Enterprise Energy Management:

The key to the right power at the right price

Brad Forth and Terrence Tobin
Power Measurement, Victoria, BC
May 22, 2001

Introduction

The evolving global energy environment is more closely connecting the needs of large industrial, commercial and institutional energy consumers with those of the power utilities and energy services companies that serve them. In some regions, deregulation of the electricity industry is introducing consumer choice, competition amongst energy suppliers, and significant demands on the electrical infrastructure.

Beyond price, large energy consumers are increasingly demanding higher value for their energy investment. For many businesses, especially those that are part of the burgeoning digital economy, this includes an expectation of energy delivered at higher levels of quality and reliability.

These factors are driving enterprises on both the *supply* and *demand* side of energy to seek better strategies to manage the cost and quality of the energy product and the energy *assets* that produce, deliver, control and consume it. However, to achieve this, all enterprises face three very large and fundamental challenges:

- The need to support the economic and efficient delivery, purchasing and use of energy.
- The need to guarantee higher levels of power quality and reliability the grid cannot currently deliver.
- The need to supply the increasing demand for energy while establishing a market-based pricing system.

The key to addressing all of these challenges is an Internet-enabled *enterprise energy management* (EEM) system that delivers real-time information and control through an efficient, economical and scalable architecture.

Controlling Costs and Efficiency

Energy suppliers, service companies and consumers are well positioned to take advantage of opportunities within the new energy environment; however, most do not have the tools to support informed decisions that will help them control energy and improve operational efficiencies.

For example, it is estimated that commercial and industrial enterprises in the United States together pay over 200 billion dollars a year for their electricity[1]. Though this is a very large line item on their income statements, it is largely unchallenged and unmanaged. These businesses need to take active charge of their energy management and procurement in the face of rising energy prices. To do this requires a full understanding of their energy needs and the ability to manage its use.

Few firms have the ability to verify the billing coming from their energy suppliers, or to allocate the appropriate amounts to specific cost centers or activities within their operations. Not only could this information help to accurately represent the true cost of goods sold, but it could also help to identify facilities or departments that are exhibiting energy inefficiencies or waste.

Consumers or energy service providers managing multiple geographically dispersed facilities or campuses, such as hotel or store chains and government institutions, could see substantial savings by aggregating total energy consumption and negotiating bulk utility purchases. This requires an economical system to acquire historical and real-time load profile information from multiple locations [Figure 1]. Facility managers will also want to normalize usage patterns in conjunction with occupancy, temperature, weather and other variables in order to accurately benchmark and project energy requirements.

Large campuses and industrial facilities can also benefit from analyzing historical energy trends and production schedules to accurately predict needs and execute hedging strategies. With this information, "what if" scenarios can be developed to help plant or facility managers optimize loads or processes and judiciously negotiate utility rates or firm energy contracts.

Large energy consumers want to take advantage of *demand response* or *load curtailment* programs offered by energy suppliers. These programs give price concessions in return for the consumer reducing their load at times when energy

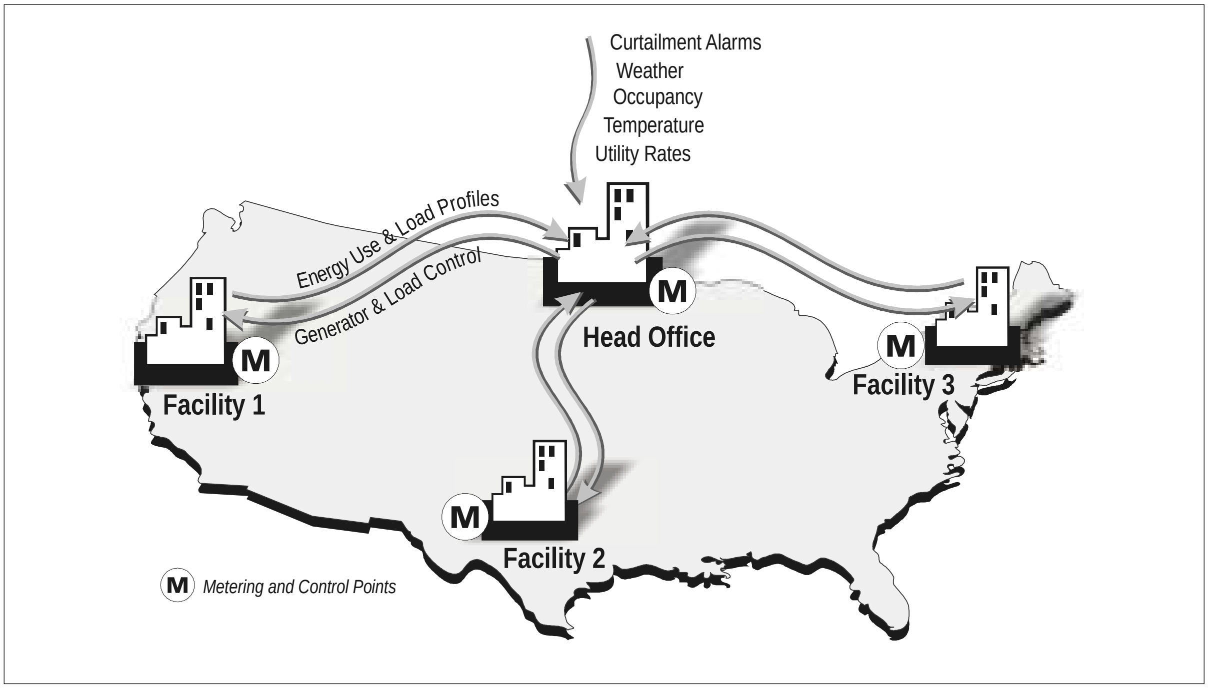

Figure 1: Energy data collection and control between dispersed locations

[1] Stephens, Inc. 2000. *Emerging Power Technology*

consumption across the power grid is at a critical peak. In some cases, the consumer may want to buy power off emerging spot markets. Some simply want to avoid penalties from the utility for exceeding a maximum power *demand* level during peak times, or consuming energy inefficiently below a minimum *power factor* level (typically caused by large motor loads). All of these opportunities are dynamic in nature. To respond to them, energy managers or their service providers need efficient, automated ways of switching or adjusting non-critical loads (lighting, heating, air-conditioning, chilled water, etc.), turning generators on or off to reduce the energy drawn from the utility, and controlling capacitor banks for power factor correction.

Businesses on both the supply and demand side of energy are also seeking ways to optimize the use of their energy assets and reduce maintenance costs. Having information on usage trends throughout an enterprise can defer capital investments by helping discover unused capacity, and supporting decisions regarding on-site generation. A system that can constantly monitor and log distribution and protection equipment stresses and operations, and perform remote control functions throughout the enterprise, can also help personnel better manage capital expenditures, minimize nuisance tripping of breakers, extend equipment life and schedule maintenance more economically.

Powering the New Economy

The "new digital economy" is composed of enterprises such as large data and communications centers, Internet hosting facilities, online retailers, and manufacturers with sensitive processes such as computer chip plants. These operations require near 100% uptime, and the aggregate load that these businesses represent is growing at a phenomenal rate. By the year 2010 the digital economy is expected to consume between 40% to 50% of the energy used in the U.S.[2] Additionally, even "old economy" enterprises are increasingly dependent on automation equipment and Internet-enabled solutions for manufacturing, procurement and 24-hour customer service call centers.

The power grid was developed to deliver "three nines" of clean, reliable power; that is, it provides a constant flow of energy 99.9% of the time. This is sufficient for

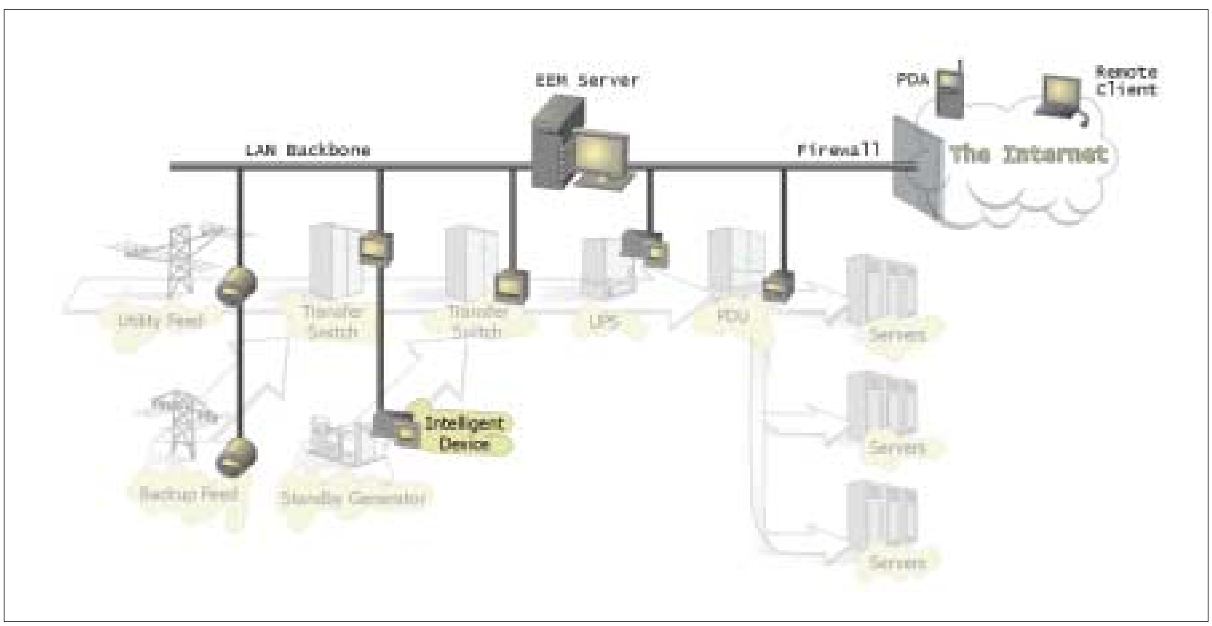

Figure 2: Typical assets in a high-reliability power system

[2] Source: Stephens, Inc.

lighting systems and motor loads, but new digital assets and processes require very precise streams of electrons at highly regulated voltages, translating to power reliability as high as "six nines" (99.9999%) or higher. Clearly, there is a vast disparity between what is available from the grid and what this rapidly expanding segment of the economy requires.

To support their power needs, power-critical businesses typically have one or more feeds coming from the utility, some form of stand-by generation, and a transfer switch that selects between the utility and generator feed. However, because generators typically cannot start up instantly when needed, other forms of mitigation equipment, such as UPS / battery systems and flywheels, are used to "fill the gap." These are connected by a variety of electrical distribution equipment including transformers and circuit breakers. All of this equipment ultimately serves power to the myriad sensitive loads such as data servers, communications switches, or process automation machinery [Figure 2]. Each of these pieces of equipment would typically come from different vendors.

To achieve the high level of power reliability required, all of this equipment must be managed and coordinated with a system that lets facility personnel or a service provider monitor electrical and physical characteristics in real-time and perform automated control. Personnel need fast, convenient access to enterprise-wide status at workstations, and the ability to receive early warning alarms anywhere, to help avoid interruptions. They also need detailed power quality reports to help correlate poor power quality with negative impacts on operations and processes.

In addition, some power-critical businesses may also need to perform cost allocation. For example, Internet "hotels" hosting data and communications assets for other companies often need to allocate energy costs to their clients. In other situations, a facility owner may need to allocate costs to various cost centers or product lines throughout one or more facilities. In both cases, accurate measurements need to be taken regularly from a large number of load points.

Addressing Rising Demand and Market-Based Pricing

The energy supply and delivery environment has changed dramatically in recent years. Rising demand for energy has begun to exceed both generation and transmission system capacity in many regions, while legislators push for deregulation to encourage efficiency through open market dynamics. Both of these conditions have forced energy suppliers to seek new solutions.

To meet the challenge of supplying the rising demand for power during peak periods, many independent system

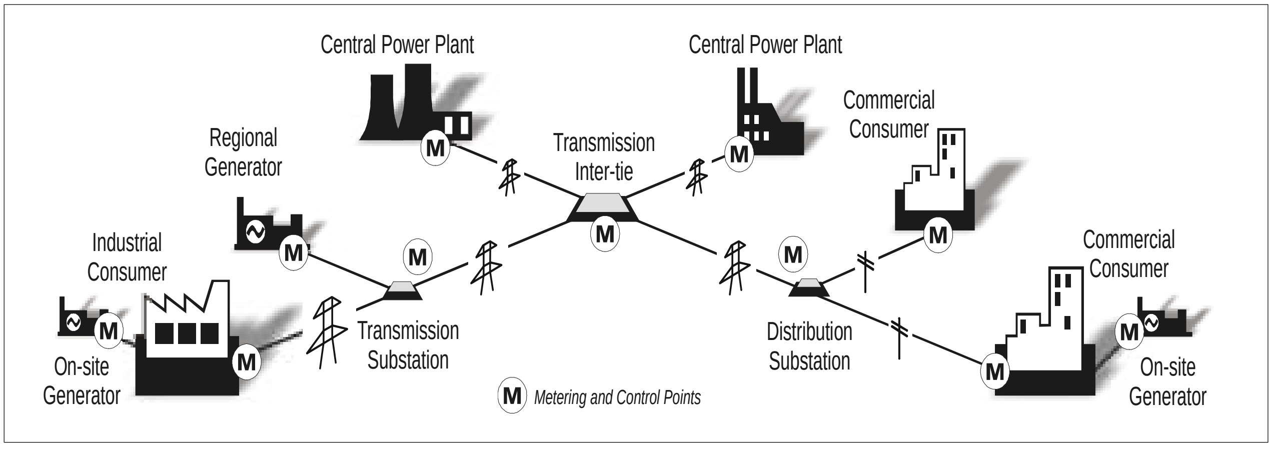

Figure 3: Energy suppliers and consumers connected over a power grid

operators (ISOs) and utilities are opting for *load curtailment* or *demand response* programs to reduce peak demand. These programs can offer an economical alternative to building more generation and transmission capacity, or purchasing high-cost energy for reserve purposes. To support these programs, and help prepare for a far more dynamic market in the near future, some organizations are also installing, or helping users to install distributed generation. The success of these initiatives depends upon the implementation of a cost-effective system that can, within minutes, send alert signals to thousands of customers, confirm curtailment activities, control regional generators, or directly control loads or generation at customer sites.

As many parts of the globe move toward an open energy market, it must be recognized that electricity is a unique commodity; because it cannot readily be stored, its generation, delivery, and consumption must be managed in real-time. This makes it critical that real-time energy information systems be in place to support pricing structures based on the true balance between supply and demand. Further, the unbundling of vertically integrated utilities as a result of deregulation is producing far more interchanges across the transmission "grid." ISOs, transmission companies and other parties that control the grid now need metering at far more places than before to support settlement, and to manage the large quantities of energy, and money, flowing through these points [Figure 3].

Add to this the growing concern of large industrial and commercial energy consumers over the quality and reliability of energy they receive. In response, energy suppliers are starting to offer power quality guarantees, and attempting to help premium power customers find optimal locations for new facility construction. Beyond this, federal and international regulators are beginning to set standards that enforce minimum power quality and reliability levels at the grid level. However, the vast majority of revenue metering devices and supporting information systems that exist today were not designed to take into account these new contracts and requirements. They cannot assess and, in turn, differentiate the quality of the product delivered, which is a hallmark of a market-based economy.

Thus, a technological barrier is preventing true market economics from prevailing, regardless of what the regulators had intended. The existing infrastructure for metering and settlement does not support the information and transaction requirements of a true real-time, value-based pricing scenario. A new kind of system is needed. One that can deliver high-accuracy energy and power quality information in near real time to a variety of parties, both within the enterprise operating the grid as well as those trading energy across it.

EEM Offers a Universal Solution

New enterprise energy management systems offer businesses — on both the supply and demand side of energy — the key to controlling the cost, quality and reliability of the power delivered or consumed. An EEM system can be thought of as a layer of *energy I.T.* (information technology) that rides atop a company's entire collection of energy assets. It is a permanently installed system, running 24 hours a day, that provides all the information and control capabilities necessary to enable management, accounting, engineering, and maintenance personnel to make the best decisions, and to take proactive control of energy — and

Figure 4: Typical EEM intelligent energy monitoring and control devices

energy assets, throughout their entire enterprise.

Typical Components

EEM systems consist of a collection of networked software and intelligent, microprocessor-based devices [Figure 4] that can span widely dispersed geographic locations and multiple points within each site. To accommodate growth, the system should be modular and scalable.

The distributed devices are located at key points throughout the power supplier or power consumer's enterprise; for example, at the electrical *service entrance* to each facility, and inside each power substation or facility on critical feeders, equipment and loads. Due to the critical nature of the applications, these should be highly reliable, industrially hardened devices that are protected against tampering, and have non-volatile memory to retain energy and power quality logs in the event of a communication failure.

To be cost-effective, each device should be simple to install, and offer a combination of functions including three-phase revenue-grade metering, power quality analysis, load profiling, event capture and communications. To support true real-time pricing, devices should be capable of capturing *interval* data to a resolution of five minutes or less, and be able to communicate this information, in near-real time, to the consumer. Devices located at critical points should also have the ability to determine compliance with applicable power quality standards.

Additional inputs, outputs and automated control functions should be provided to import pulse data from other utility meters (gas, water, etc.) and to monitor and control the status of external equipment. Multiple communication ports that directly support a variety of industry-standard protocols will allow for information sharing with billing and automation systems [Figure 5].

The remote devices are connected over a sophisticated communication network to *head-end* system software [Figure 6]. Within a facility or campus, the existing corporate local area network (LAN) can provide a fast and economical communication backbone, especially when Ethernet ports are integrated into each device. For communication with dispersed substation or facility locations, an EEM system should leverage the speed, economy, and flexibility of public networks such as the Internet, digital cellular, CDPD wireless, telephone, etc. Remote devices should include the intelligence necessary to distill and transfer only the most relevant information from large amounts of data, thus minimizing network traffic.

The pervasiveness, economy, and scalability of the Internet make it the top networking choice for the future. Most enterprises are already moving toward web-based business models, and EEM is simply another business system that should be considered in that context. Leading EEM systems provide direct access to real-time data in each remote device using a common Web browser interface. Information can also be "pushed" out from each device using

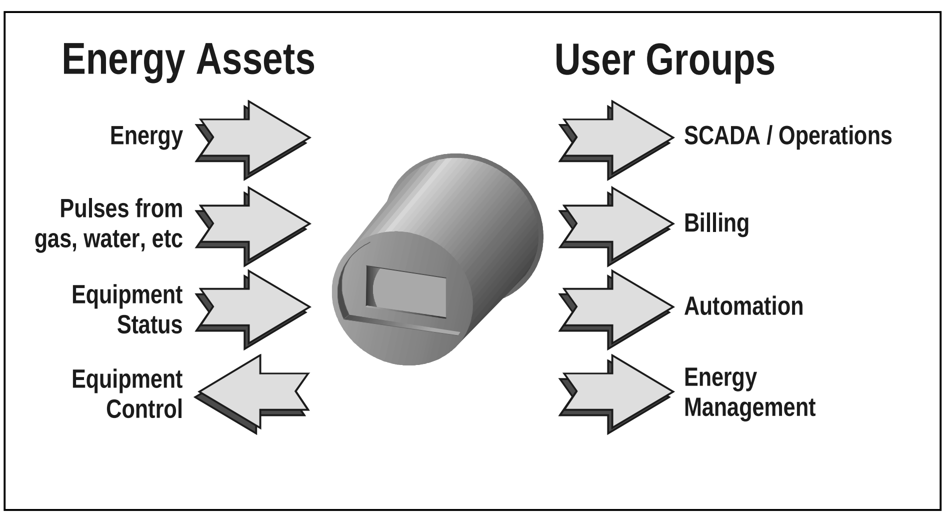

Figure 5: Device inputs and outputs

standard e-mail messages. E-mail offers a distinct advantage over web-browser access; it accommodates corporate firewall restrictions, making it ideal for sharing information between organizations. Open connectivity with multiple platforms should ideally be provided through new, versatile standards like XML.

The head-end EEM system software operates across an enterprise's existing corporate local or wide area network (LAN / WAN), automatically uploading real-time and historical information and storing it to one or more central data servers. The database should be in an industry-standard format (e.g. ODBC) to allow for data sharing between applications and other automation and business systems. Similar to the remote devices, the software needs to be reliable and, ideally, based on a robust client-server architecture.

The EEM software should offer fast access to real-time information, generating online or hardcopy reports in the format most useful to each party [Figure 7] including personnel within the enterprise, and secure access to parties outside. The head-end software should provide detailed graphical analysis screens for operations and maintenance personnel that allow them to stay on top of conditions and "drill down" to isolated problems when they occur. Familiar Web browser interfaces provide controlled access to energy and power quality information, while messaging to

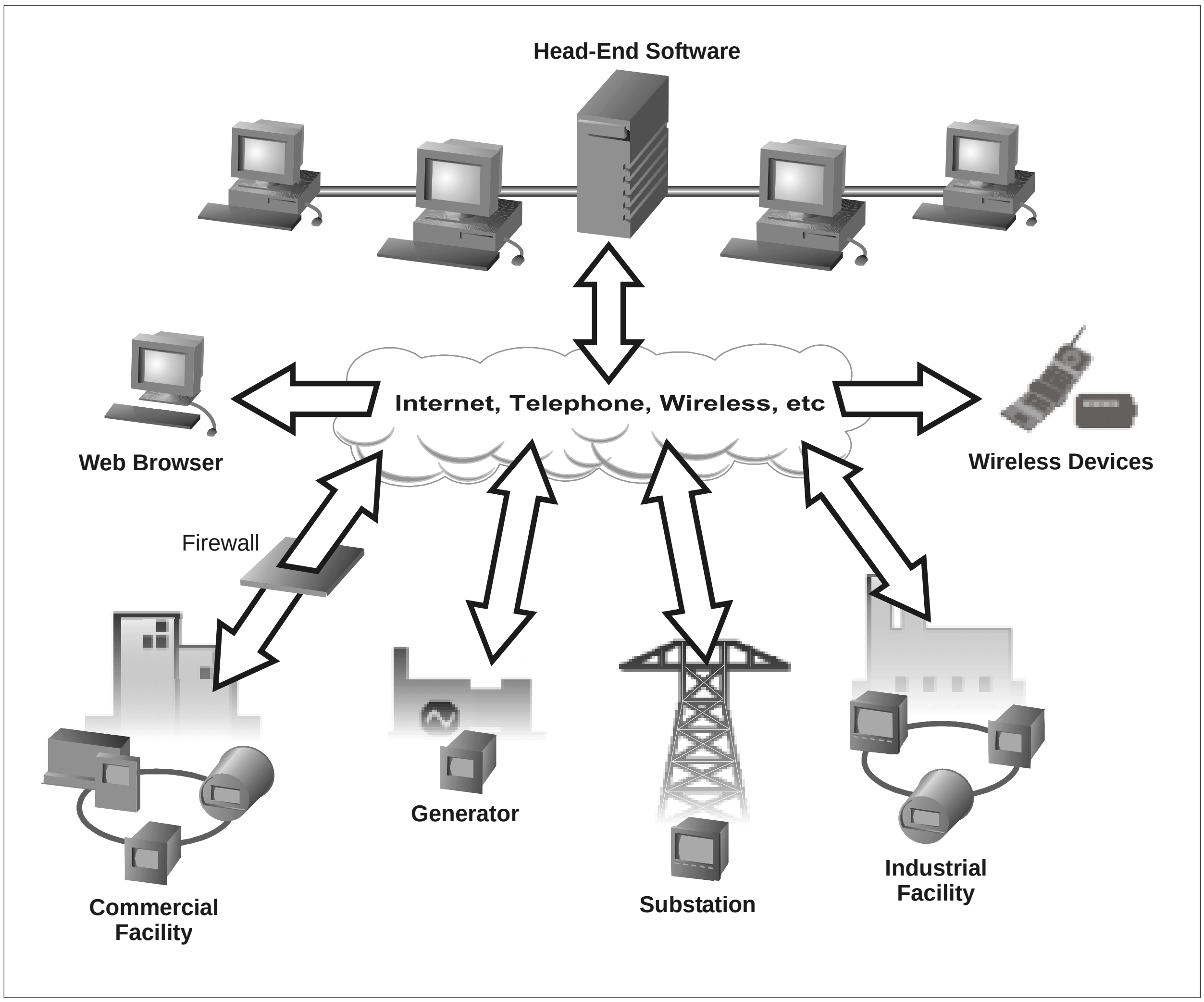

Figure 6: Enterprise energy management system

Figure 7: Typical EEM software screens and reports

cell phones, pagers, or PDAs (personal digital assistants) keep personnel abreast of critical conditions.

The system also should provide configurable alarming functions, and allow for manual or automated remote control over generators, loads, and electrical distribution equipment throughout the enterprise.

EEM for Industrial and Commercial Consumers

An EEM system can give energy consumers the ability to take ownership of the procurement and consumption of electrical energy. The system can help accurately identify enterprise-wide energy needs by aggregating and profiling usage patterns, and by helping perform variable analysis against utility rate choices. It can help procure energy effectively, verify billing, and allocate energy costs to tenants, clients, departments or processes.

Energy managers can respond to real-time pricing or curtailment signals and control their generators or loads to economic benefit. They can test the cost impact of various initiatives, compare the performance of various facilities against each other to find waste, and establish benchmarks to drive management to achieve better performance. EEM also supports preventative measures by providing “up front” verification of electrical equipment status to optimize performance and reduce maintenance time.

An EEM system can capture power quality anomalies in real-time, transmit alarm messages to operations staff or the service provider, and be ready with the information necessary to help pinpoint and correct problems. This information can also support decisions regarding power quality mitigation strategies or facility location, while monitoring and coordinating all mitigation equipment and other energy assets throughout every facility helps achieve maximum value.

EEM for Energy Services

EEM systems give energy service providers (ESP’s) an economical and feature-rich way to offer competitive value-added reporting, performance contracting and consulting services to large numbers of customers, with multiple facilities spread across wide geographical areas. Intelligent devices can be located at the customer’s service entrance and within their facilities, with head-end software at the offices of the ESP.

An EEM system can also support ESP’s operating as *application service providers.* The provider can give controlled access to information to their client through a local “seat” on the head-end software, or Web browser access from any location. The client can view real-time system status or custom reports showing aggregate billing, allocated costs, power quality event histories, and more. Customers can use the information to find opportunities for cost savings and to identify power quality problems, or the service provider can manage this for them.

In response to spot market pricing or curtailment signals, the head-end software can recognize an opportunity based on individual clients or an aggregate, communicate with the distributed clients and/or assets, receive permission to implement any required control, and do so automatically via the network.

EEM for Grid Enterprises

An EEM system enables demand response or load curtailment programs for ISO and utility enterprises by providing the high-speed communications necessary to efficiently contact customers, control distributed generators or loads, and verify operations. It also automatically acquires the energy logs from each location to support settlement and billing.

An EEM system also provides the intelligent devices that offer the energy metering, power quality analysis, and communications capability required to support real-time, quality-based pricing and settlement. These devices have the high-accuracy required to meter the high voltages involved and the flexibility necessary to support new and evolving billing structures. Power quality and reliability benchmarking and verification tools help grade the energy product, determine the appropriate mitigation technology for the application, and locate the best sites for premium power consumers.

Many power utilities have traditionally used dedicated supervisory control and data acquisition (SCADA) systems to monitor real-time system conditions and perform manual or automated control. These are often separate from systems used by power quality and metering groups. An EEM system can meet the needs of all groups, helping reduce capital and maintenance costs, while providing new and useful information to each group to support cost-control measures.

Conclusion

Enterprise energy management systems give both energy suppliers and consumers the tools to meet all of the challenges and opportunities of the new energy environment. EEM directly addresses a broad range of requirements throughout the power delivery chain. It provides an integrated solution to managing new billing structures, distributed generation, energy purchasing, cost control, operational efficiency, and reliability.

A single, shared system that delivers a broad range of functionality can satisfy the needs of many different groups within an enterprise, while integrating seamlessly with existing systems. The economy offered by such a solution also allows monitoring and control to be installed at more locations where it would otherwise have been cost prohibitive.

By taking advantage of existing corporate and public infrastructures, such as the Internet, installation and operation costs can be minimized. Coupled with reduced energy costs, avoided downtime, and increased efficiency, this can represent a very short payback period on an EEM investment, often under a year.

For most businesses, EEM can represent the key to the right power at the right price, removing the barrier to implementing best energy practices, and helping each stay competitive in a rapidly evolving marketplace.

-end-

POWER MEASUREMENT

POWER MEASUREMENT, 2195 Keating Cross Road,
Saanichton BC, Canada V8M 2A5, Toll free: 1-866-ION-SMART
Tel: 1-250-652-7100 Fax: 1-250-652-0411 Web: www.pwrm.com