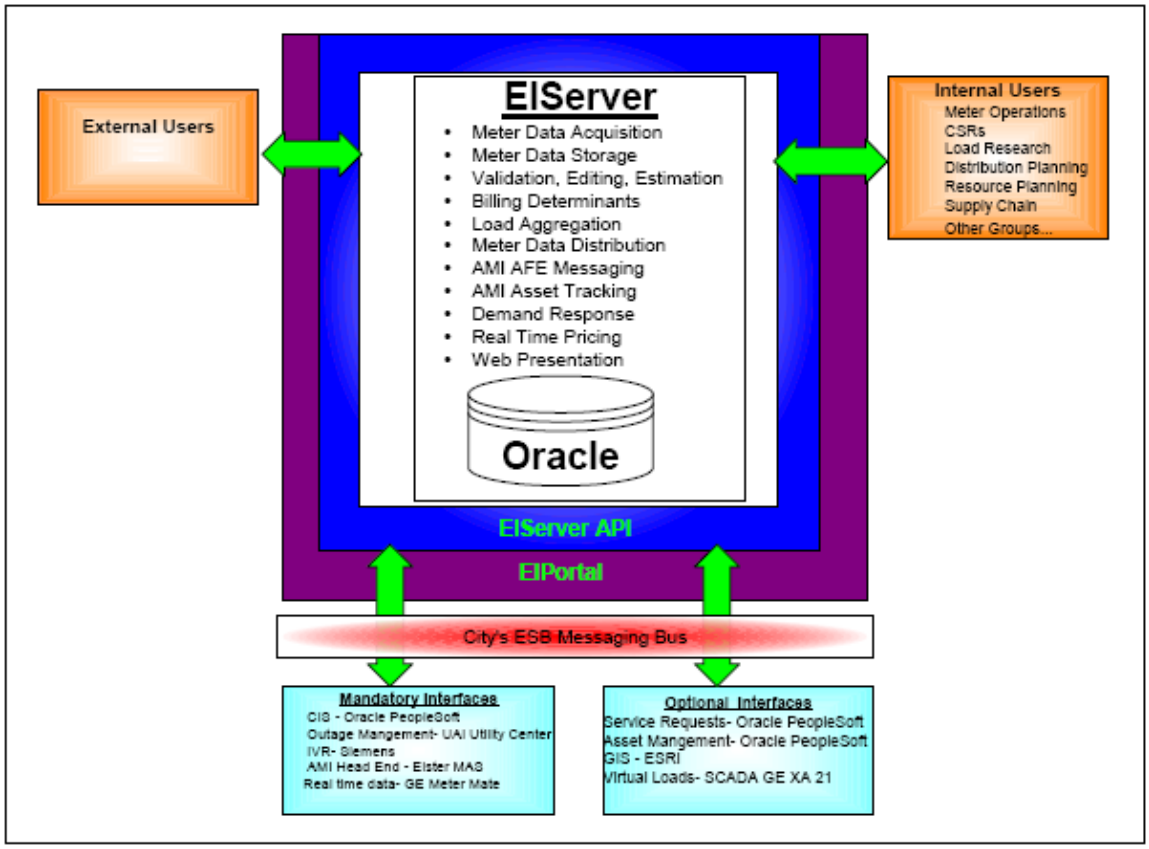

Figure 4

In addition to fulfilling these important business functions, EIServer® will streamline business processes surrounding meter data collection, reporting and processing.

2.2 System Configuration

EICT is proposing a fully managed, hosted solution where EICT will provide the application and web hosting platform at our secure data center, as well as, personnel to maintain the application on a day-to-day basis. Secure access to the system is made available remotely via a portal (EIPortal) built around IPSec VPN standards.

A fully managed system will provide web access to the meter data in any number of reports and graphs created to support the wide variety of business applications required. Access to data can be limited to individuals or groups so that only the information they need to support their position will be made available to them.

2.3 Virtual Meters

EIServer® uses the "Virtual Meter" concept to aggregate meters. In order to create clear and useful reports, you may need to combine data from several physical meters. The Virtual

Meter feature allows you to combine raw data on the physical meters with other Virtual Meters and mathematical functions of your choice to chart any parameter you want to log. Once created, the virtual meter can be used to compute new billing determinants for cost comparisons between utilities.

Because Virtual Meters can combine data from other Virtual Meters, the possibilities are unlimited. Modifications of a Virtual Meter are automatically included in all Virtual Meters that contain the modified Virtual Meter. A Virtual Meter can contain more than one channel, with a maximum of 32 channels in any meter.

The meter data aggregation is completed when the data is initially loaded. If new meter aggregations are created, they are available for use as soon as they are created and reported upon. There is no trigger needed for aggregation. The reporting or graphing features of the system present "Virtual Views" of the data. Figure 5: Set up screen for Virtual Meter demonstrates the Virtual Meter concept.

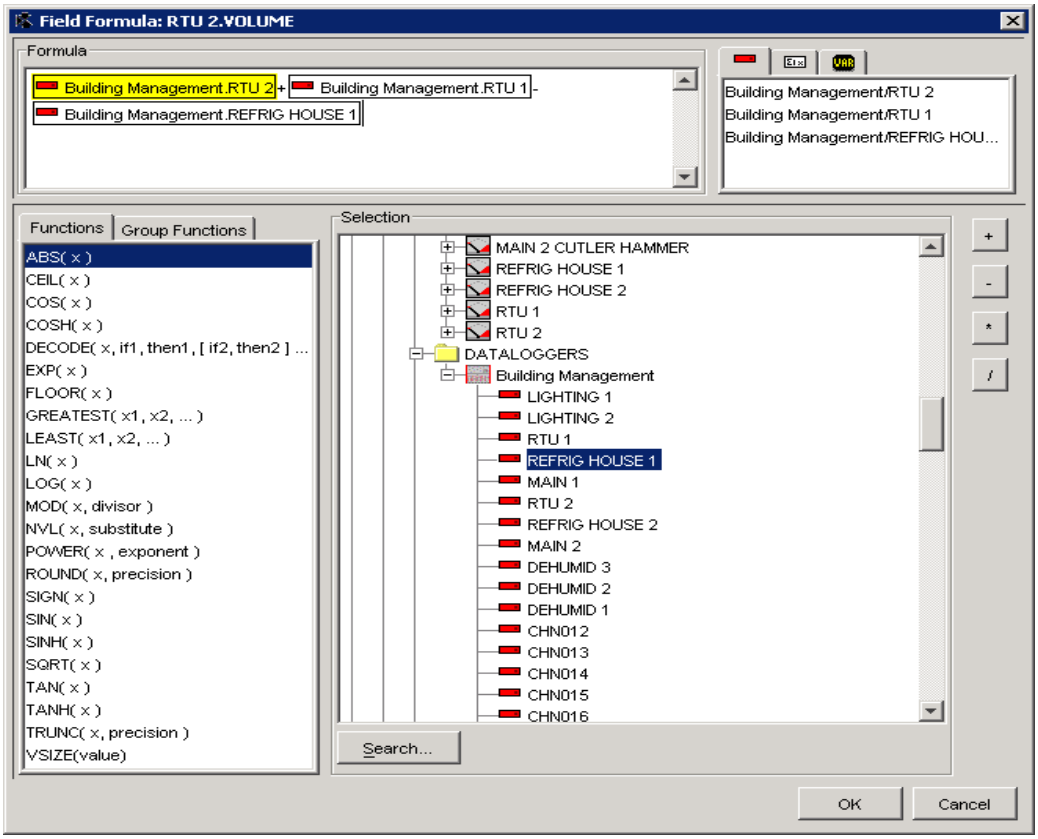

Figure 5: Set up screen for Virtual Meter

2.4 Validation, Estimation and Editing

EIServer comes standard with powerful validation capabilities that will provide a high degree of flexibility in ensuring the meter data collected by the MDA is accurate.

The system will be configured with a central repository of approved validation algorithms that can be mixed and matched and assigned at the meter channel level to meet the validation requirements.

Validation algorithms can be grouped and assigned to specific customer types or meter types and be assigned automatically as meters are setup and commissioned into the system.

Figure 6 : Validation illustrates the main set-up screen for specifying validation algorithms.

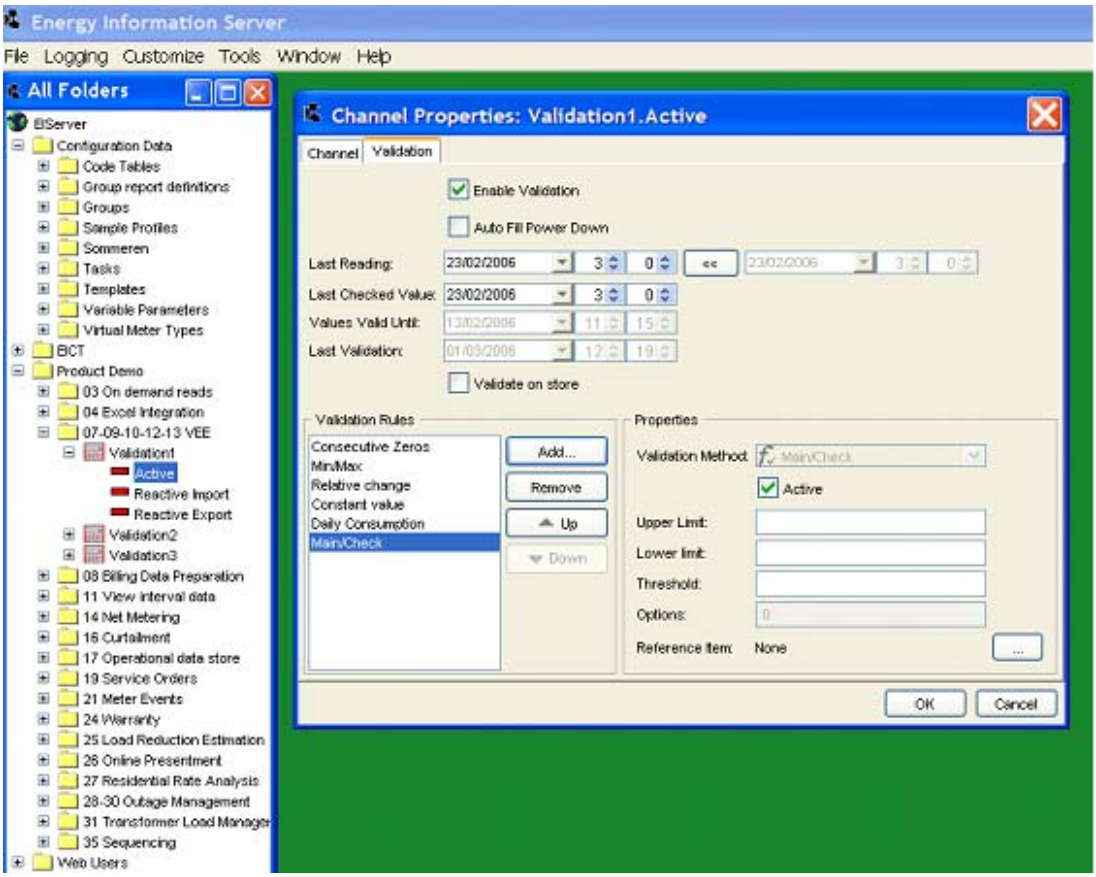

Figure 6 : Validation

In addition to validation algorithms based on the meter data, such as maximums and minimums, daily consumption, etc., EIServer has the capability to validate meter data from interval state information provided by the meter. Figure 7 : Master Data Editor below shows a sample of interval states that can be used as filters.

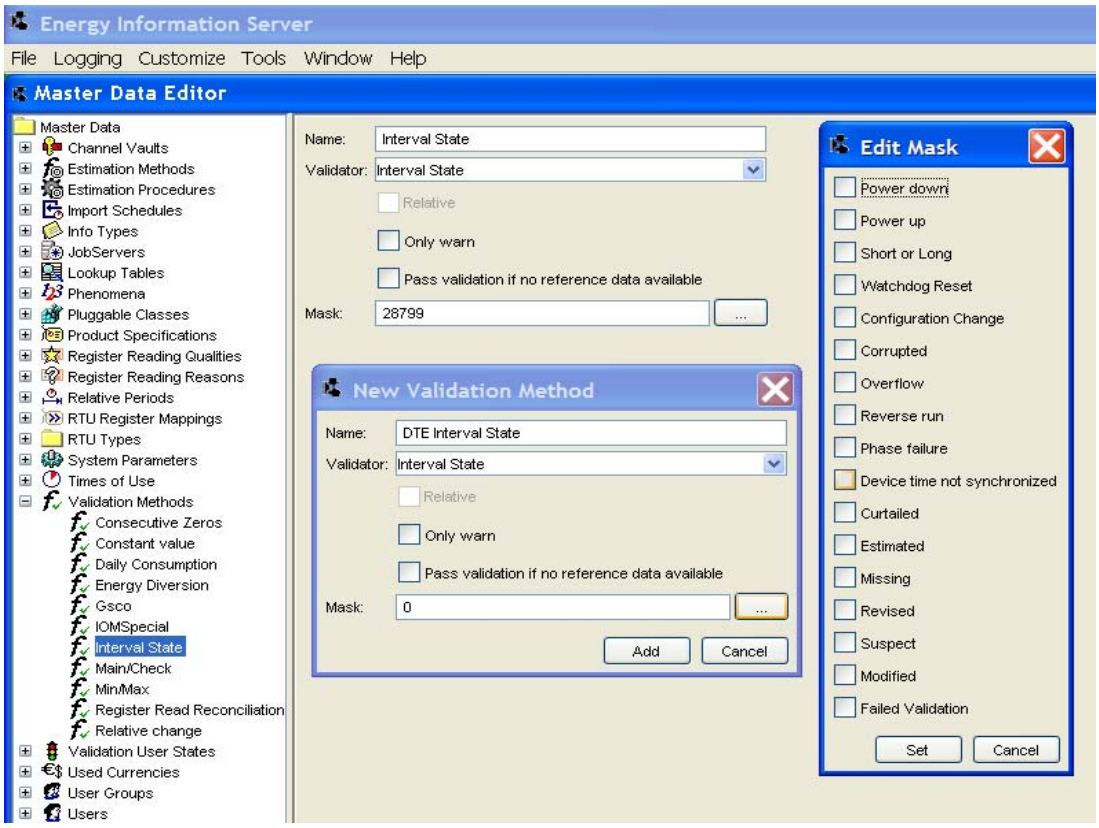

Figure 7 : Master Data Editor

As with the standard validations rules, the interval states can be configured on a channel-by-channel basis.

EIServer® has a wide range of manual and automated editing and estimation tools.

For manual edits, EIServer provides operators with a user-friendly interface and a rich set of functional tools to correct suspect data and modify interval statuses, as illustrated in Figure 8 : Data Editing.

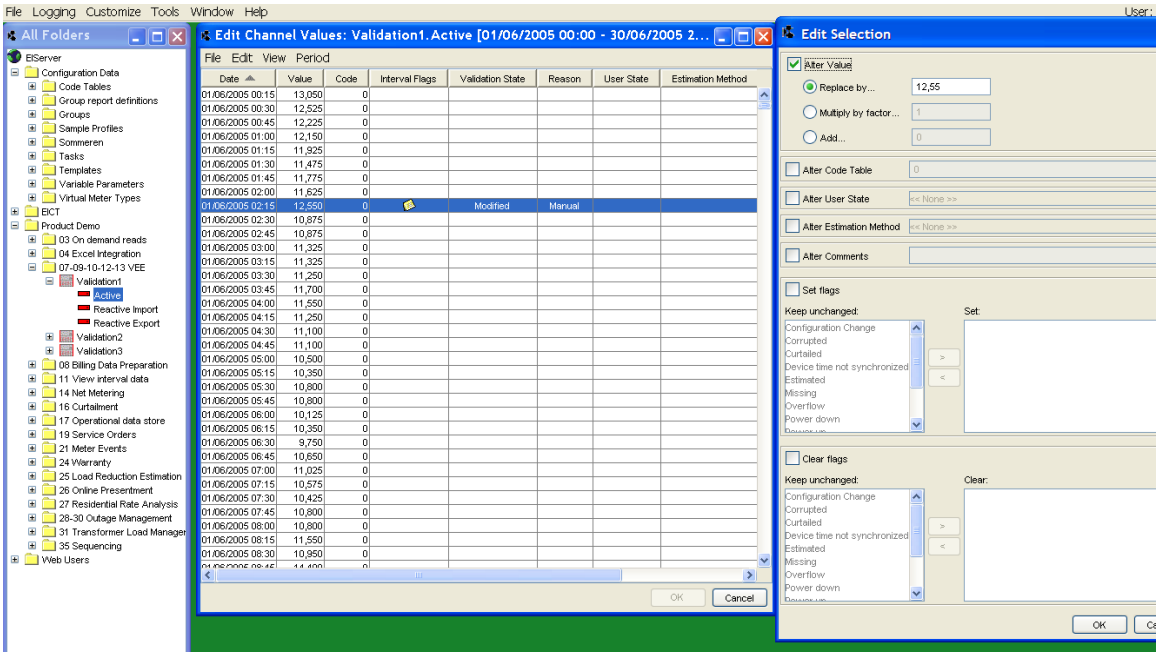

Figure 8 : Data Editing

Like validation algorithms, EIServer®'s estimation algorithms are highly configurable and are specified individually at the channel level. More importantly, EnergyICT has developed knowledge-based auto-editing/estimation capabilities in EIServer that determines the type of estimation/editing algorithm to use based on the reason for validation failure and the available information to estimate the missing or bad data.

For example, linear interpolation can be used for gaps in data of less than an hour, but a relative time-period with a meter advance would be used for periods over an hour where a meter advance is available. All information of why and how the data was changed is logged or versioned in the system, guaranteeing SOX compliance.

Figure 9 : Auto Editing & Estimation illustrates the auto editing/estimation functionality.

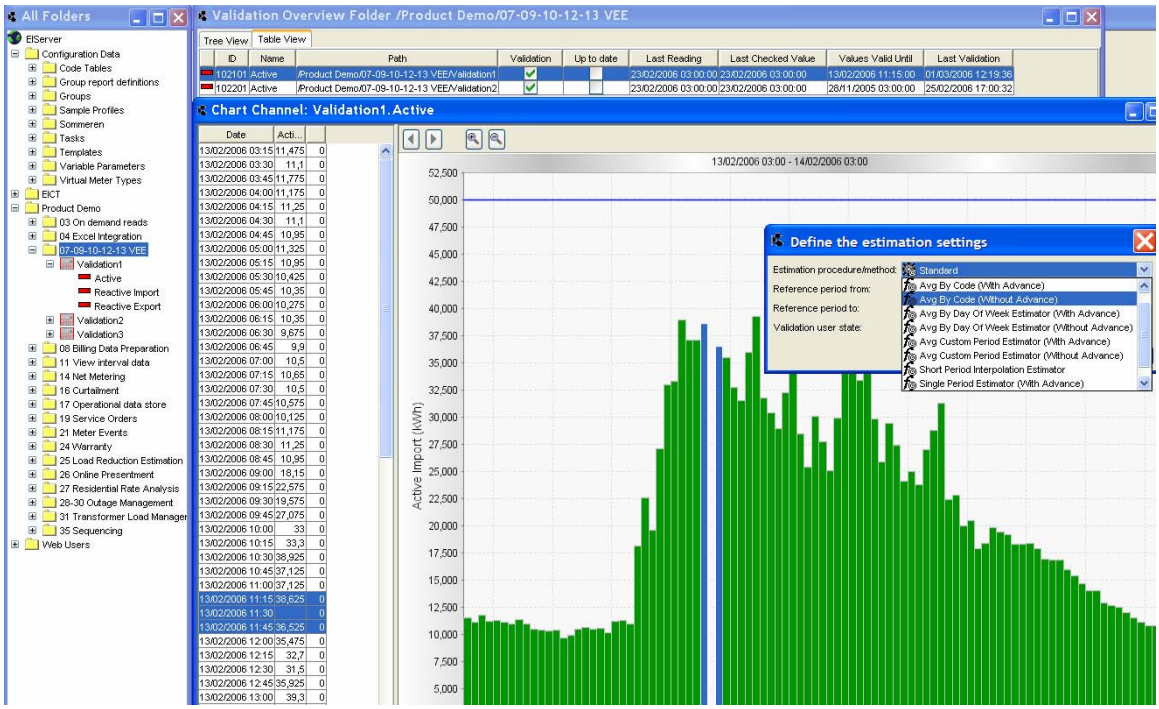

Figure 9 : Auto Editing & Estimation

2.5 Forecast Energy Usage

The Load Forecasting module is designed specifically for end customers looking to get accurate next-day forecasts of interval-by-interval energy consumption. This capability provides the customer with the ability to predict when new peaks are about to occur and undertake passive or active[1] actions to reduce energy consumption.

Forecasting in the system is accomplished using a special type of Virtual Meter incorporating an advanced regression algorithm that produces reliable results. Given the main building block of the forecasting module is built on a Virtual Meter, creating forecasted reports and graphs is a process similar to creating normal reports and graphs, which provides a wide range of report and graphical offerings.

EIServer®'s load forecasting module has many uses. Typically, it is used by end customers that are participating in some form of market-based rate that requires a strong compliance to an agreed upon baseline. Having a robust estimate of what is going to be consumed the next day gives the end customer the ability to predict overages and make operational changes to lower overall usage if required.

[1] EIServer is capable of sending control signals to the EnergyICT® RTU+ equipment to automatically control up to 16 individual loads.

Figure 10: Typical Load EIServer® Load Forecast Graph illustrates the forecasted interval-by-interval load plotted with the actual[2] load, and the percent error between the actual and forecasted[3] values.

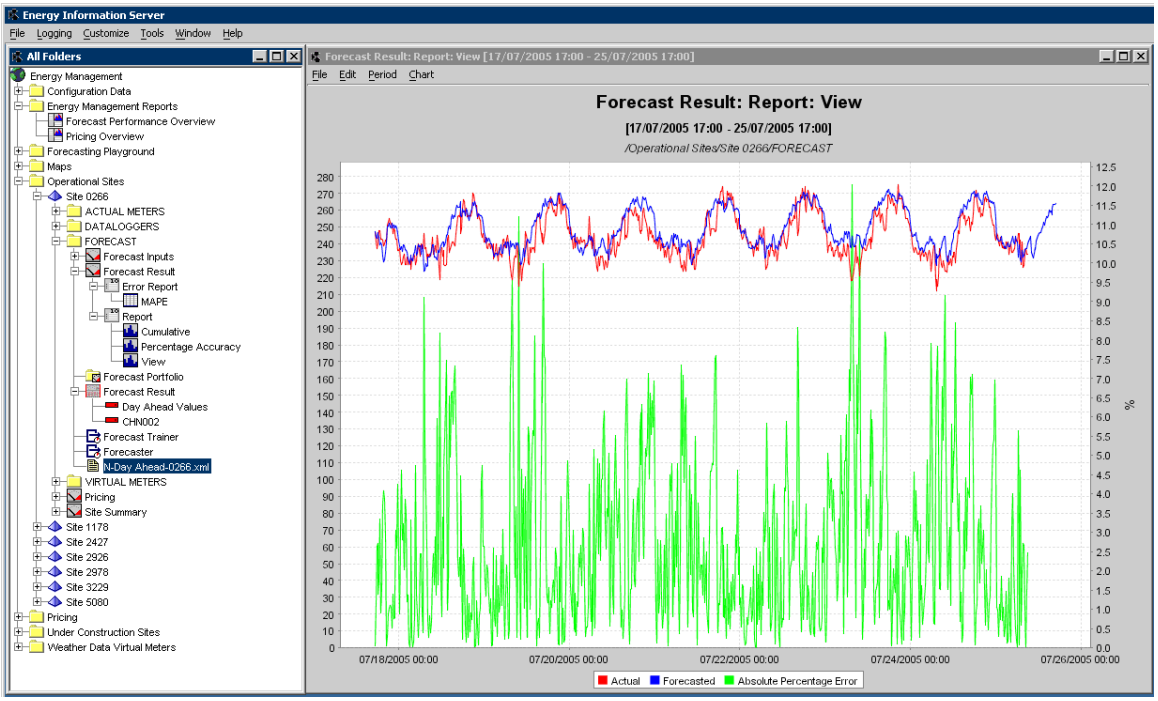

Figure 10: Typical Load EIServer® Load Forecast Graph

Code tables can be also be applied to the forecast results to produce forecasts of energy expenditures, assisting facilities in determining their cash requirement for energy consumption during periods of extreme weather.

EIServer®'s forecasting module not only predicts energy consumption values, but also the moment when they will be reached, giving plant or facilities managers the ability to better understand their peak load requirements.

Forecasting can be also be combined with EISpectors® to monitor whether parameters stay within certain forecasted limits, which is particularly useful as an automated means of verifying the models performance by comparing actual loads to predicted loads and sending an alarm if the defined baseline deviation threshold is exceeded.

The Load Forecasting module can also be used in combination with other features of the system. In addition to the wide range of reports and graphs available for facility-by-facility load estimation, EIServer® also provides the customer with a summary reporting feature

[2] EnergyICT® also manufacturers a line of web-enabled data loggers that provide end customers real time energy consumption feed back at the sub-billing interval level.

[3] Next day load shapes are typically generated at midnight the day before they are required.

that allows the end-customer to evaluate the performance of their forecast over a long period.

Figure 11: Load Forecasting Summary Reporting details the overall mean error for each site by date. If the operator sees a suspect number, then a simple click of the mouse on the suspect value will open a daily interval-by-interval graph that will provide the detail required to evaluate or act on the anomaly.

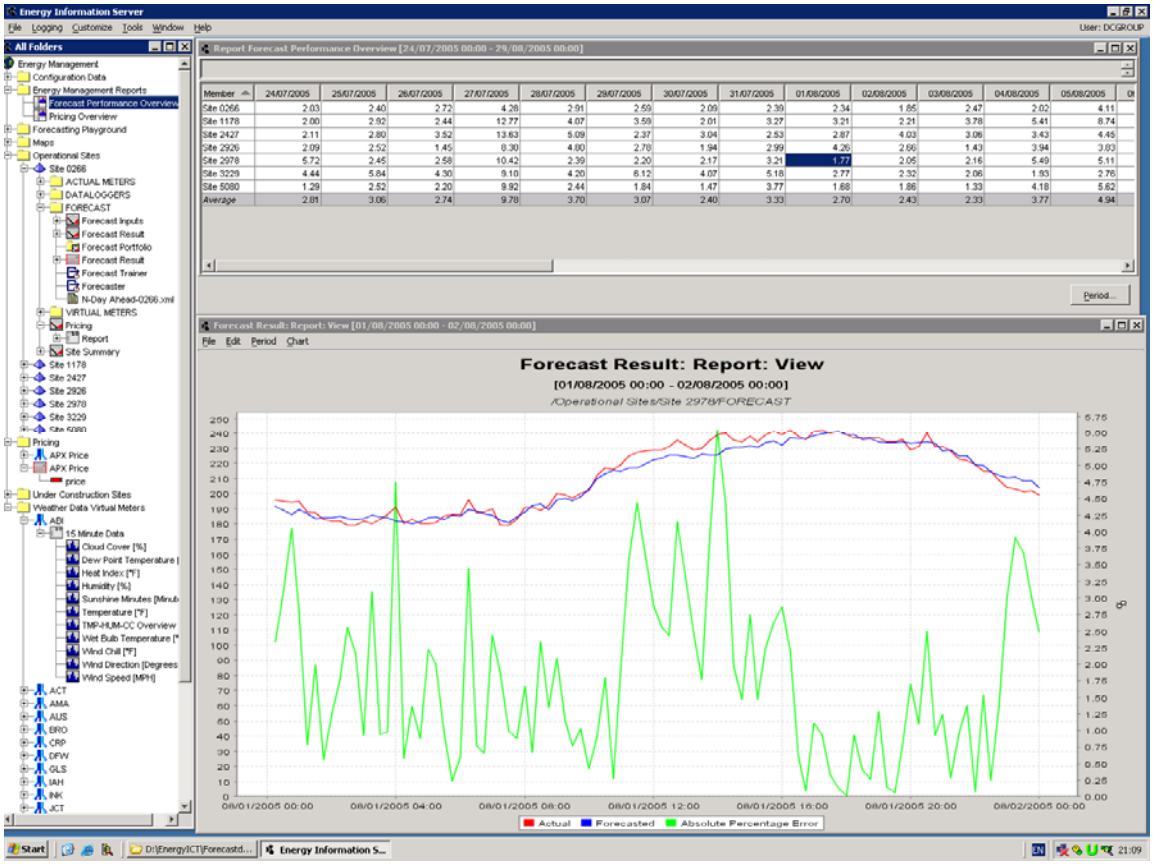

Figure 11: Load Forecasting Summary Reporting

2.6 Demand Side Management

The EIServer® application can be configured to schedule load reduction events and even automatically control facility and equipment loads. Using the EISpector® module to monitor usage/events; when a threshold level or defined rule (such as a deviation of actual usage to a baseline) a signal can be sent to an EICT RTU+ device. This device in turn can signal a building automation system or DDC controller to run a pre-programmed control sequence to shut down equipment or change a temperature set point or any number of other actions.

Conversely, the system does not have to automatically control the load. If a condition that is being monitored (as mentioned previously) occurs, notification can be initiated via email, text message, cell phone, etc… to personnel and load reduction actions can be performed manually.

This portion of the EIServer® system is utilized in conjunction with the Work Flow Module, an optional add-on to the base system.

2.7 Historical Energy Usage

Data selection is completely configurable within the EIServer® system, which allows Administrators to give their users the option of selecting predefined periods such as today, yesterday, last week, this month, last month, this year, last year, or custom periods using online calendars.

EIServer® also allows the Administrator to set a specific default period by individual report or graph. This is particularly useful for end customers that always look at a specific period and do not want to specify a period each time they want to look at data.

Most graphs and reports within the EIServer® can be run for any time period.

Relative periods are initially set up in the EIServer® using the Master Data Editor. When a report or graph is initially developed, the default time period is selected from these Relative Reporting periods. The Administrator or operator then has the ability to select the time periods that will be available for a user when they run the reports or graphs.

From web access there also exists the option of going to the Next Period of time chosen, or going to the Previous Period of time chosen. Along with these pre-determined reporting and graphing time periods, the user is given the option of choosing a Custom time period. The user can then enter any date/time period desired.

In addition to all of these options, there is a “Real Time” option that allows a timed update of the graph or report in a web browser window. The user does not need to refresh his screen; it will be updated automatically on a timed interval.

2.8 Create & Model Rates

The EIServer® Complex Billing Module provides the capability to model virtually any rate using a wide range of complex billing determinants. Figure 12: Billing Determinant Specification Screen displays one of the main screens used to create the billing determinants and calculate a large commercial billing report.

The process can be broken down into three steps. The first is to create the individual billing products for each component of a bill or rate. This step is accomplished using EIServer®’s powerful scripting language. Figure 13: EIServer® Billing Determinant Scripting Example illustrates the required script to retrieve on-peak energy.

The second step required is to populate a table of prices associated with the various billing determinants calculated in the first step. EIServer® allows these prices to vary over time with an easy to use interface for input.

The last step in the process is to create the individual billing reports. EIServer® makes this simple by allowing the user to reuse templates of billing reports for facilities that have similar charges.

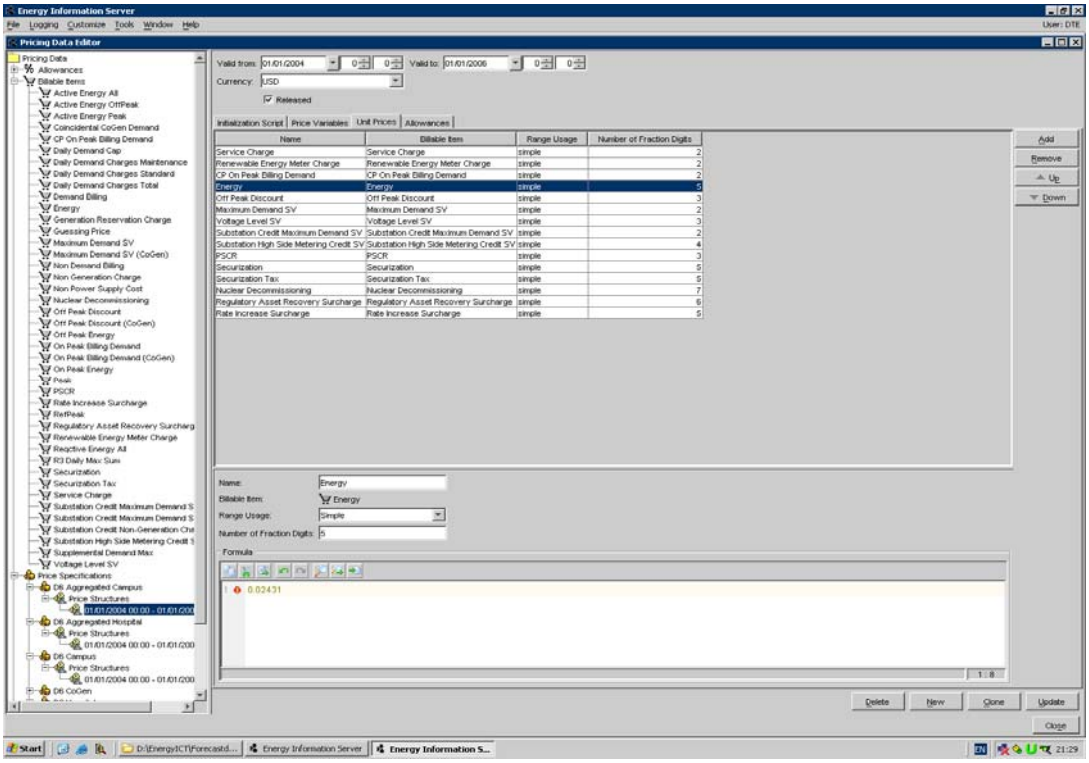

Figure 12: Billing Determinant Specification Screen

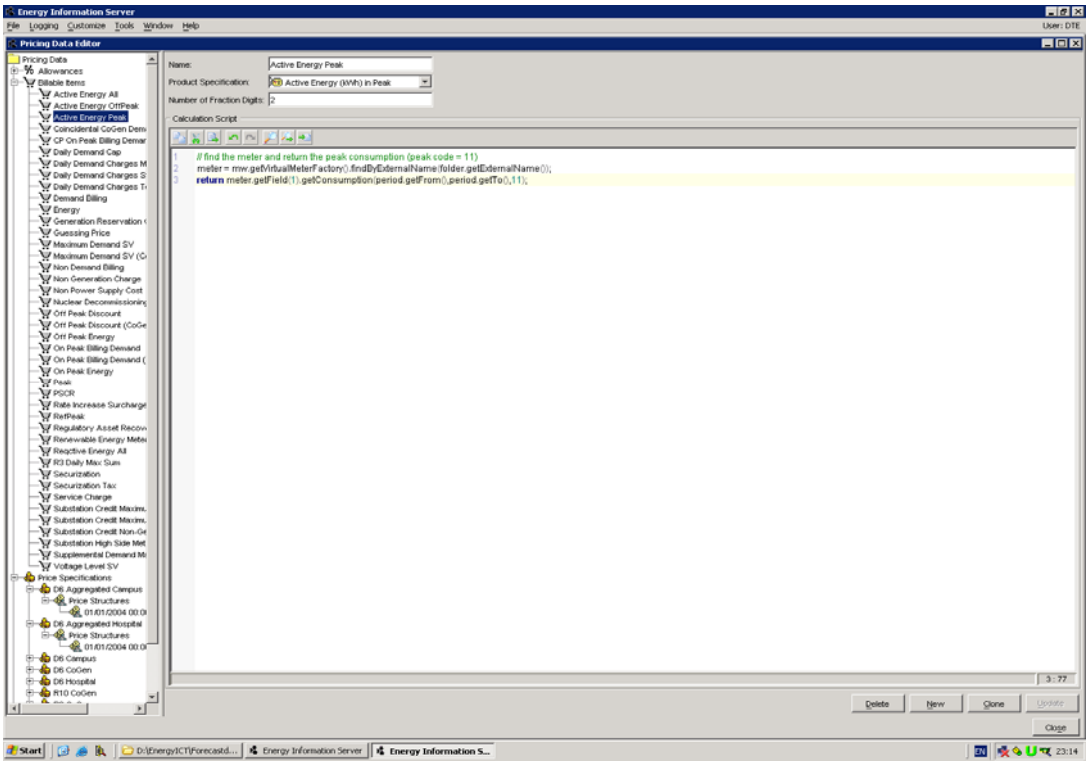

Figure 13: EIServer® Billing Determinant Scripting Example

2.9 Cost Savings Calculations

The EIServer® allows users to evaluate whether or not their specific energy consumption and load shape can generate cost reductions either by 1) switching to another supplier's rate or 2) by reducing consumption for specific periods. The system provides the ability to run the data for a location through different rate structures to determine the most cost effective model. This information can then be used to negotiate with the local electricity supplier.

Additionally, through the use of Virtual Meters, different load reduction scenarios can be simulated across a TOU periods to determine how the reduced load would affect the energy costs. These simulated cost savings calculations can provide insight into not only the best rate for the facility but used to optimize the building automation schedules and equipment operation.

2.10 Weather Data

Weather data is treated in similar fashion to all data stored in EIServer®, meaning all of the extensive reporting or graphing capabilities of the system are available for any type of weather variables.

Figure 14: Weather Data Graphed with Energy Data shows a simple time series graph detailing interval data for energy consumption, temperature data, and humidity data on a 15-minute interval basis. This time series concept can easily be re-configured to show sums, averages, maximums, or minimum for any time period the user is interested in (hourly, daily, etc….).

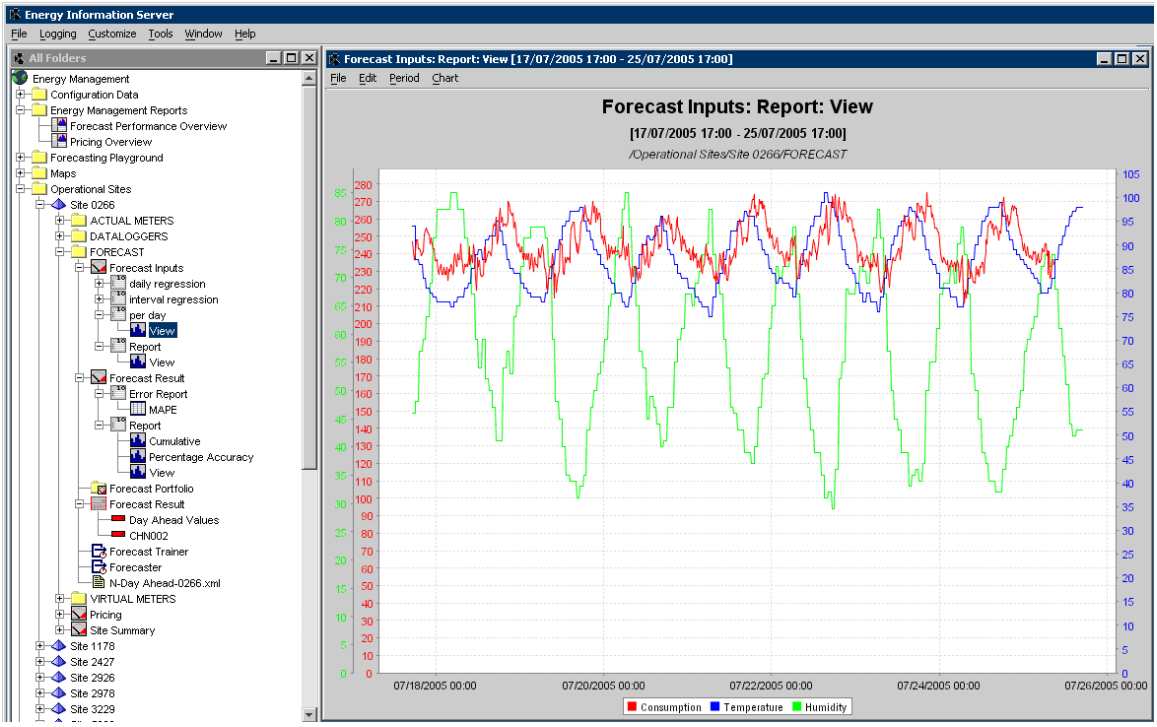

Figure 14: Weather Data Graphed with Energy Data

Typically, users want to see how their energy consumption or demand values vary with temperature variables. Figure 15: Daily Energy Consumption versus Average Temperature provides one of the many possibilities for graphing weather data in a regressive fashion. In this example, daily energy consumption is plotted against the average daily temperature to show how energy consumption varies with increased temperature.

As mentioned in the previous paragraph, this concept can be extended for any time interval for any type of data. The power of EIServer® 's Virtual Meter concept and the ability of operators to create custom reports and graphs providing the ability to tailor its web presentation material to specific end customer needs.

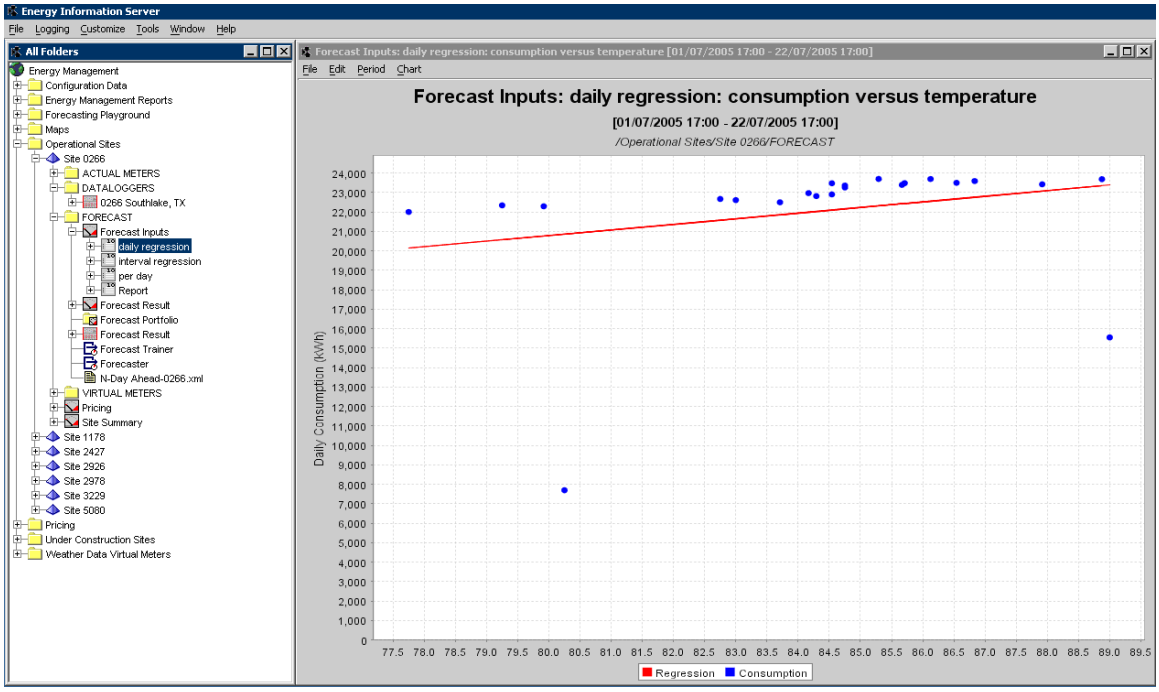

Figure 15: Daily Energy Consumption versus Average Temperature

2.11 Preformatted Most-requested Reports

Automatic report generation and delivery of predefined reports is supported in EIServer® through EISpectors®. EISpectors® allow the users of the system to have reports saved to disk, delivered via email, printed, or sent via FTP. An export schedule is defined, allowing export down to the interval, hour, day, week, month year, or any other predetermined granularity that has been configured.

A relative period can be utilized, or filters can be set up to allow export based upon logical expressions and conditions. As an example, you could have a report generated once a day and also have a report generated and emailed to a user when a demand exceeds a certain predetermined level, or pricing structure.

Simple or extremely complex equations can be set up using this functionality. Reports and graphs may be delivered in Excel format, PDF format, HTML format, and PNG (Portable Network Graphic) format. These reports and graphs can be sent directly from the EIServer® platform or from another SMTP server. Figure 16: Setting Up Automatic Report Generation with EISpector® through Figure 18: Export Functionality Options show the steps required to set up this functionality in order to output reports and graphs.

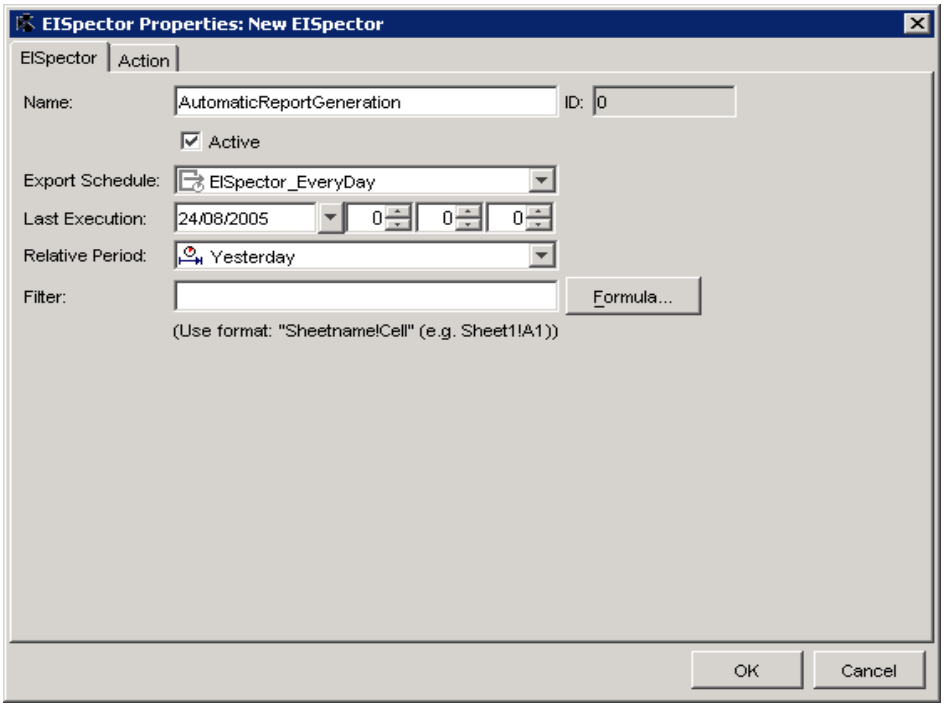

Figure 16: Setting Up Automatic Report Generation with ElSpector®

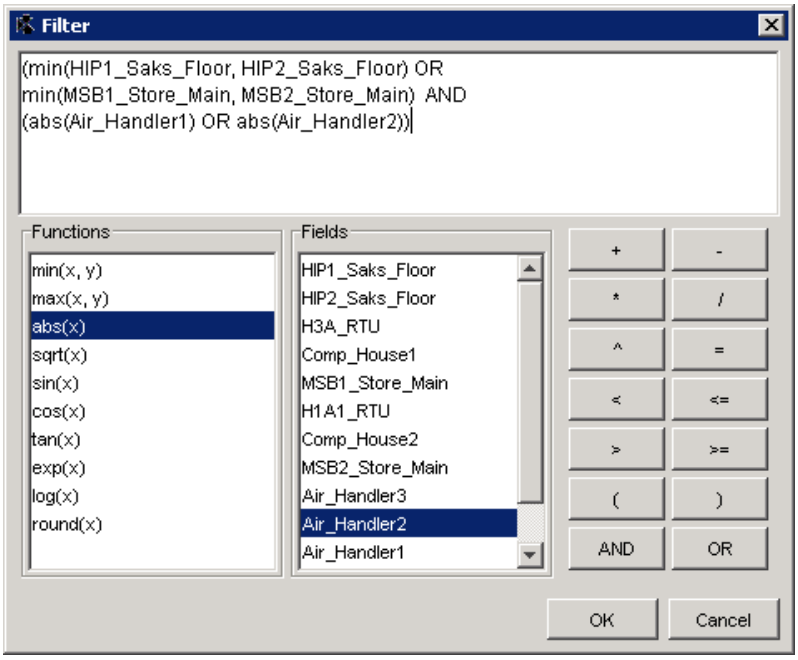

Figure 17: Possible Trigger Conditions for Automatic Reporting

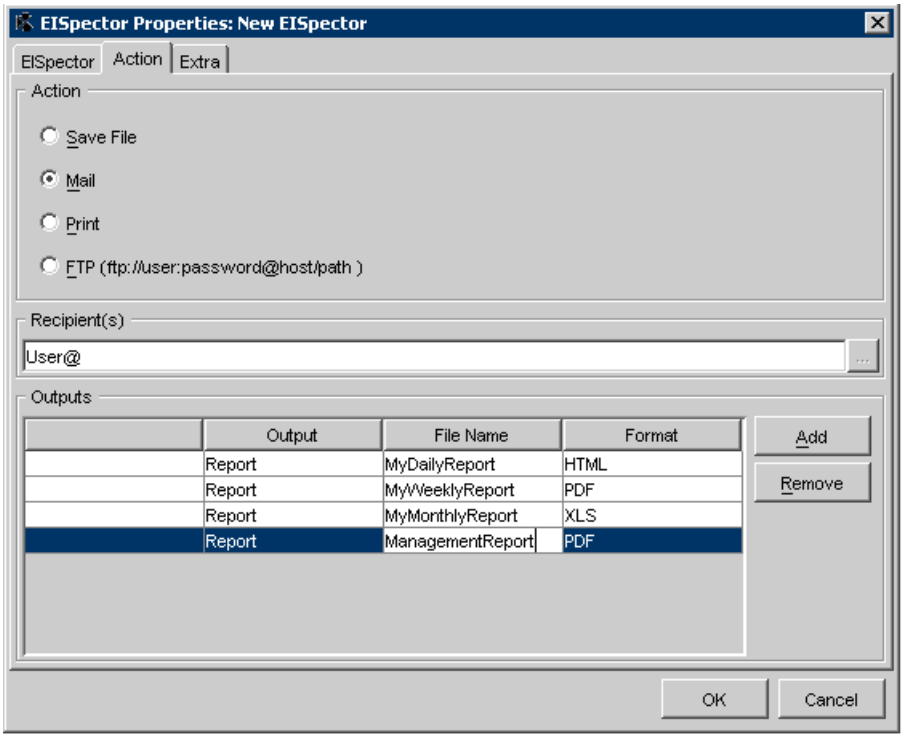

Figure 18: Export Functionality Options

2.12 Exporting Data

All reports and graphs are available for export. The number of reports available for export is limited only by the number of reports that have been created for the particular system.

Reports and graphs can be delivered via the web interface in Excel format, PDF format, HTML format, and PNG (Portable Network Graphic) format. Raw interval data can be exported as an Excel file, Web Query, CSV or XML format.

2.13 Pre-Notification of Peak Demands & Penalties

One of many great strengths of the EIServer® platform are its Energy Inspectors (EISpectors®), which were described in Section 2.12. EISpectors® are designed specifically for the automatic **PRE**-notification of energy managers on conditions that may cause utility penalties or peak demand charges. Typically, energy managers are sent a group of reports and graphs, along with a message signaling an unwanted pending situation. When coupled with EIServer®'s real time monitoring capabilities, EISpectors® offer the ultimate customer service offering for utility customers.

3. MONITORING AND CONTROL

The EIServer® monitoring and control system is comprised of three components:

1. Instrumentation
2. Communications
3. EIServer® Hosted Application

3.1 Instrumentation

EICT's complete line of hardware and software has been designed specifically for use with the EICT solution. An EICT data logger (WebRTU-Z2, RTU+V6 or RTU+Server) would be installed at a particular location or all locations. This hardware provides the communications infrastructure and interface for:

- Real time monitoring of facility loads (**sub-metering**)
    - Installing Current Transducers (CTs) in the sub-panels and on the main loads provide data at a customer defined frequency (i.e.; 15 minute interval data)
        - CTs can be hardwired back to the data logger or use the EICT radio frequency (RF) enabled devices to push data from remote locations within the facility back to a centralized data logger for storage and transfer to the EIServer® host
        - The RF option significantly reduces installation time and costs
    - Data is stored at the data logger for up to 30 days as well as pushed back to the EIServer® centralized, hosted application after each completed interval
    - Data is available for reporting, graphing, aggregating, exporting, etc… as soon as it reaches the EIServer® Oracle® database
- Real time two-way communication
    - Once the data logger connects to the EIServer® it establishes a secure connection that provides two-way communications to the device for initiating control events, updating firmware, configuration updates, etc…
    - Using a series of contact closures (Digital Outputs), the data logger can signal a building control system to run preprogrammed control sequences to control equipment at the facility or open/close a relay to turn equipment on/off
- Choice of Communication Mediums
    - Local/Wide Area Network (Ethernet) with access to the Internet [no data transfer fees]
    - Cellular Modem [one time setup and monthly data transfer fees]
    - Analog Modem [local analog telephone line required]

3.2 Communications

The second component of the system will be the communication layer allowing for real-time data visibility. At the heart of the communication infrastructure will be the EIServer® application hosted in EICT's secure data center.

Communication between the data logger (a WebRTU-Z2 or any other EICT data logging equipment) installed at the customer site and the EIServer® application will use either the customer's local Ethernet network with Internet access (LAN/WAN) or a cellular modem (GPRS).

For WAN connectivity, which is the preferred means of communication as there is no additional communications operating costs, EICT uses a secure, encrypted **"push technology"** that has been approved by IT departments for our customers such as Wal-Mart, Tesco, MI-5 and NATO. EICT will provide the necessary IT documents for distribution to assist with validating network security.

Alternatively, GPRS communication can be used for all communication with the EICT hardware. Although just as reliable as the WAN option, its use comes with an additional monthly fee to GPRS providers. In order to minimize data transmission costs, EICT uses a data push technology that compacts meter data into efficient packets for transmittal to the central system. Data transmission frequencies are very configurable and can be changed during the data-posting task.

3.3 EIServer® Hosted Application

The third component of the system will be EICT's EIServer® software configured to meet all communication, monitoring, signaling, and reporting requirements.

Figure 19: EIServer® Open Architecture illustrates a high level view of the proposed solution built around EICT's "proven scalable" EIServer® application. EICT has designed its flagship solution with the future in mind. At each level, the latest proven technologies are utilized with an emphasis on business logic analysis resulting in an open architecture that can easily be expanded. The EIServer® architecture is best described as a series of expanding layers surrounding a core.

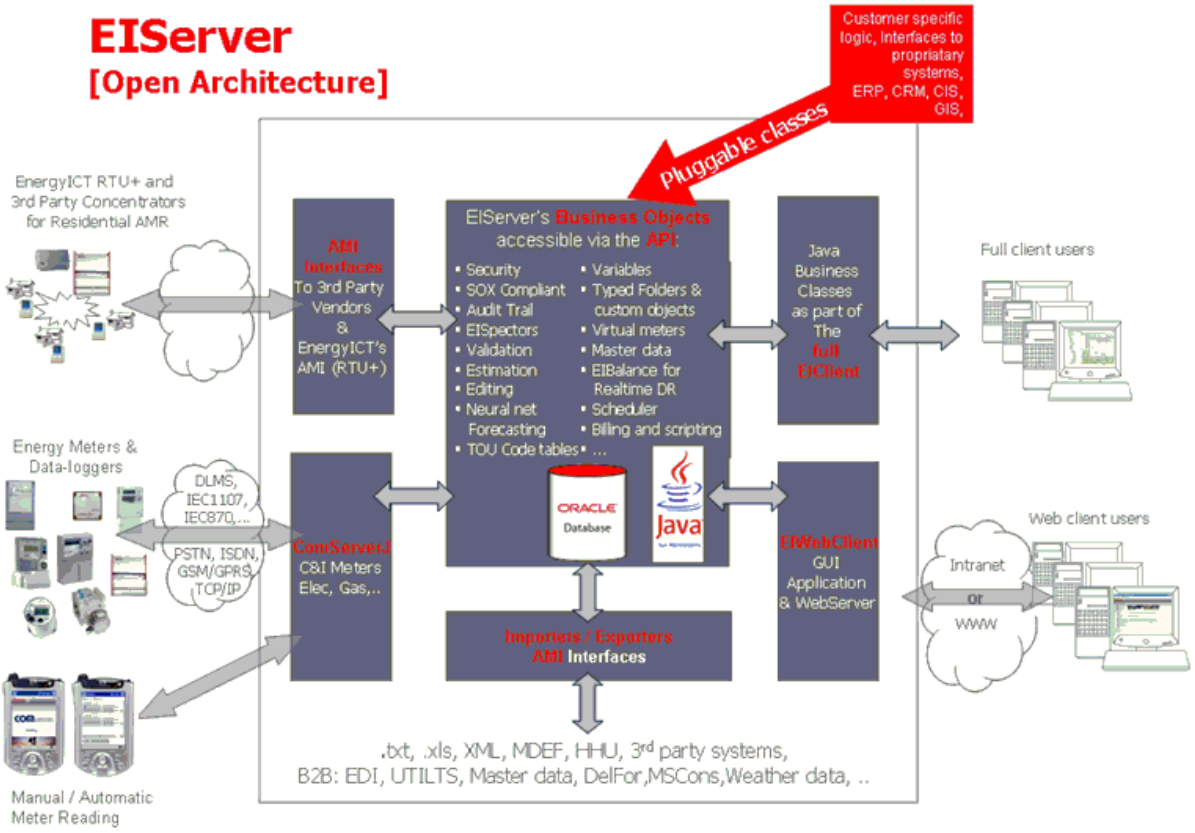

Figure 19: EIServer® Open Architecture

At the core of EIServer® is an Oracle® database, which guarantees outstanding performance. Taking advantage of the object model available in the Java language, a business logic layer has been designed that uses these objects for storage and retrieval of data.

On top of this, a number of functional components have been developed that expose the objects below, and through them, the data warehouse. For remote connectivity to the database, the EIPortal® communication layer was introduced.

Finally, furthest from the core, external applications (including those developed by third party suppliers) access the EIServer® data warehouse through a number of means, either locally or remotely.

Once instrumented with a WebRTU-Z2, RTU+®V6, or RTU+Server device, each site will return real time information on how the end customer is consuming energy. Real time can be a predetermined interval ranging from 10 seconds up to 15 minutes. The EIServer® application 'Full Client' will provide administrator access to all of EIServer®'s capabilities. The end customer will have access to the system via a web client using a standard Internet browser (Internet Explorer or Firefox).

It is important to note that the EICT® system to be installed is a “real time” system and that as soon as an interval period has ended, the load data is recorded and, once transmitted, is viewable on the web pages.