Practical Knowledge about *Data*: Acquisition, Metering, Monitoring and Management

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Abstract

Interval data is the "new found" backbone of both supply-side and demand-side programs. The ability to acquire utility interval data has been available for years but mostly used by utility companies and large commercial customers for billing and settlement purposes. Data acquisition is finally becoming a common practice outside the utility company arena to where it is recognized as a valuable asset and tool and is being required by building owners, facility engineers, ESCOs/ESPs and supply-side entities so they can accurately predict savings from an energy efficiency project, help mitigate performance contract (PC) risks, be used as a tool to negotiate better electricity rates in deregulated states, etc.

One important aspect of data for a supply-side program is the value of aggregating interval data across an owner's building enterprise. If the buildings reside in a deregulated state, the aggregated data can be used as a tool to negotiate a better utility rate. The importance of data for a demand-side program is being able to evaluate and assess 15-minute load profile data for anomalies in whole building consumption and identify improper start-stop sequences for mechanical systems.

A Model for Using Interval Data

A good model for using interval data is to start with the supply-side to reduce *costs*, move through the meter to the demand-side and use the data to reduce *consumption*. Historically, data acquisition for the purpose of supporting demand-side programs or energy conservation measures has been the most common use of data. But now that we have the hardware and software to implement a "cost-effective" data project and deregulation has opened different avenues of opportunities, acquired data supports both sides of the meter which also doubles the value of the data. By integrating a building enterprise's energy data into the same database, the enterprise data-set becomes an invaluable asset that can be used to make educated decisions about energy costs and consumption. Using interval load profile data instead of monthly utility bills across the building enterprise provides the owner a *substantial advantage* in predicting savings, benchmarking facilities, verifying performance contracts, etc. The ultimate result of implementing an enterprise data project is that one of the primary expenses for a building owner, i.e. utilities, is that the utilities can be potentially reduced thereby making the company more competitive and profitable.

Data should be the backbone of an enterprise supply-side services program. Without a historical utility consumption data-set, a supply-side services program becomes only a subjective set of guidelines and predictions. A historical data-set can range from monthly utility bills to "near real-time" interval pulse data from a utility meter. Acquiring utility consumption on a 15-minute interval is the quasi standard in the U.S. 30-minute and hourly data are standards in some countries and all that is needed for some applications. One important aspect of data for a supply-side program is the value of aggregating interval data across an owner's building enterprise. If the buildings reside in a deregulated state, the aggregated data can be used as a tool to negotiate a better utility rate.

The importance of data for a demand-side program is being able to evaluate and assess 15-minute load profile data for anomalies in whole building consumption and to identify improper start-stop sequences for mechanical systems. Not only is the empirical data-set valuable from an analysis standpoint but the resultant graphs and charts make it easy for a staff member or energy engineer to easily identify problems with equipment or anomalies in the building's operation or equipment's performance. The visual graphics and ease-of-use of most data presentation software engines permit one to easily compile data for any timeframe and then present it for graphic presentation.

What is Interval Load Data

Data collected from a data source end-device (electric, gas, water, et al.), usually every 15-minutes, is considered interval load data. For whole-building meter electrical loads, the resultant 15-minute interval load profile is a graph depicting a snapshot of the building's consumption at any time during the day. When the data is used for submetering, the same graph gives very definitive information about runtime, how efficient the equipment is running, is it weather dependent, etc. Figures 1. – 2. are examples of interval load profiles.

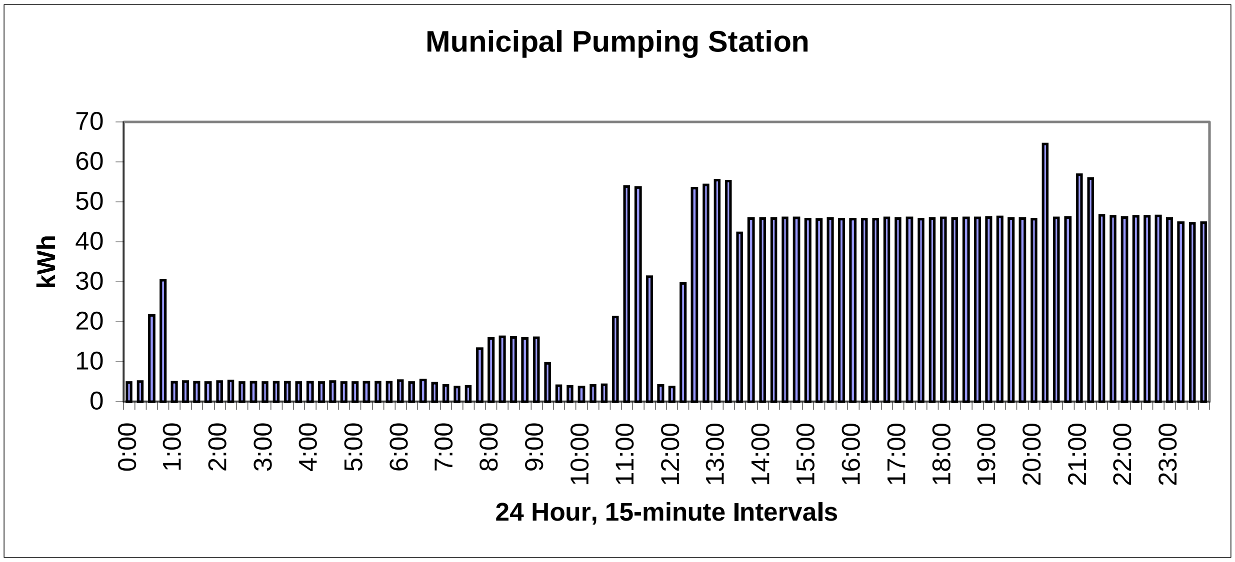

Figure 1., 24 Hour, 15-minute Interval Load Data for a Municipal Pumping Station.

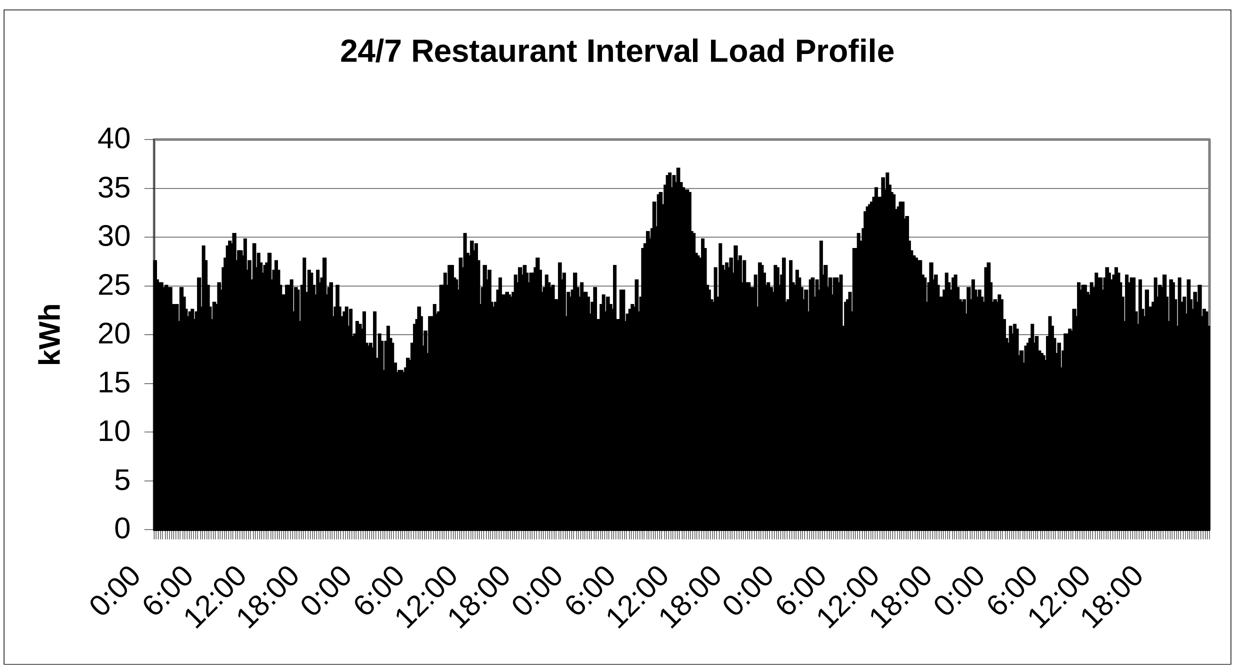

Figure 2., 6-day, 15-minute Interval Load Data for a 24/7 Restaurant.

Types of Data-Acquisition Projects

There are three levels of a data acquisition project.

Short-term data acquisition. These projects are for the purpose of obtaining a snapshot of a consumption profile. These snapshots are ideal for companies developing an energy efficiency project such as a Performance Contract. Before having the means to obtaining interval data from a data source cost-effectively, most energy efficiency projects were developed and savings based only on utility bills or assumptions derived from interviews with the staff of a facility. Short-term data projects do not provide the necessary information to make decisions about long-term decisions regarding consumption habits or supply-side pricing. Snapshots also give energy engineers a basis to index multiple buildings so the buildings with the highest Energy Use Index (EUI) can be targeted first. A PC company's bid is also more confident and accurate because much of the guesswork, and additional monies to cover the unknowns are eliminated.

One of the most important uses of short-term data is being able to substantially mitigate the risks associated with a Performance Contract. By having a data-set that depicts periods of maximum demand, abnormal spikes resulting from maverick equipment, etc., a PC company can now specifically calculate what savings they can achieve as opposed to relying on utility bills.

Long-term Measurement and Verification (M&V). This type of project is used primarily for more intense evaluation and assessment of a facility's utility consumption. M&V projects are often used for verifying how well a Performance Contract succeeded in achieving predicted savings or quantifying the economics of a PC project. Long-term data projects also identify the trends or anomalies in buildings or equipment. M&V projects should adhere to more formal procedures such as the International Performance Measurement and Verifications Protocol (IPMVP).

Monitoring and control (alarming). Data used for these projects take the purpose of data acquisition to the next level. The terms "data acquisition" and "monitoring" or "control" are not synonymous. There is a marked difference in costs and types of equipment used in data acquisition projects compared to monitoring and control scenarios. If all that is needed is consumption data for evaluation and assessment so that better and more educated decisions about your energy costs can be made or anomalies are identified so that risks associated with performance contracts can be mitigated, then the project engineer is mainly concerned with data acquisition without a reaction requirement (no monitoring or control component).

If data is needed for management, monitoring or use with strategies for demand-response, curtailment or real-time-pricing, for example, then an entire different hardware infrastructure (and costs) is required. The reason is that if one monitors data, an alarm will be initiated if the data signal reaches a prescribed threshold. The signal is meaningless unless there is a human or electronic reaction to the signal that initiates a strategy that will eventually reduce an associated cost (e.g., maintenance, energy, etc.). And unless the reaction is electronic, the margin for error or human inaction substantially increases resulting in substantial penalties or lost savings.

Developing a Data Project

When developing a data project, two basic questions should be answered.

1. What data do you want?
2. What are you going to do with the data when you get it?

The answers to these fairly simple questions are critical to formulate a strategy and level of sophistication for the project, all of which will impact a data project's costs.

The first basic question one should answer is what type of data do you want. Since electricity consumption is the basis for most metering projects, kW and kWh are typically considered standard data. It should also be considered whether this data will be used in a utility bill auditing software program in the future. If so, then the data source should be the utility meter that the Independent System Operator (ISO) uses unless there is definitive legislative language that permits consumption data from different end-device data sources (e.g., current transformers) to be used for settlement purposes.

The follow-on to power and energy data is power quality. Most interval demand recorders (IDRs) do not provide this without an add-on feature to the meter but there are other end-devices such as current transformers that acquire such data. Other types of data available are gas and water consumption (flow), temperature (outdoor and indoor), start/stop runtime, CO^2, relative humidity, etc.

As mentioned earlier, the terms “data acquisition” and “monitoring” and “control” are not the same types of projects. Therefore, the answer to the second question is that you want to monitor the data source or want to initiate a control strategy based on the data acquired, then the project will take on other costs. If an energy management control system (EMCS), a building automation system (BAS) or a supervisory control and data acquisition (SCADA) system already exists, then the first costs of a data monitoring and control project can be significantly abated. Otherwise, the project engineer should allocate adequate funds to install one of these systems. Otherwise, acquiring data for the basic purpose of evaluation and assessment of data can be relatively straightforward.

Implementation of a Data Project

Before finalizing the Scope of Work (SOW) and developing a clear understanding of what the deliverables are, a site survey may be required. As with any energy project, the success of a project is usually as good as the site survey. A data project usually requires personnel that have a basic understanding of building mechanical systems, electrical devices and infrastructure, data end-devices such as utility meters and current transformers, cabling, IT networking, knowledge of different communications protocol such as modems or TCP/IP and the Internet. As one can see, it takes personnel with a more substantial knowledge base than that of just an understanding of basic energy-efficiency projects.

One frequent challenge to a data project is the type of data signal and its format. As an example, if kW and kWh data is being acquired as a pulse signal from one end-device such as a utility meter and the data format for other types of data (e.g., power quality) may originate from an end-device with a different signal such as Modbus RTU. Therefore, the project engineer should ensure that the datalogger and/or the data presentation software engine can accept and use both formats. As long as the data format is a pulse, Modbus or analog signal, it can usually be translated into usable data that can be presented by most data presentation software engines. The typical challenge is to ensure data emanating from multiple data source end-devices is that the data software engine can understand and interpret the multiple signals or the datalogger can translate the different data signals into a common format required by the data presentation software engine.

Another common barrier and challenge to a data project is the direction of the data flow or communications protocol. If the software engine requires the host server to dial-in to the datalogger/communications module, the customer is required to install a dedicated phone line and then pay the recurring phone charges. This scenario may be required if the project is for a sophisticated demand-response tariff or the project is for a mission critical application. If the project is just for data acquisition, data upload once per day is usually adequate. The preferred communications method is to have the datalogger/communications device “dial-out” of the facility in the early morning hours to a toll-free number using an existing phone line such as a fax line. If the project is just for data acquisition, the latter communications protocol is preferred because of the substantial savings to the customer from not having a dedicated phone line. The issue of the facility owner having to pay for a dedicated phone line that is accessed just once a day is usually a major sales obstacle to overcome and typically an easy “excuse” for a decision maker not to move forward with a data project, especially when they don’t completely understand how valuable the end results are.

Another critical issue to address before beginning a data project is to decide whether to complete the work in-house or to outsource some or all of the components. The following are issues to consider before deciding whether to attempt a project in-house or outsource it.

- Procurement of materials and hardware.
  - What type of equipment will be needed?
  - Where does the equipment come from? Do I have to buy the equipment or can I lease it, especially for short-term data requirements.
  - Who manages the equipment (inventory, maintenance, shipping, etc.)?
  - Who manages the ordering of equipment and services from utility companies?
- Required knowledge for a successful data project.
  - Who has the background and knowledge to develop and implement a data project?

  - * What's the value of in-house staff member's time when comparing their existing workload and daily tasks to requiring them to learn all aspects of a data project from scratch?
- Implementation.
  - * Who's going to physically install the hardware?
  - * Who's going to retrieve the equipment (short-term projects)?
- Use of the data.
  - * Who has the ability to interpret the data?
  - * Who is best suited to maximize the value of the data?

Components of a Data Acquisition, Metering, Monitoring and Management Project

There are five components of a data project.

- Data source end-devices. These are the actual hardware and metering devices such as current transformers, utility meters, etc.
- Connectivity. This component addresses how the installer is going to physically get the data from the end-devices to the datalogger. The majority of the time the two devices are hard-wired but there are some wireless mediums available.
- Central Data Gateway and Communications Device (datalogger). This device can be a simple single channel logger that has only one direction for communications flow to those that have a modem dial-in and dial-out capability or a TCP/IP interface for direct web-based data presentation. The more advanced dataloggers also have methods of acquiring data concurrently from end-devices with different data signals and then translating all the data into the same format required by the data presentation software engine.
- Data warehouse and hosting. This element can be provided internally by the company if the IT personnel and equipment infrastructure is already available. For most companies it is usually more cost-effective to outsource this task to Application Service Provider (ASP) company that has already invested in the computer server and communications hardware and provide the service to other companies. It may also be that the data cannot be accepted, interpreted or used by the data presentation software engine or there is no remote access to the datalogger. In the case, the project engineer may be required to physically connect to the datalogger with a laptop and download the data.
- Data presentation software engine. The entire data project revolves around this component. The software dictates which direction the communications are to flow, i.e., from the server toward the end-device or from the datalogger to the host server. This one criterion establishes whether a dedicated phone line will be required or whether the data can be presented on the Internet. The trickle-effect of the software requiring a dedicated phone line is the challenge of having the customer pay for a dedicated phone line.
- When developing a data project, "each" meter point must be assessed to determine what data is required and what the data will be used for, as previously mentioned. As one can see from Figure 3., there are also several options within each component. The next decision path in developing a data project is to determine which of the different options within each of the five components will best meet the overall needs and costs of the project for each meter point.

Logistical challenges also often plague data projects. The implementation of a national level installation project can often be very costly due to contractor ineptness, return trips, etc. Another common obstacle is detached meters that are far from a power source or in the middle of a parking lot with no way of reaching it. In these instances, a low-cost, minimum maintenance, wireless solution is required. These issues highlight the need for a well-prepared plan of action in order to deploy an effective data project with hundreds of meter points.

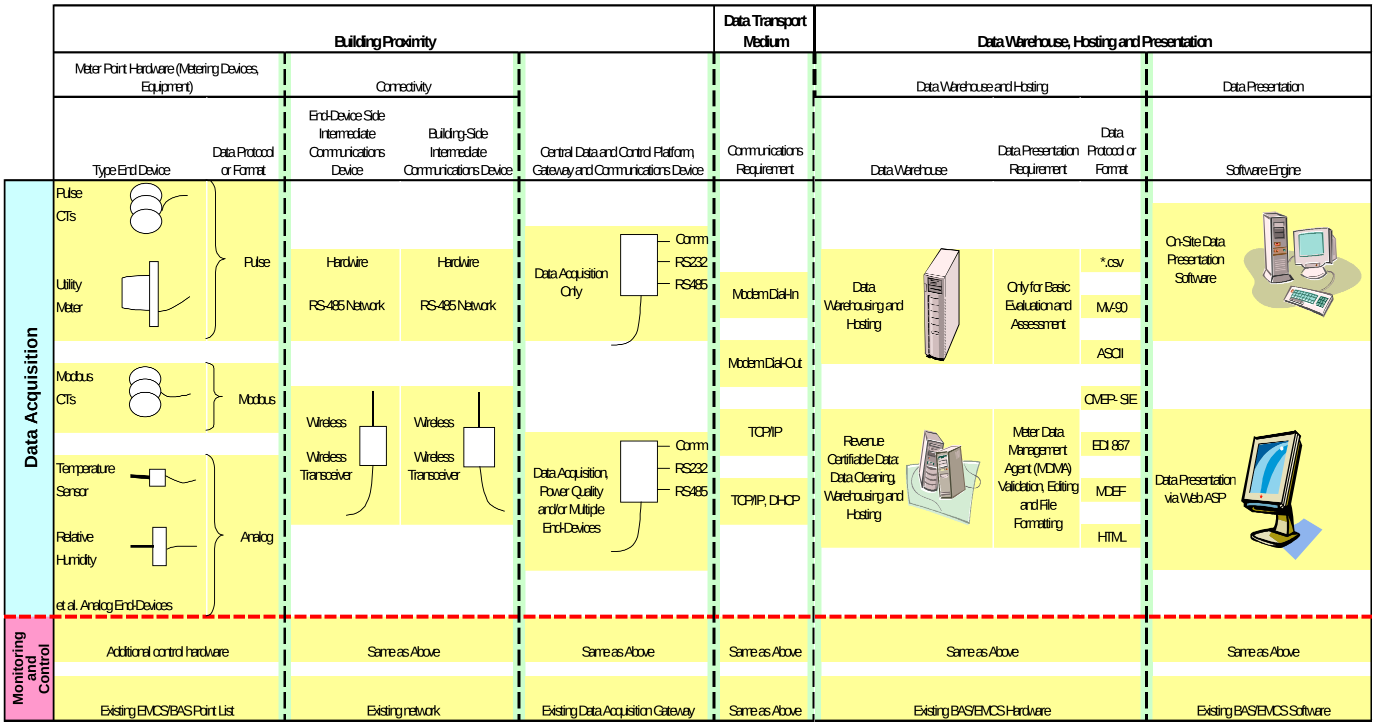

Figure 3., Components of a Data Project.

Turning Data into a Value

By the definition of "value," the data a building owner has paid to acquire needs to be translated into a worth, i.e., savings from energy reduction, streamlining O&M practices, etc. Adhering to the aforementioned model, the project engineer should first use the data-set for supply-side issues. The ultimate parallel between a data-set of interval data and the project's supply-side is to be able to negotiate better tariffs using real-time-pricing, load curtailment, and similar rate structures. In states that are not deregulated, the data-set can still be useful by determining whether changing to a different rate such as time-of-day or general time-of-use can reap savings based on the building's operations.

After addressing the supply-side opportunities and issues, the project should move through the meter to the demand-side. First use the data-set to benchmark the facilities. They can then be prioritized so that the ones with excessive EUIs can be identified and pursued first. Secondly, view the load profiles of each facility to spot anomalies in consumption, peaks, etc. By viewing load profiles, the project engineer can also plan ahead to avert peak demand loads using strategies to peak shave, shed load, etc.

There are numerous data presentation software tools available to translate acquired data into graphs and reports. The graphical tools range from simple one parameter bar graphs to intense graphs that can overlay numerous parameters to determine the correlation of dependent and independent variables. Some software engines permit the user to start at a higher level view of a data-set and then "drill down" to view or assess a specific timeframe or other variable. Figures 4. – 6. depict examples of different diagnostic and analysis tools of typical data presentation software engines.[1]

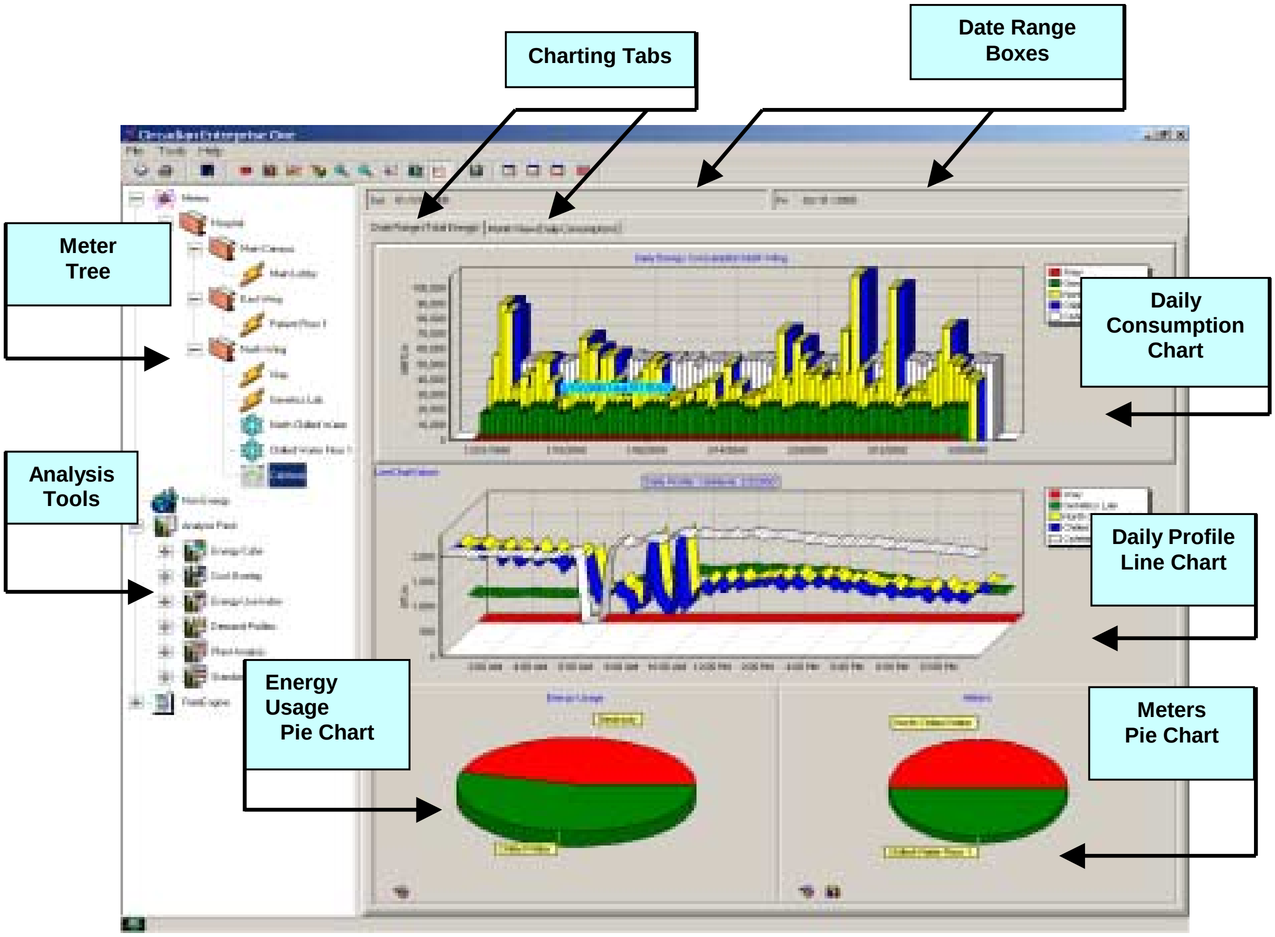

Figure 4., Charting (Total Energy).

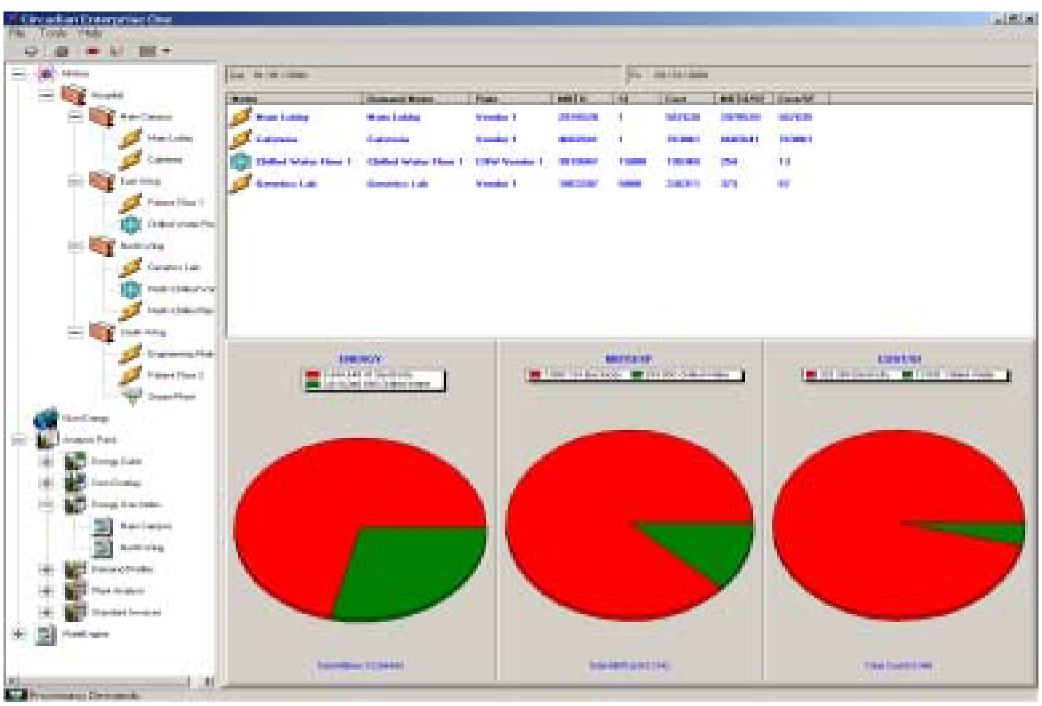

Figure 5. Benchmarking Tool.

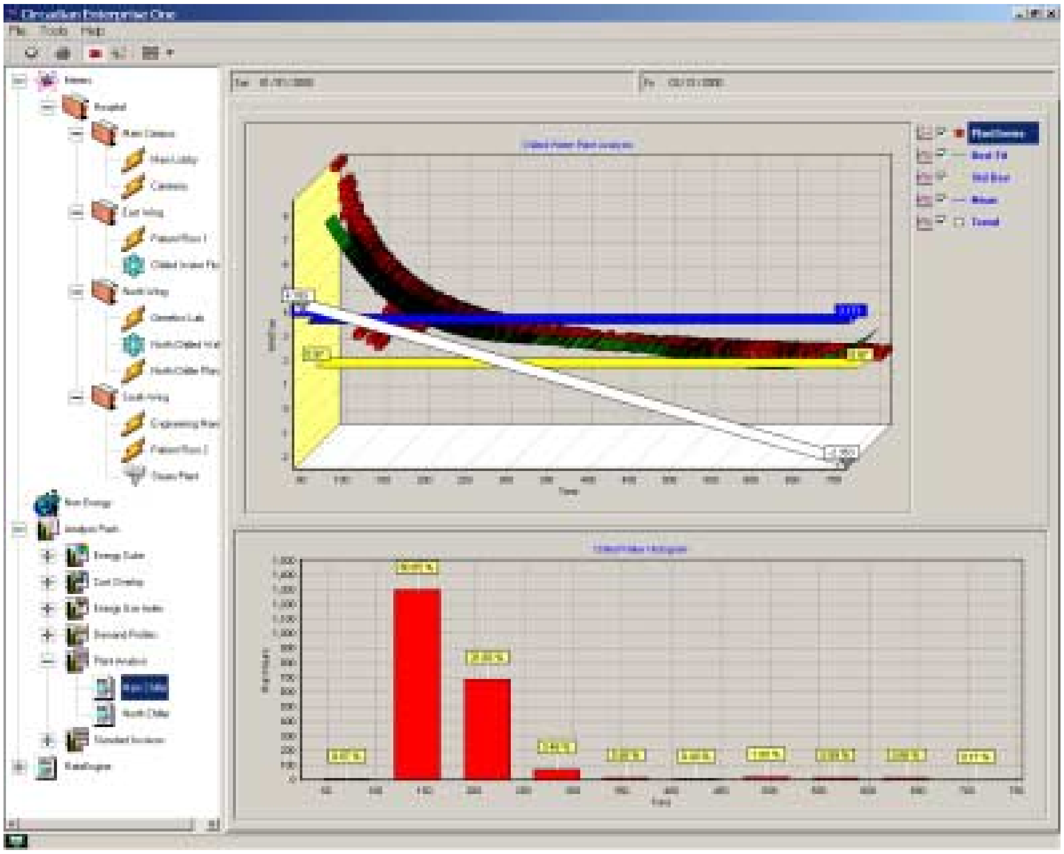

Figure 6., Chilled Water Plant Analysis

Conclusions

Facility owners and engineers, Performance Contract companies, building and equipment commissioning engineers and utility companies are finally becoming more educated about the value of interval load profile data. And since data supports both supply-side and demand-side projects and decisions, the value of interval data is doubled making the resultant cash flows and economics of a data project even more convincing. The value of data is now being recognized throughout the energy industry to a degree that many energy related projects now require interval data to support both supply-side and demand-side issues. If the end-user doesn't understand the components of a data project, the project can be a costly and futile effort that results in abandoned equipment and the loss of a potentially valuable asset…data.

References

1. With permission, Circadian Information Systems™.