Submetering Technology and Applications

David Bovankovich, V.P. Engineering
Hunt Power/E-MON

ABSTRACT

Today's submetering equipment, both hardware and software, can provide much more than a simple reading of energy consumption. Enhancements in all areas of submetering are available to supply an abundance of valuable data to the user. These data can be readily utilized for advanced billing applications, power quality analysis, load control, and energy management.

As a complement to the submetering hardware, advanced AMR software can increase the flexibility and value of the energy data gathered. Through use of aggregated readings and remotely accessed data, the user can be positioned to lower energy usage and costs.

SUBMETERING TECHNOLOGY

With the advent of electronics, the electric meter took a major step forward from the electromechanical device that had its roots in the 1890s. No longer is the industry tied to a device that had, as its basic purpose, been designed to simply provide an accumulative reading of the amount of energy consumed.

At first, there were meters of hybrid design that utilized an electromechanical foundation tied to an electronic module for some advanced functionality, such as time-of-use capability. However, electric meters were soon advanced to fully electronic designs, providing engineers with the means to include a wide range of enhancements and more valuable functions for the user.

With the advent of completely solid-state designs, the next evolution in metering technology was made more feasible. This was through divorcing the meter from the socket. Solid-state electronics gave en-

gineers the flexibility to design hardware that did not depend on a socket for its mounting or its voltage and amperage inputs. Although the socket-style meter is still used by utilities for monitoring the main building electrical feed, the use of non-socket designs is much more valuable and versatile in submetering applications, where multiple tenants or entities within the building are to be accurately monitored.

Today's non-socket meter design utilizes remotely mounted CTs, or current sensors, that are installed on the load that is being monitored. These do not require a specialized CT cabinet for their application. In some cases, the current sensing devices can be mounted, literally, hundreds of feet away from the meter's location, providing greater flexibility for the user. This is a definite asset in cases where the meters are to be ganged together at a single location, making the physical reading of the meters more convenient.

TYPES OF SUBMETERS

Submeters can be obtained at various levels of capabilities and diversity. They can be as simple as a unit that displays only accumulated energy, to more complex units giving detailed data on power quality and allowing a certain amount of load control for energy management purposes. Some of the available types will be explored in the following paragraphs.

KWh Meters

The kilowatt-hour meter is, by design, the most simplistic of the available types of submetering hardware. This style of meter is the closest relative to the original electromechanical meter in that it is designed to simply count kilowatt-hours.

Consumption is displayed on the front of the kWh meter and read manually. Some models have an output pulse that can be used with energy management systems (EMS) or interval data recorders (IDR). This enhancement can be used for load data acquisition or, with an EMS system, for load control capabilities.

Demand Meters

With the demand meter, additional information is available to the user. Complementing the accumulated kWh is the display of peak demand in kilowatts (kW). As a billing factor in commercial and industrial

energy usage, this is important in metering those applications. The kW demand is usually defined as the highest rate of consumption for a 15-minute time period. However, some utilities utilize a 30-minute demand period in their tariffs.

A simple demand meter will indicate the peak demand; however, a more complex demand-type meter that also displays the time and date of the peak will be more useful for the energy consumer. Demand meters are also available with an output pulse if they are to be used with an EMS or IDR. Otherwise, the data will be readily available on the meter's display.

Time-of-Use Meters

The application of a time-of-use meter provides a breakdown of energy usage based on specified time periods. In places where the local utility bases its tariffs as a function of the time of day that the energy was consumed, this type of meter will provide a data breakdown that reflects those specific periods. Typical periods can be peak, intermediate, and off-peak. The cost of electricity is highest during the peak period, and lowest during the off-peak period.

A time-of-use meter is usually set up to show the different periods on its display as a manual read. Both kWh and kW can be shown for the individual periods, allowing the accurate application of the correct tariffs.

Recording Meters

Moving up the meter scale brings us to products that not only account for energy consumption, but also store the information as interval data—internally. Data are normally stored in 15-minute increments. However, greater and lesser time periods are usually available as a choice for the user.

Downloading the energy data into a computer, with the appropriate software, will provide the user with detailed graphs and charts that show energy usage patterns and trends. More advanced meters, with reactive or power quality features, will register enhanced interval data that provide more detail than the basic kWh and kW information trending of lower level devices.

Communication with recording meters is typically done with a computer, and can be either directly connected or remotely read through other means, such as telephone or satellite modems.

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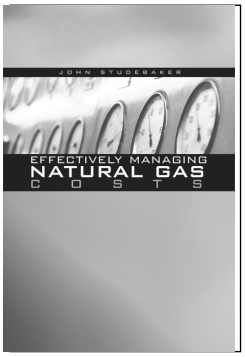

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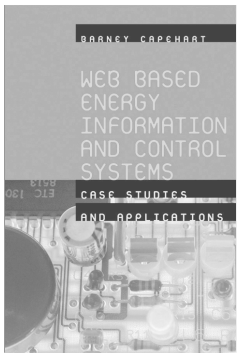

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Power Quality Meters

This group of meters is probably the most diverse of all of the meter types, and can be obtained with various levels of data. Power quality can be interpreted to mean something different from one individual to the next. To one person it may be something as basic as data on volts and amps, while another may consider it as complex as detailed information pertaining to the multiple orders of harmonics present in an electrical circuit. With this diversity, the user can choose a meter that provides only the level of data that is needed, or desired, without the requirement to spend more than necessary.

On the lower end of the power quality scale, information on amps and volts will allow the user to determine possible circuit overload conditions and also to see if the system voltage is too high—or too low. Either condition could damage equipment, so an early warning could possibly prevent an expensive loss.

A bit further along the power quality meter route, we will find data on kVA and kVAR. This is often referred to as "apparent" power (kVA) and "reactive" power (kVAR). Probably the most important data are in regard to the kVAR component. This reactive power is basically the lost energy in magnetic circuits, such as motors, ballasts, and transformers.

Power factor is the result of the reactive energy and is a measure of the inefficiency occurring during the use of electrical energy in reactive circuits. Most electrical tariffs contain penalties for poor power factor conditions. Locating, and correcting, these conditions can lower energy costs.

On the upper end of the power quality meter scale, we find equipment that looks at electrical harmonics. Some of the meters show this as total harmonic distortion, while some provide greater detail and break it down into multiple orders of harmonics. This may be important to certain users, as this may help to pin down the cause of the harmonics. Usually, harmonics are displayed as content in both voltage and amperage data.

SUBMETERING APPLICATION

Just as there are many types of submeters, there are varieties of applications for these devices that are many orders of magnitude greater.

We certainly won't attempt to describe all of these in this document, but we will bring up some applications that should be of interest to a diverse group of users.

Indeed, the list of applications is certainly not inclusive, as more are being added regularly. Submetering is a valuable addition to the energy user's toolbox, and can be the foundation for considerable savings in both energy usage and cost.

Billing

The use of submeters for tenant billing is, to date, the largest niche for this device. In the past, tenants in master metered buildings, both residential and commercial, have had to pay for their electricity as a percentage of the total building use. This was often factored by the square footage of the tenant's space.

This method was, and still is, inequitable. As there is such great variety in the amount of electricity energy usage from one tenant to another, it works out that some of the tenants subsidize the energy usage of the others. Where some residential tenants are home all day, others are rarely home. While some have powerful stereos, microwaves, large screen TVs, etc., others are content with just a few lights and a small radio. It's easy to understand why billing on a square footage basis is not fair or equitable.

Add a submeter to the equation, and the tenant now pays for only the amount of energy actually consumed—no more, no less. The amount of the electric bill is now in the individual tenant's hands. Monthly costs can now be controlled, not reluctantly accepted as a fixed amount.

Energy conservation may very well enter into the heavy user's vocabulary, as higher costs, now directly presented to the "energy hog," may provide the necessary incentive to curtail some of the excess usage.

Accounting

Just as submeters were applied for tenant billing purposes in the residential and commercial community, the industrial world also has needs for the accounting of energy use.

Metering of the different departments in an industrial facility will provide an accurate breakdown of the energy usage in great detail. It will actually allow the accountants to assess the energy budgets with real data, not a factored amount that can be off considerably from the

true usage. This will provide a better foundation in decision making, especially pertaining to whether to purchase new—or overhaul existing—equipment and machinery. New, energy efficient equipment may be a better choice to lower operating costs over its lifetime.

Load Shifting

Electrical tariffs designed for the commercial and industrial user usually include a demand charge in addition to the usage cost. Most of the time, these tariffs also have different rates for different times of the day. They may be simple peak or off-peak rates, or may contain intermediate levels of cost. The peak cost is typically from late morning until evening. These costs can be considerably higher than the off-peak costs.

Installing submetering with AMR software that allows the energy usage to be profiled can provide the user with the detailed data that show the energy consumption, and demand, in fifteen-minute intervals. This will permit the user to make the quality decision on whether or not certain loads can be shifted to take advantage of the lower rates during different periods. Load shifting can lower monthly costs by thousands of dollars, if the option is available.

Curtailable Rates

With this option, the user is given a very favorable energy rate that is lower than the normally applicable tariff if he is willing to cut back, or curtail, his consumption of electricity within a short time—if the utility requests this action. There is usually a threshold of load in this request, and the user must maintain usage below that level during the requested time period. If the threshold is exceeded, there are severe cost penalties assessed upon the user.

In this application, a submeter with a load control set-point that activates a relay, or contact, is a great asset. This gives the user the necessary tool to prevent any penalties and maintain the favorable rate.

Lowering Sales Tax

In some states, the energy consumed for the manufacturing of a consumer good is sales tax exempt. This exemption applies only to the direct manufacturing energy cost, and does not include storage, office, or HVAC energy use.

Submetering of the equipment used strictly for the product's manufacture will provide the user with the data necessary to apply for this exemption. In a large industrial manufacturing operation, the sales tax exemption can also amount to thousands of dollars each month. Obviously, any lowering of the energy cost to produce a product will improve the bottom line and boost the corporate financials.

Electronic Watch Dog

Submetering, especially with the detailed data from an AMR installation, will provide the user with an electronic watch dog. To lower consumption and the costs associated with electrical usage, it is advantageous to have some way of knowing when and where power is being used.

There have been many cases where lighting that should have been turned off has been left on all night. Metering of the lighting will quickly bring this detail out in the open, allowing the situation to be remedied. With the application of modern non-socket based meter designs, it is very easy to monitor multiple panels with a single meter by paralleling multiple current sensors and combining them at the meter.

The "watch dog" meter is in no way limited to lighting loads, and can be applied to any type of load desired. With the gathered usage data, the user can be aware of any out-of-the-ordinary usage patterns anywhere in the facility. Even in buildings that utilize an energy management system, submetering can detect failures or overrides that may occur within the system, allowing the user to take corrective measures or provide maintenance.

Energy Management Systems

In facilities with an energy management system, the use of submeters with output capabilities can add to the system's performance. Utilizing energy usage data from the building's main meter will not provide the details necessary to operate the system at its best possible level of performance.

By applying metering at multiple points throughout the facility, the input of "real-time" usage data to the energy management system lets the user fine-tune the system for optimum performance. The metering can also serve as a "watch dog" in this application, keeping an eye out for any performance deterioration.

The use of multiple meters being input into the energy management system can also be of value to the installer if performance contracting is part of the equation. In addition to any functional changes that may occur with the energy management system, the addition of unexpected loads or new electrical equipment can adversely affect the performance contract. With detailed data, the contract can be renegotiated.

Control Meters

In cases where a full-blown energy management system is not required or financially feasible, submeters with load control capability may be the answer to lowering energy usage and costs.

This type of meter has a control relay within it that allows the user to set high and low limits. The application is similar to that for curtailable rates. In this case, however, the savings come through lowered peak demands and reduced consumption—not through specialized tariffs from the utility. In areas where the tariff option is not available or the consumer wants greater control of his energy usage, a control meter may be the right tool for energy savings.

In areas where the utility has a ratchet clause for demand in its tariff, controlling demand levels in one month can effectively lower the bills for the following eleven months. Applied correctly, control meters are a tool that can also save the user thousands of dollars in electrical energy costs.

Real-time Metering

With the advent of combining computerized automated meter reading with advanced submeters, "real-time" metering is now available to all.

In this scenario, a metering system anywhere in the world can be accessed in real time, providing the user with the capability of observing all aspects and details of the current energy usage at a facility. This is possible through phone modems (cellular and land line), through web access, or through satellite communications. Load and operating conditions are readily viewable, and energy decisions can ultimately be made a continent away, if necessary.

Multiple facilities can be accessed and compared, giving the user more valuable data for decision making in regard to similar facilities and their performance. Possible damaging conditions, such as over- and

under-voltage, or over-current, can be observed. Steps can be taken for damage prevention or mitigation.

Aggregation

Submetering data from multiple facilities can easily be aggregated with AMR software. This gives the user a valuable tool for rate negotiation with the supplying utility—or with other suppliers in a deregulated marketplace. With modern AMR software, literally thousands of locations can be aggregated into a single load graph or chart.

Net Metering

As more facilities are utilizing co-generation, wind, or solar power, net metering becomes a valuable tool.

The net meter allows the user to account for the energy being received from the utility, as well as the energy being sent into the utility's grid from the facility, when the power being created at the facility is in excess to the building's requirements.

This excess power can possibly be sold to the utility at wholesale, or the amount can be subtracted from the power delivered from the utility. In either case, the excess, internally generated, power can be used to lower the utility energy bill.

CONCLUSION

This article is intended as a guide to metering diversity, but not an inclusive one. There are many uses and applications still waiting to be discovered or tried. In the world of submetering, this is only a primer.

Installed practically anywhere, submeters can be used for everything from accounting to energy conservation and control. Their capabilities can be simple or complex, based upon the users' needs or requirements.

In the previous paragraphs, we have merely scratched the surface in the use of metering, with a sampling of applications. Properly used data from the equipment can be extremely valuable in lowering energy usage and costs, easily paying for the metering hardware and software in a relatively short time.

It's not typical, but in one case, a nine thousand dollar system paid

for itself in ten days because of the lowered demand cost derived from its use in New York City. In another application, in New Hampshire, simple load shifting—based on meter-supplied data—saved a foundry over two thousand dollars a month in demand charges from the supplying utility.

In conclusion, the diversity of applications for submetering, especially non-socket based designs, allow almost unlimited flexibility in their use. It is up to the user to utilize this valuable tool for energy conservation and cost savings.

ABOUT THE AUTHOR

Dave Bovankovich joined Hunt Power/E-Mon in 1986, bringing with him over 20 years of electrical plant engineering, facility maintenance management, electronic design, and metering expertise. As E-Mon's technical liaison with the utility industry, Dave has participated in deregulation meetings nationwide and the United States Energy Association's (USEA) Energy Efficiency Forum. He belongs to the Alliance To Save Energy (ASE), Association of Electrical Engineers (AEE), and Energy Services Marketing Society. Dave completed his education in electrical engineering at Mercer College.

Dave can be reached at Hunt Power/E-MON,
One Oxford Valley, Suite 418, Langhorne, PA 19047
Phone: 215-752-0601; e-mail: *dbovank@emon.com*