Reducing your Exposure to Energy Risk with Enterprise Energy Management

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Whether the need is to reduce costs or improve yields, increase uptime or improve customer satisfaction, the top priority for any facility manager is always a question of risk. The supply of reliable, clean, and cost-effective energy is mission-critical, yet this continues to be one of the least carefully managed inputs to a business, and this translates to poorly managed risk. Fluctuating energy prices in a deregulated market might spike one month, wiping out a whole quarter's profits. Unplanned production downtime caused by utility interruptions or on-site equipment failure can be very costly.

Managing these risks requires accurate measurement of the cost, quality, and reliability of the power from the source to the load. An enterprise energy management (EEM) system reduces risk by providing key performance indicators that help managers determine whether critical operating parameters are within expectations (Figure 1). An overview of the current state-of-the-art in EEM technology was provided in a recent issue of *Strategic Planning for Energy and the Environment* (see "EEM: The Right Power at the Right Price," Vol. 22, #4). Looking at energy in terms of business risk offers further insight to the benefits of such systems.

EEM systems deliver relevant information in a timely fashion through a combination of accurate cost/revenue metering, embedded power quality/reliability monitoring, and a cost-effective internet-based communications infrastructure. With an EEM system, risk can be managed in terms of understanding what is going on, understanding what will happen if a particular action is taken, and helping make decisions to reduce risk, improve profitability, and maximize the return on the energy investment across the entire enterprise.

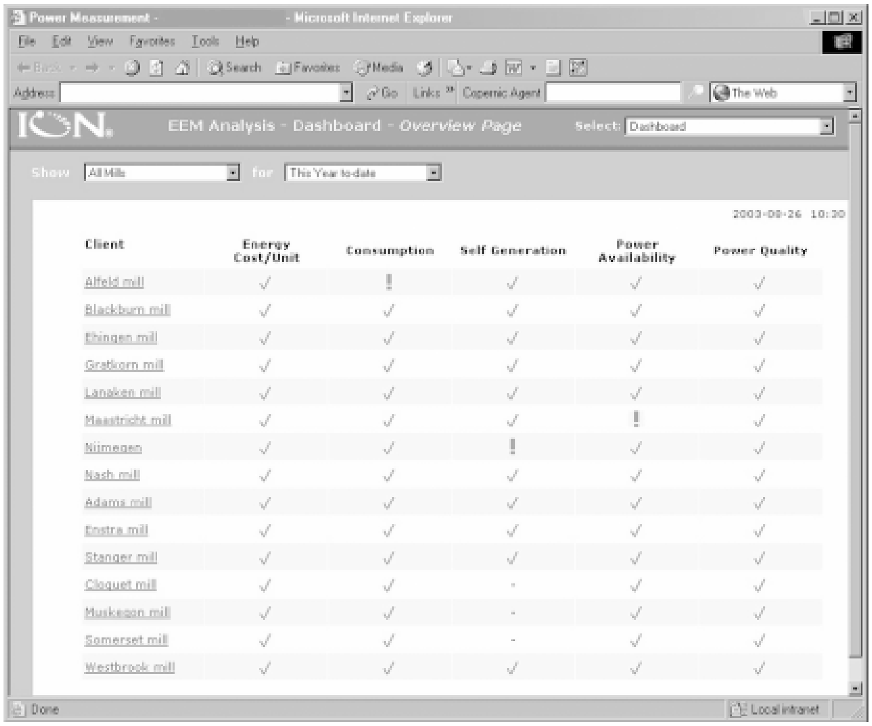

Figure 1. An EEM system's digital dashboard showing energy performance indicators for a multi-site industrial enterprise.

UNDERSTANDING ELECTRICITY-RELATED RISK

Risk managers and risk management objectives are common. Identifying and controlling anything that puts the business at risk helps avoid the unexpected: unforeseen operating costs, unexplained drop in production yields, uncontrolled environmental emissions, and so on.

Electrical energy is almost always mission-critical, and other *energy commodities* and the *energy assets* that deliver them may be equally critical to the financial viability of the business: e.g. water, air, gas, and steam. The true value of these commodities is a balance between cost, reliability, and quality.

Remarkably, the technologies used to manage these attributes often operate in isolation, if at all. They traditionally include a mix of utility metering and billing systems to quantify cost and revenue, supervisory control and data acquisition (SCADA) systems to measure operating parameters of the infrastructure, and dedicated portable instruments to measure power quality.

The result is usually high cost for poor access to incomplete information. The impact is that there is only limited knowledge of the risk exposure due to each business-critical commodity. An EEM system offers a holistic approach to managing this exposure to risk.

RISKS RELATED TO ELECTRICITY COSTS & REVENUE

> **A Case Study:** A large property management company was running the risk of sudden increases in the spot price of electricity for some facilities. They needed to track consumption against energy cost from a variety of sources in real time (spot market, on-site generation, load shedding) to be able to make rapid decisions about the most cost-effective energy supply. Looking back at the previous month's consumption as provided by a conventional metering system, it was not able to provide accurate, rapid information for business-critical decisions.

With deregulation, the consumer is often trading off energy cost against quality and reliability through energy services contracts that allow loads to be shed, or generators to be controlled remotely. This has a direct effect on financial risk. Specific knowledge is now needed about the amount of energy consumed, when, and where. It may make financial sense to switch to on-site generation if spot prices are too high, for example. It also may be worthwhile to negotiate a supply agreement for multiple locations. Accounting practices may also justify more careful tracking of energy usage for specific manufacturing processes.

Conventional energy cost analysis systems will record and track energy consumption patterns in each section, department, or area. It is quite easy to do multi-dimensional analysis: for example, compare usage trends for week one with week three, or from Plant A to Plant B.

Most systems offer some kind of cost allocation, utility bill verification, and sub-tenant billing. The best systems even go so far as to integrate real-time energy pricing to allow "what-if" scenarios to be worked out by energy traders.

RISKS RELATED TO RELIABILITY

> **A Case Study:** A large processing plant had a 30MW cogeneration capability on-site and normally exported excess power to the grid. Grid level phase faults and switching transients caused damage to the generator, which eventually failed and resulted in large demand penalties and repair costs. The mill was running the risk of high penalties unless they could track and prove the cause of interruptions.

Historical continuity does not guarantee a reliable, risk-free energy supply in the future. The standard approach to compensate for an unreliable supply is to buy expensive redundancy (oversized transformers, multiple utility feeds, backup generation, UPS with a room of batteries, oversized power distribution equipment, etc.). This might help ride through a power failure or disturbance, but it cannot help predict a system failure or determine the cause when it happens.

The key to affordable reliability and reduced risk is not only redundancy, but also predictive analysis and maintenance. Knowing in advance that a system is likely to fail—or is perhaps weakened by damaging disturbances—makes it possible to fix the problem before it becomes one. This requires knowledge about the impact of the power and loads on the infrastructure, and about the infrastructure's impact on power reliability.

RISKS RELATED TO QUALITY

> **A Case Study:** A financial data center made a heavy investment in on-site generation and on-line UPS for critical stand-by power. The transfer to stand-by generators was not always smoothly handled, however, and the internal diagnostics did not provide any clues. They were running the risk of putting traders off-line in a volatile equity market.

With an hour of downtime in a data center sometimes worth millions in losses for a brokerage,[1] electricity is the single biggest infrastruc-

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[1]Allen, "Championing power quality and reliability - a risk management perspective," *Energy User News*, December 2002

ture issue that can influence financial business risk. Waiting for a power quality problem to manifest itself as equipment misoperation or failure is unfortunately still the most common way of finding out that a real problem exists.

Poor power quality is as much an *indicator* of equipment deterioration as it is a *cause* of equipment deterioration. The latest energy saving and control technologies—typically *non-linear* loads—are often a source of poor power quality (e.g. harmonics) that can affect distribution equipment reliability, and in turn further affect the quality of supply.

Carefully measuring and tracking sags, swells, transients and harmonics can show how these disturbances impact the life and behavior of equipment throughout a distribution network or a facility; looking for them after the system fails is too late.

The challenge is often to identify the source of a problem and corroborate these sources over the whole system. For example, if five locations are experiencing transient voltage disturbances at nearly the same time or with a similar signature, there is a good chance the problem has a common source.

TRADITIONAL MANAGEMENT METHODS FALL SHORT

Traditional monitoring, analysis, and prediction methods for managing energy cannot manage in a holistic fashion all aspects of cost, reliability, or quality delivered directly to the load, *measured in terms of financial risk* to the enterprise.

A supermarket chain's efforts to reduce consumption are usually made one building at a time, while tracking and comparing the efficiencies of all locations against industry benchmarks could identify advantages in bulk energy contracts or local generation. A wind generator farm operator installs accurate energy metering at each inter-tie point to ensure proper payment, but may be exposed to the greater risk of high repair costs if switching transients on the grid damage the wind farm infrastructure.

An automotive painting facility's efforts to minimize energy cost-per-unit prompts them to install high-efficiency drying lamps, without realizing the greater risk of the lamps introducing harmonics that could burn out conductors and result in fire, or cause equipment failure and plant-wide shutdown. High efficiency compressor motors installed by a pharmaceutical manufacturing plant may show reduced energy costs, but the resulting harmonics generated by their electronically controlled windings may impact the stability of neighboring equipment.

Power system instability resulting from cost savings in one area can lead to poor product quality or reduced yields of a very valuable product in another. The key is to be able to ensure high reliability and good quality at a reasonable total energy cost, where this is measured in terms of financial risk to the company.

For manufacturing facilities, a lower energy infrastructure cost (cheap components) will decrease reliability and increase the risk of reduced yields. For commercial buildings, a weaker infrastructure will also increase risk the of business interruptions that can be significantly more costly. Thus, in a chemical plant it could very well be acceptable to reduce yields by 1 percent if this is the result of 10 percent energy cost savings; but for an equity trading company a loss of 1 percent of transactions will be completely unacceptable.

THE ENTERPRISE ENERGY MANAGEMENT SYSTEM

An enterprise energy management (EEM) system delivers *key performance indicators* to identify areas of potential financial risk. The question "what now?" can be answered by multi-dimensional energy analytics, delivering timely information needed to avoid unexpected costs, unexpected reliability problems, and unacceptable power quality.

An EEM system must deliver key performance indicators in a timely manner, and it must provide sufficiently complete information to allow useful analysis. The topology shown in Figure 2 provides a simple overview of an EEM system. Sensors for cost-related data (billing metering), reliability-related data (operational metering), and quality-related data (power quality metering) are deployed at every key asset or distribution point.

These sensors require some on-board intelligence to reduce the data load to meaningful information and key performance indicators. A high speed, flexible, and open communications infrastructure (Ethernet, wireless, serial links, telephone) ensures that information and performance indicators can be passed to decision makers quickly. The software tools and reports provide rich information in the form of key performance indicators to simplify the decision-making analysis based on

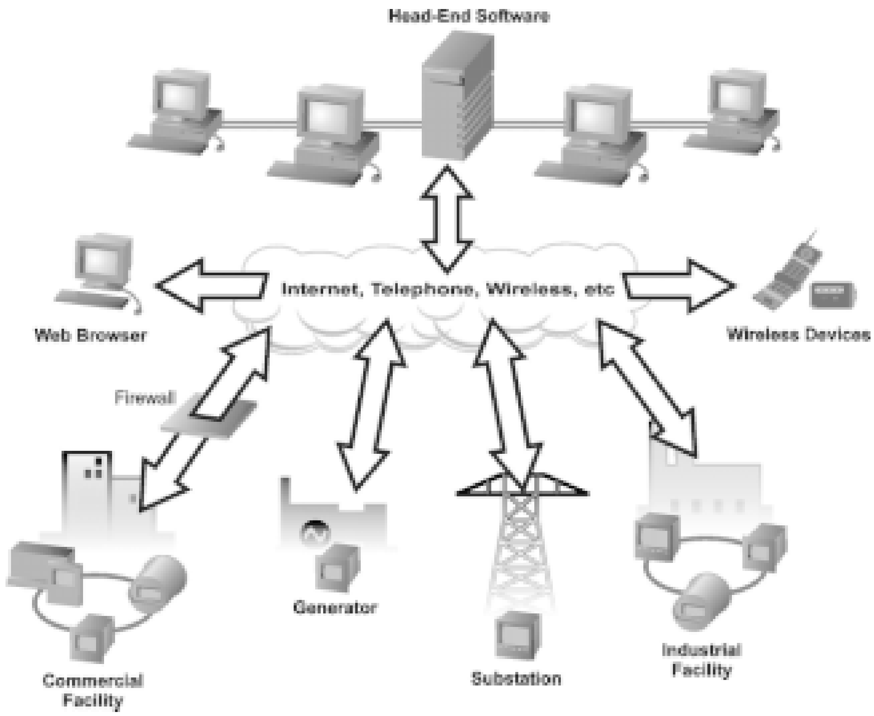

Figure 2. Typical topology of an enterprise energy management system

what-if scenarios, statistical indicators, performance trends, and so on.

Sub-metering across the enterprise and throughout each facility enables the EEM system to accurately track consumption levels for each building, tenant, department, process, or other cost centers. This helps ensure commercial building owners are properly compensated for the energy used by each tenant. It also supports the normalization of energy costs for different types of tenants, helping plan reliable power systems for new buildings.

Trending and prediction data also help a facility avoid penalties from the utility for exceeding high *peak demand* or low *power factor* limits. Loads can be rescheduled to "smooth out" a consumption curve, and generators or other equipment can be manually or automatically engaged in response to EEM system alarms. Since environmental standards and hefty fines are a consideration for some industries, an EEM system can support normalization of emissions levels versus energy consumption to help avoid the risk of excessive pollutants when a plant is not running at optimal efficiency.

In a commercial building, consumption and temperature will be closely correlated, unless there is a large shift in loads—perhaps from a new tenant that requires a large server room, for example. Combined with the air conditioning load, the infrastructure may not be adequate in summer months and may require an upgrade. An EEM system can deliver the performance indicators to avoid running the risk of exceeding the capacity of the infrastructure [Figure 3].

An EEM system will reveal energy consumption trends per square foot for multiple facilities. Energy managers for any business with multiple plants or facilities will be able to determine which facilities are the least energy efficient, so that capital costs to save energy can be applied in the most effective manner. The EEM system will also record historical load trends for individual sites as well as aggregated across the enterprise. Armed with this information, energy managers will be better able to project energy needs and negotiate bulk energy purchase contracts.

All businesses can benefit from auditing and comparing expected monthly energy expenditures to plan. An EEM system can accurately "shadow bill" against the utility billing meters to ensure actual billing charges match predictions, and catch any utility billing errors [Figure 4]. Any other energy-related commodity such as water, compressed air, gas and steam can be profiled over time and between facilities to identify anomalies in supply or demand [Figure 5].

ENSURING A GOOD RETURN ON AN EEM INVESTMENT

Any investment in information systems must offer a reasonable total cost of ownership over the life of the system. In some circumstances, manual meter reading and portable power quality instruments could also provide the data required. Yet the cost of collecting, transmitting, storing, and processing all that data can be extremely high relative to the amount of information. And this is not a one-time survey; full-time, in-depth monitoring is critical to success.

An integrated EEM solution combines the permanent metering, monitoring, analysis, communications, and reporting tools required in a single, cost-effective solution. Some key features required for an effective EEM systems are:

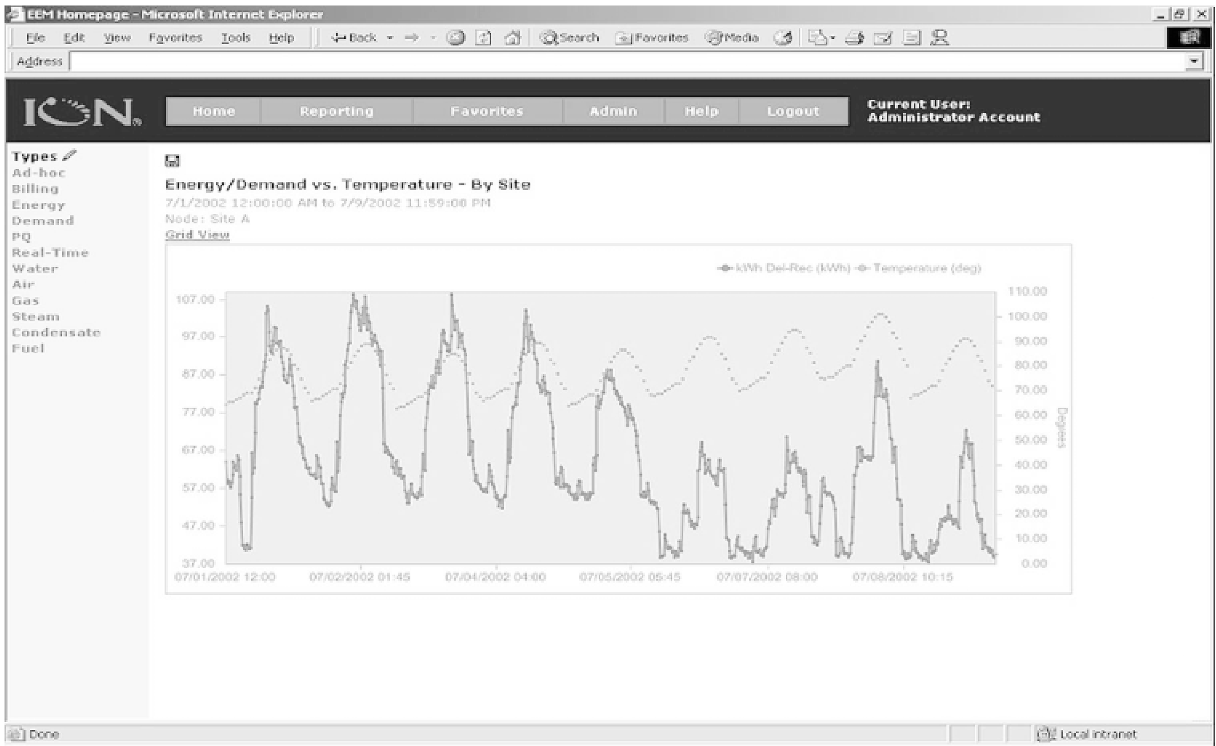

Figure 3. Key performance indicators for energy consumption

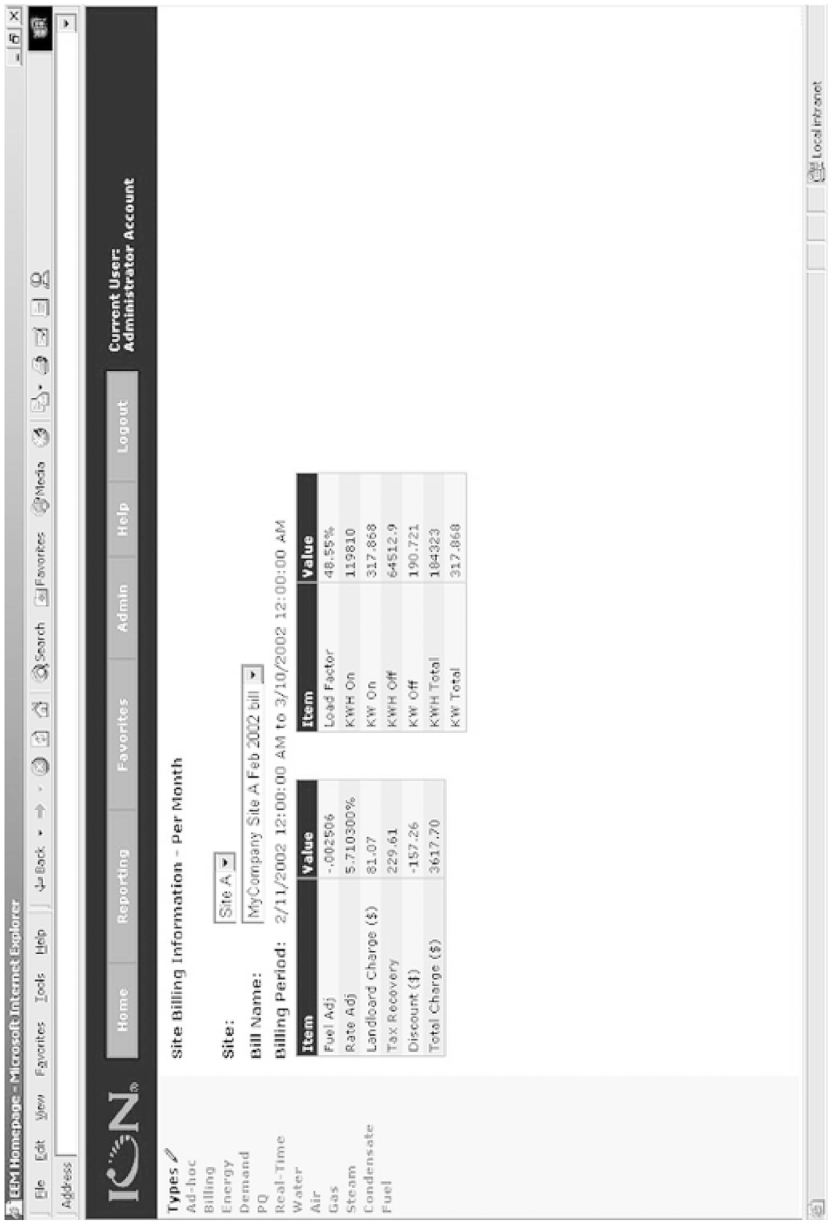

Figure 4. Key performance indicators for shadow billing

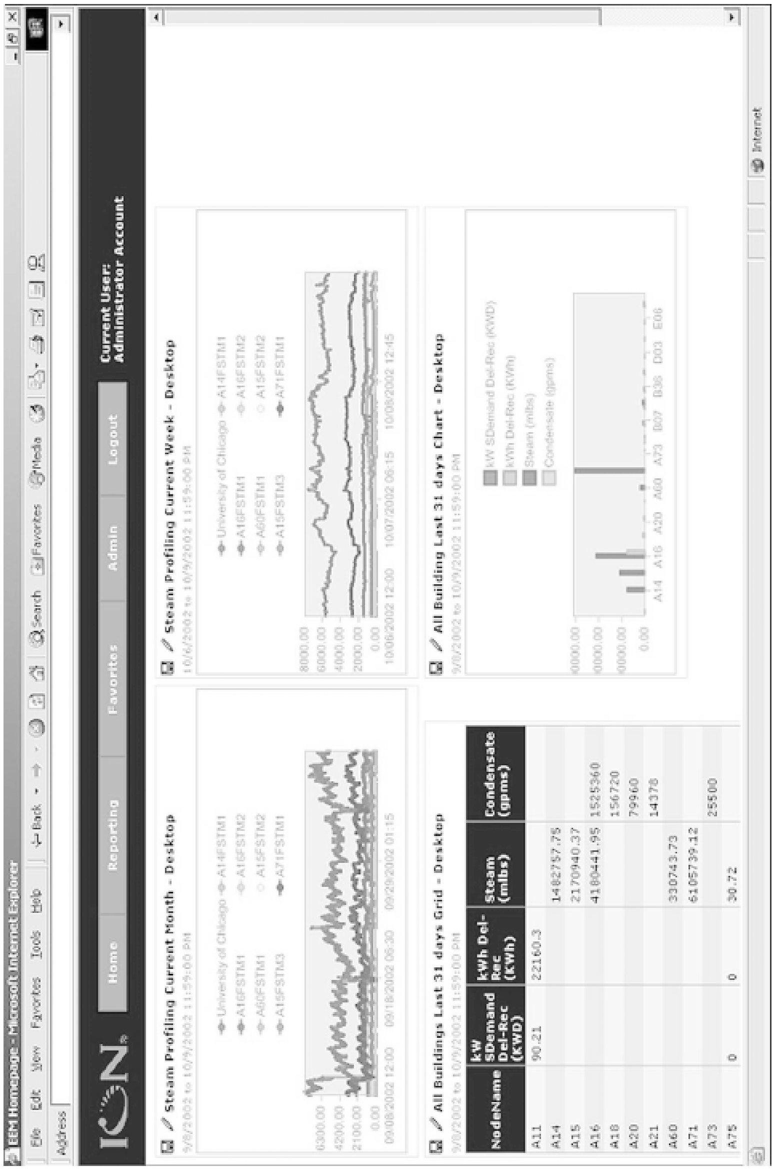

Figure 5. Key performance indicators for steam profiling

- Energy analytics tools to ensure that key performance indicators can be determined to analyze the performance of the process, the business unit, or the whole enterprise.

- Tariff-class 0.2 percent accuracy for energy, demand, and usage data to ensure that billing is accurate and correct.

- Embedded Ethernet connectivity to ensure immediate and low-cost access through non-proprietary communication networks that are easy to maintain and scale up.

- Support for internet protocols and email/web features to ensure that information and data can be accessed directly with commonly available tools.

- Monitoring user-defined quality and reliability metrics to ensure that the supply meets contractual commitments.

- Monitoring compliance in accordance with the IEC61000-4-30 standard, or other accepted power quality standards, to ensure that the supply meets expectations, using recognized metrics.

- PQ troubleshooting tools to ensure that when a disturbance occurs, the capabilities are in place to track down the cause to avoid a recurrence.

- Customized information delivery for each person that needs it—in real time—to ensure that the relevant intelligence is available to make fast decisions to avoid disruptions, equipment failure, and cost overruns.

CONCLUSIONS

Energy is a mission-critical commodity that must be managed to reduce the exposure to risk for an enterprise. An enterprise energy management system can mitigate this risk by providing the data, information, and knowledge required about the cost, reliability, and quality of the power supply.

The EEM system in turn requires tariff-class accuracy to provide good cost information, embedded analysis capabilities to ensure that useful reliability and quality metrics can be tracked, and internet-based communications infrastructure that makes the system cost-effective for large enterprises.

An EEM system will provide the necessary key performance indicators required to make business decisions that lead to reduced risk and improved profitability. This intelligence should also form the foundation of an ongoing strategic energy management program of measurement and verification to establish best practices and maximize savings long term. Look for "Maximizing Energy Savings with EEM Systems" in a future issue of *Strategic Planning for Energy and the Environment*.

ABOUT THE AUTHOR

Rudi Carolsfeld graduated from the University of Victoria, Canada, with a Master's Degree in electrical engineering. In 1993 he joined Power Measurement and is now business development manager for Europe. He is a member of the IEEE.