North American Policies and Technologies

ELECTRICITY Transmission & Distribution TODAY

THE ELECTRICITY FORUM

July/August 2008
Volume 20, No. 6

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IT'S TIME TO CAST OUR GAZE DOWNWARDS FOR EMISSIONS

By Don Horne

Forget the air – it's the wastewater that needs attention.

The drumbeat of zero emissions and clean air has been pounded into the ears of utilities looking to increase their generation base.

The quick answer has been to expand with wind and solar, accompanied by a coordinated demand response program that can keep peak usage within the limits of existing generation.

Plentiful supplies of coal may now be utilized with the new scrubber and sequestration technologies, providing utilities with large baseload generation while maintaining air quality standards.

But while we've had our eyes cast to the skies to address the problem of the toxic emissions belching from the smokestacks, we are now creating another problem beneath our feet by solving the original one.

The effluent generated by these new scrubbing techniques has created a situation where we are robbing Peter to pay Paul – moving the toxins from the air to the water flowing from the scrubbing process.

Shilpa Tiku, an analyst with Frost & Sullivan, says "While strict air emission norms led plants to install the flue gas desulphurization (FGD) process using wet scrubbing, this has caused wastewater discharge from the FGD process, which poses a challenge to the utilities.

"Discharging FGD blow down water is not very easy, as the constituents are very complex and the standards are tough to meet."

Basically, the toxins that were filtered from the stacks now have to be filtered in the waste water pipes leaving the facility. But let's leave this problem for a moment and address the other end of the system – where the water is entering the facility.

Coal plants consume very large amounts of water for the steam and cooling process, and the boom in new construction and massive retrofitting of existing plants will definitely raise awareness of water quality both coming into and exiting these plants.

It is doubtful that many operators would be willing to sit back and watch their multi-million dollar scrubber system become inhibited because the water being introduced to the system was impure or very hard in nature.

The water treatment in the power industry market alone is expected to reach $1.17 billion by 2013. Last year, revenues reach $580 million.

One process that works well is thermal wastewater treatment.

The thermal wastewater treatment process helps treat FGD blow down for recycling and reusing the wastewater. In the thermal process, water goes through various stages of treatment to emerge as almost pure water.

The concentrate left behind by the thermal process contains contaminants that are much smaller in volume than earlier contaminants and can be treated by biodegradation, digestion, or other residual solids mitigation technologies that are available in the market. However, since it is a capital-intensive technology, utilities are hesitant to invest large amounts of money in it.

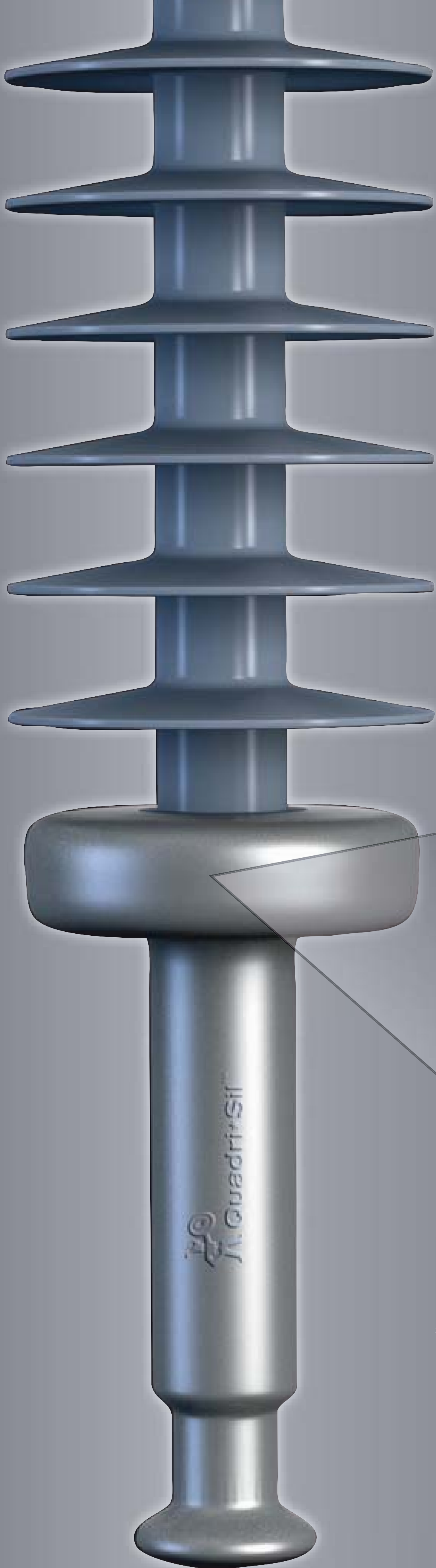
But there remains the two constricting elements that will necessitate some form of water quality technology:

- a need to protect the facility from unwanted elements entering the system;
- environmental standards demanding that effluent meets EPA requirements.

Like anything, any system needs to be looked at as a whole, not by its various parts.

Whether it is through the retrofitting of an older plant, or the design of a new coal facility, there needs to be a systemwide examination of what is going in and what is coming out before the first shovel is sunk into the earth – because the cost of adding on, redesigning or closing down altogether is something that no utility can afford.

don@electricityforum.com



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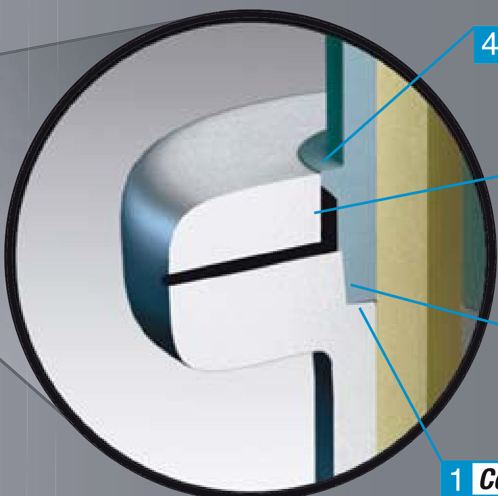

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ENERGY EFFICIENCY IN THE POWER GRID

The concept of energy efficiency has moved in and out of favor with the public over the years, but recently has gained renewed broad-based support. The confluence of economic, environmental and geopolitical concerns around reducing America's exposure to disruptions in the supply of energy has moved efficiency to the fore. As a result, a number of initiatives are now underway to improve efficiency in a variety of areas, but much more can and should be done.

The United States is not alone in these efforts. China presently has ten efficiency programs aimed at bringing the country's energy intensity — the amount of energy used per unit of GDP — in line with rivals such as the U.S. and the European Union. The EU likewise has taken steps to improve energy efficiency in its member countries by 20% over the next fifteen years.

Efficiency is a simple concept that can perhaps best be summed up with the cliché, "doing more with less". Perhaps the best-known efficiency program among American consumers is the Energy Star program that helps them to identify appliances like dishwashers and refrigerators that use less energy than other similar models. Indeed, the term "efficiency" is typically associated with how energy is consumed at the point of end use, but the concept of efficiency can also be applied to how energy is produced and distributed.

This article will focus primarily on the electric power system, where most end-use applications outside of transportation and heating get their energy. We will first present a broadly inclusive definition of efficiency and then explore a variety of ways the grid can be made more efficient.

GENERATION

To gain an appreciation for the impact that improved efficiency can have, it is useful to examine the price we pay for inefficiency, and nowhere is this more apparent than in the generation of electric power. Typically, the process converts the latent energy in a fuel stock (coal, gas, uranium) into mechanical energy in a generator and ultimately electrical energy. However, other generation sources like wind and hydro power use the mechanical energy of moving masses of air or water to produce electric energy. Still other devices, such as fuel cells, use chemical reactions to generate electric energy. In all of these cases, though, some of the input energy is lost in the process.

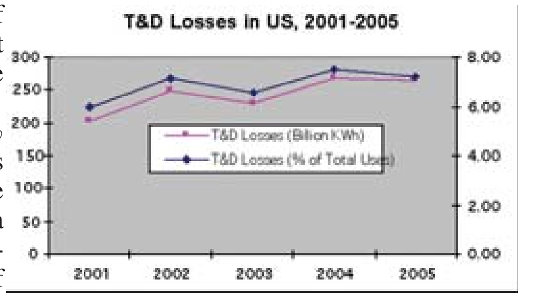
The efficiency of generation varies widely with the technology used. In a traditional coal plant, for example, only about 30-35% of the energy in the coal ends up as electricity on the other end of the generator. So-called "supercritical" coal plants can reach efficiency levels in the mid-40s, and the latest coal technology, known as integrated gasification combined cycle or IGCC, is capable of efficiency levels above 60%. The most efficient gas-fired generators achieve a similar level of efficiency.

Obviously, though, even at 60% efficiency there is a tremendous amount of energy left behind in the generation process. That represents a higher cost of production for the generator, as well as a substantial waste of limited resources. There is, therefore, tremendous economic and ecological incentive to improve the efficiency of power generation so that more of the energy content of the input fuel is carried through to the output electricity. There are a variety of ways to improve generator efficiency, such as combustion optimization using modern control systems, but for the purposes of this paper we will focus on what happens after the generation process.

TRANSMISSION AND DISTRIBUTION

Once electric energy is generated, it must be moved to areas where it will be used. This is known as transmission — moving large amounts of power over sometimes very long distances — and is separate from distribution, which refers to the process of delivering electric energy from the high voltage transmission grid to specific locations such as a residential street or commercial park. Distribution is usually considered to encompass the substations and feeder lines that take power from the high voltage grid and progressively step down the voltage, eventually to the 120v level at which power enters our homes.

The transmission and distribution or "T&D" system, then, includes everything between a generation plant and an end-use site. Along the way, some of the energy supplied by the generator is lost due to the resistance of the wires and equipment that the electricity passes through. Most of this energy is converted to heat. Just how much energy is taken up as losses in the T&D system depends greatly on the physical characteristics of the system in question as well as how it is operated. Generally speaking, T&D losses between 6% and 8% are considered normal.



Source: Energy Information Administration

It is possible to calculate what this means in dollar terms by looking at the difference between the amount of electric energy generated and the amount actually sold at the retail level. According to data from the Energy Information Administration, net generation in the United States came to over 3.9 billion megawatt hours (MWh) in 2005 while retail power sales during that year were about 3.6 billion MWh. T&D losses amounted to 239 million MWh, or 6.1% of net generation. Multiplying that number by the national average retail price of electricity for 2005, we can estimate those losses came at a cost to the U.S. economy of just under $19.5 billion.

Congestion charges represent another significant cost of inefficiency in the T&D system, but are only partially determined by the physical characteristics of the grid. Congestion occurs when the scheduled or actual flows of electricity

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Energy Efficiency
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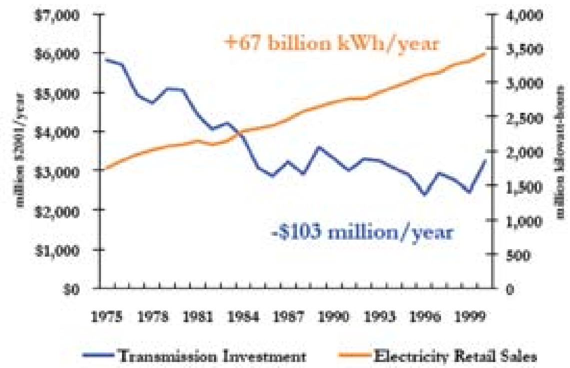
are restricted either by physical capacity constraints on a particular device or by operational safety constraints designed to preserve grid reliability. In order to meet demand, the system operator must find an alternative source of power that avoids the bottleneck. That alternative generator will be less economical, and therefore less efficient from a market perspective. A more robust T&D system, then, can provide a level, congestion-free playing field on which generators can compete.

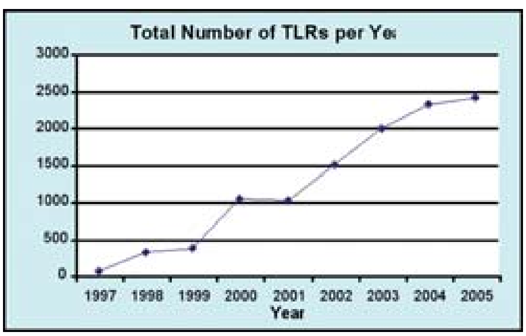


Transmission Investment vs. Retail Electricity Sales Source: IEEE

Congestion is the result of a number of factors, notably a lack of adequate transmission investment and an increase in bulk power transactions in competitive energy markets. Recent figures on congestion at a national level are difficult to ascertain, however the experience of two of the nation's largest power markets will serve to illustrate the scope of the problem.

The California Independent System Operator reported congestion costs of $1.1 billion in 2004, $670 million in 2005, and $476 million in 2006. It's worth noting that the ISO attributes much of the reduction in the '04-'05 period to critical expansions on the state's "Path 15" north-south transmission corridor. Similarly, the PJM interconnection, which serves the largest territory of any regional transmission organization in the US, reported congestion costs of $750 million in 2004, $2 billion in 2005, and $1.6 billion in 2006. PJM notes that since 2002, congestion costs have come in at 7-10% of annual total billings.

As these figures make clear, the cost of inefficiency in the T&D system is significant. However, the impact of congestion



Source: NERC

is not limited to the cost associated with dispatching less economical generation. Often the situation requires grid operators to curtail service to consumers in some areas to protect the integrity of the grid as a whole. These "transmission loading relief" actions (TLRs) have increased dramatically in recent years, up nearly 150% just in the 2001-2005 period.

Clearly too there is an inference to be drawn from these numbers about the relationship between efficiency in the T&D system and the reliability of that system. In every region of the United States, for example, there are generation plants designated by the local grid operator as "reliability must-run" or RMR. These units are run regardless of their economic merit because their output is needed to maintain voltage levels. RMR units are often older, dirtier and less efficient than modern plants, due to the fact that they tend to be located in urban areas where siting new plants is all but impossible. There are alternatives to RMR generators (i.e., FACTS devices, which are described in a later section), but our current reliance on them can be viewed as a byproduct of a less-than-optimal T&D system.

DEMAND-SIDE ENERGY EFFICIENCY

The average person would likely point to energy consumption as the point where "efficiency" measures can be applied, and while our focus here is mainly on the supply side, it's worth noting a few examples to illustrate the impact of demand-side efficiency efforts.

Most people are probably familiar with the Energy Star program mentioned earlier, or with the increasing popularity of compact fluorescent light bulbs that use a fraction of the electricity used in conventional bulbs to produce the same amount of light. But the single largest consumer of electric power is the industrial motor, which is used to run everything from assembly lines to compressors to the fans that blow air into the combustion chamber of a coal-fired generator.

It is estimated that fully 65% of industrial power is used in motors of various sizes, most of which run at full speed whenever they are turned on, even if they don't need to. This is because the vast majority of industrial motors are controlled by drives that cannot alter the speed of the motor. Variable speed drives, also known as variable frequency drives, ramp the motor's speed up or down to meet the requirements at a given moment in time. The resulting energy savings can be enormous. VSDs can reduce consumption by as much as 60%, which in energy-intensive facilities can equate to millions of dollars a year in energy costs.

What's important to note here is the leverage that demand-side efficiency improvements can have when they a) greatly impact a small number of large energy consumers (e.g., VSDs), or b) have a more modest impact that is multiplied across many smaller energy consumers (compact fluorescent bulbs). Obviously, the former case is more easily realized than the latter, if only because there are relatively few people who need to be convinced of the value of the new approach. Consider, then, the potential of measures that enjoy the best of both worlds—a multiplicative effect combined with a small number of decision makers. That, in essence, is the main selling point for supply-side efficiency in the power system, and is where ABB has focused much of its technology and expertise. If a single utility implements a given technology across its entire system, thousands, if not millions, of customers come along for the ride.

IMPROVING EFFICIENCY IN THE T&D SYSTEM

One example of efficiency measures aimed primarily at the utilities that operate the T&D system is an initiative underway at the US Department of Energy to implement new efficiency standards for distribution transformers. These are the grey cylinders you see perched atop utility poles in residential neighborhoods, and the metal-housed units placed on cement pads at ground level. There are over 40 million distribution transformers in service today in the United States. They are among the most ubiquitous and the most standardized pieces of electrical equipment, and for that reason make a prime target for improvements that can then be propagated across large areas.

The proposed standards will have a relatively modest impact on the efficiency of a given transformer, around 4% over current models. However, when this incremental gain is multiplied across the thousands of units operated by even a small utility, the result is impressive. The Department of Energy expects to issue a final rule on the new standard later this year with implementation set for 2010.

There are other initiatives at the distribution level, but if we focus our attention on the measures that have the greatest potential for improving efficiency, we inevitably must look to transmission. There are numerous technologies that are already being applied to boost efficiency in transmission, and still more that have yet to reach full commercial implementation. In the following sections, we explore some of these technologies.

HVDC

Most of the transmission lines that make up the North American transmission grid are high-voltage alternating current (HVAC) lines. Direct current (DC) transmission offers great advantages over AC, however: 25% lower line losses, two to five times the capacity of an AC line at similar voltage, plus the ability to precisely control the flow of power. Historically, the relatively high cost of HVDC terminal stations relegated the technology to being used only in long-haul applications like the Pacific DC Intertie, which connects the vast hydro power resources of the Columbia River with the population centers of Southern California.

With the advent of a new type of HVDC, invented by ABB and dubbed HVDC Light, the benefits of DC transmission are now being realized on much shorter distances. The Cross-Sound Cable connecting Long Island and Connecticut is one example of this technology.

FACTS DEVICES

A family of power electronics devices known as Flexible AC Transmission Systems, or FACTS, provides a variety of benefits for increasing transmission efficiency. Perhaps the most immediate is their ability to allow existing AC lines to be loaded more heavily without increasing the risk of disturbances on the system. Actual results vary with the characteristics of each installation, but industry experience has shown FACTS devices to enhance transmission capacity by 20-40%. FACTS devices stabilize voltage, and in so doing remove some of the operational safety constraints that prevent operators from loading a given line more heavily. In addition to the efficiency gains, these devices also deliver a clear reliability benefit.

GAS-INSULATED SUBSTATIONS

Most substations occupy large areas of land to accommodate the design requirements of the given facility. However, each time power flows through a substation to step down the voltage, more energy is lost as the power flows through the transformers, switches and other equipment. The efficiency of the lower-voltage lines coming out of the substation is also markedly lower than their high-voltage counterparts. If power can be transmitted at higher voltage to a substation that is closer to where the energy will be consumed, significant efficiency improvements are possible.

Gas-insulated substations essentially take all of the equipment you would find in an outdoor substation and encapsulate it inside of a metal housing. The air inside is replaced with a special inert gas, which allows all of the components to be placed much closer together without the risk of a flashover. The result is that it is now possible to locate a substation in the basement of a building or other confined space so that the efficiency of high-voltage transmission can be exploited to the fullest extent.

SUPERCONDUCTORS

Superconducting materials at or near liquid nitrogen temperatures have the ability to conduct electricity with near-zero resistance. So-called high temperature superconducting (HTS) cables now under development, which still require some refrigeration, can carry three to five times the power of conventional cables. The losses in HTS cables are also significantly lower than the losses in conventional lines, even when the refrigeration costs are included. A major vendor of superconducting conductors claims that the HTS cable losses are only half a percent (0.5%) of the transmitted power compared to 5-8% for traditional power cables. Superconducting materials can also be used to replace the copper windings of transformers to reduce losses by as much as 70% compared to current designs.

WIDE AREA MONITORING SYSTEMS

Much of the transmission system could feasibly be operated at a higher loading, were it not for reliability concerns. However, if operators were given the ability to monitor grid conditions more precisely and in real time, some of these constraints would be removed. One example relates to the simple fact that when transmission lines heat up, the metal becomes pliable and the lines sag, which can cause a short circuit if they come into contact with a tree or other grounding object. Wide area monitoring systems (WAMS) have many promising capabilities, one of which is line thermal monitoring. With this functionality, transmission operators could conceivably change the loading of transmission lines more freely by virtue of having a very clear understanding of how close a given line really is to its thermal limits.

OTHER PATHS TO IMPROVED EFFICIENCY

The technologies outlined above represent only a few of the many available options for improving energy efficiency in the T&D system. The Business Roundtable's Energy Task Force T&D working Group, which ABB chairs, recently published a list of efficiency-enhancing actions and technologies, some of which include:

- Distributed generation/Microgrids
- Underground distribution lines
- Intelligent grid design (smart grids via automation)
- Reduction of overall T&D transformer MVA
- Energy storage devices
- Three phase design for distribution
- Ground wire loss reduction techniques
- Higher transmission operating voltages
- Voltage optimization through reactive power compensation
- Asset replacement schedule optimization
- Distribution loss reduction via distribution automation
- Power factor improvement
- Load management (e.g., smart metering for price-sensitive load control)
- Power electronic transformers

These options vary in terms of expense and the changes they imply for equipment purchasing or operational practices. We list all of them here simply to illustrate the many ways in which greater energy efficiency in the power grid can be achieved.

BENEFITS OF IMPROVED EFFICIENCY

The "business case" for energy efficiency is fairly straightforward: using less energy means paying less for energy. But a simple cost-benefit analysis might overlook some very important benefits that efficiency brings.

At this point, there is little doubt that regulation of carbon dioxide is coming, with the power sector as a primary target. While there are technologies both available and in development to mitigate CO2 emissions from power plants, the fact remains that the easiest ton of CO2 to remove from the atmosphere is the one that is not emitted in the first place. Greater energy efficiency in the T&D system means lower emissions in generation to deliver the same amount of consumed energy.

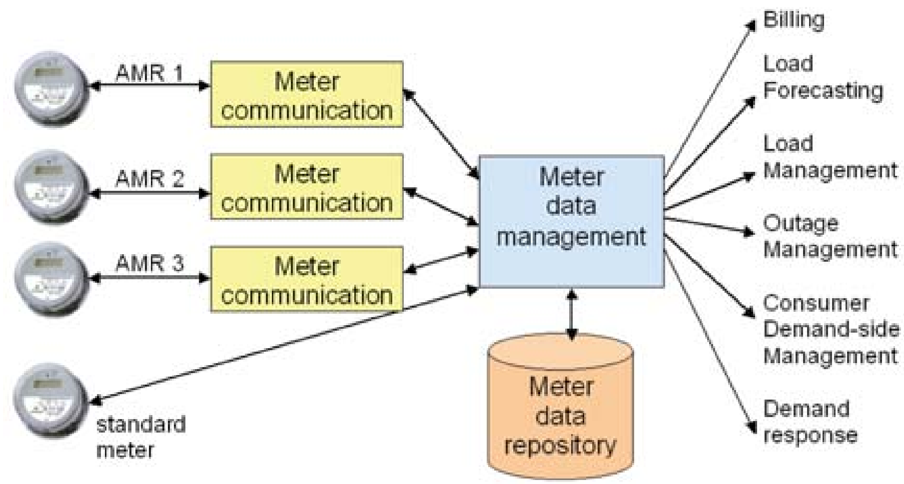
Fuel conservation and diversity is another strong selling point for efficiency, and here the benefits extend well beyond economic and even environmental considerations. Reducing US dependence on foreign fuel supplies — be they oil, natural gas or even coal — pays obvious dividends from a security standpoint, and the less we use, the less we have to buy.

Finally, within the context of the power system itself, it's important to recognize how interrelated energy efficiency is with grid reliability. In many areas of the U.S., transmission constraints have reached the point where they not only cost consumers billions of dollars in congestion charges, they threaten the integrity of the power system itself. Over the past twenty years, the situation has continued to deteriorate to the point where now the question of installing a new line is nearly moot in some locations. By the time it was completed, demand would long since have outstripped the ability of the local grid to meet it, so a short-term solution must be implemented in the interim.

FACTS devices offer a good example of how efficiency and reliability improvements often go hand in hand. Unlike siting and building a new transmission line, FACTS devices can be implemented quickly (less than a year from purchase to completion in some cases). They immediately boost the transmission capacity of the given line while also providing voltage support and bolstering the local grid's ability to withstand disturbances.

As the reliable supply of energy, especially electric energy, continues to grow in importance, the potential impact of energy efficiency cannot be overstated. With the array of technologies and methodologies now available, efficiency stands ready to play a much larger role in the energy equation.

SMART METERING FOR ELECTRIC UTILITIES



An Advanced Metering Infrastructure (AMI) facilitates the movement of meter data across the organization.

Should utilities replace current consumption meters with "Smart Metering" systems that provide more information to both utilities and customers?

This question is one of the most hotly debated in today's utility industry. It is complicated by the fact that there is no single definition of Smart Metering and that no single definition works well within all market structures. It is also complicated by differing views on the value of additional information to customers and utilities.

SMART METERING DEFINED

Because there are so many current definitions of Smart Metering, let us begin by defining what it is not. Smart Metering is not:

• An electromechanical single-read or time-of-use meter that displays consumption totals read periodically by a human meter reader.

• An Automatic Meter Reading (AMR) system in which meters communicate their monthly or daily consumption totals to a central collector using one of a number of different communications techniques, such as radio signals, powerline communications, or satellite reads.

In today's global utility industry, Smart Metering generally indicates the presence of one or more of the following:

• Any consumption meter linked to a device that informs the customer in real time about current use, consumption during a specific period, consumption trends, and/or other information designed to help the customer manage energy and water costs and usage.

• Interval meters that measure consumption during specific time periods (e.g. every 15 minutes, every hour) and communicate it to the utility at least daily.

• A one-way communications channel that permits the utility, at a minimum, to obtain meter reads on demand, to ascertain whether energy or water is flowing through the meter and onto the premises, and to issue commands to the meter to perform specific tasks such as disconnecting.

Some in the industry further restrict Smart Metering by requiring:

• A two-way communications channel between the utility and the meter that can be activated from either end.

• Stand-alone data collection and processing software, such as a Meter Data Management application. This isolates the existing billing system from the increasing meter data volumes that smart metering introduces.

• Deployment of an advanced application over a substantial percentage of a customer class. Those applying this restriction do not see the use of interval billing by a few large industrial customers as Smart Metering, generally because these programs may use individually contracts administered by key account representatives and do not necessarily rely on the highly sophisticated software applications required when large numbers of customers use interval billing.

Some analysts equate Smart Metering with Advanced Metering Infrastructure (AMI), a hardware and software system that includes meters on one end and data-using applications on the other.

WHY USE SMART METERING?

Information to the Customer

The simplest form of Smart Metering gives the customer real-time consumption information via a display device that translates the meter reading into a form the customer can easily understand. The goal of this device is to help customers to change their consumption, should they wish to do so, without having to wait for the end of the month or the end of the quarter to view the results from conservation initiatives. Displays tailored to the specific needs of the user, such as those comparing current use with neighborhood averages or with consumption in previous months, may help consumers further focus on conservation.

Some utilities have offered this sort

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Energy Usage Trends and Analysis

Smart Metering
Continued from Page 14

of display equipment for sale or as a promotion. The European Union (EU), in both the Measuring Instruments Directive and in Article 13 of the Energy End Use Efficiency and Energy Services Directive, has mandated this sort of information provision to customers. EU members, however, have been somewhat slow to implement this policy.

Information about the long-term effects of this equipment on consumption is not readily available.

Information to the Utility

Utilities can use time-of-use or interval data to better analyze and manage supply portfolios and the scheduling of generation or supply withdrawal from storage fields or reservoirs.

Interval data matched to customer type and location is particularly helpful in identifying needs for network or pipeline repairs or changes. It can also point to the location and size of leaks or theft.

Some Smart Metering systems permit meters to send "last gasp" messages when they are going out of service. These help utilities identify the location and extent of an electrical outage or a break in a water or gas main.

Utility Cost-Cutting Initiatives

Utilities frequently use a Smart Metering communications network to obtain an offcycle, "final" meter read for customers moving or leaving the area. It is common to couple these real-time final meter reads with web sites for on-line bill payment or with call centers that accept payment over the phone. Utilities frequently find it is easier and less costly to obtain rapid final payments from customers before they leave the area.

Remote meter disconnects are another cost-saving feature of many Smart Metering systems. These reduce the costs to send field crews to the premises of customers who have either requested a disconnect or who are being disconnected (or ratcheted back) for bill nonpayment.

Smart Metering applications often permit utilities to check meter status ("ping the meter") prior to sending a repair crew in response to a customer call. These checks prevent needless field crew dispatch to customer sites where problems are not the utility's responsibility.

Most Smart Metering applications permit remote theft-detection tests geared to the type of meter and the type of utility service. They can ensure that almost all bills are based on actual meter reads rather than on estimates; this reduces calls to the contact center and improves customer satisfaction.

New Products and Services

Smart Metering systems can frequently accommodate prepayment meters with multiple options for payment, such as recharging or via Internet or telephone, and with emergency overrides. Some utilities are looking at the possibility that a single prepayment meter for gas, water, and electricity may bring down the total cost of prepayment and permit utilities to respond cost-effectively to an option many consumers request as a tool to help them budget.

SMART METERING FOR ELECTRIC UTILITIES

Cost Reduction through Demand-Response Programs

Demand-Response programs are designed to solve two interlocking problems of today's electricity industry:

• Peak wholesale prices that raise the average price customers must pay for electricity.

• Peak grid use that creates blackouts and the need for costly grid expansion.

The Cost Issue

Electricity costs are rising in most markets because rising demand is outpacing supply. In some regions, peak demand is growing at twice the rate of overall energy usage. The problem is particularly acute in electricity because:

• Environmental regulations slow or prohibit the development of fossil-fuel generating plants and hydropower in some areas.

• Non-hydro renewables in most regions provides an inadequate substitute for fossil fuels and hydropower because of problems in dispatchability, distance from major population centers, cost, and technical inefficiency.

In some markets, private generation companies exist to fill gap between supply and demand with generation priced at hundreds or thousands of times the usual wholesale price of electricity in that market.

Distributors and retailers must purchase this generation because of their regulatory or contractual "obligation to serve" — that is, under a requirement to provide as much electricity as customers demand. Current electricity market norms, however, often make it difficult for both regulated utilities and retailers to recover the full cost of high-priced peak generation.

Exposing Customers to Peak Prices

Demand-Response programs solve this problem by exposing customers to these volatile peak generation prices. Customer consumption is measured in intervals that can each, in theory, carry a price that reflects the distributor's or retailer's wholesale electricity price plus overhead.

Demand-Response may involve direct participation in the wholesale market for the very largest industrials. The vast majority of electricity users, however, choose among various utility-designed Demand-Response pricing schemes. Prices may vary throughout the day on a regular schedule altered monthly or seasonally.

Utilities may also build in "critical peak" pricing periods that coincide with periods of anticipated high demand. These are generally scheduled a day in advance. Customers using electricity during these periods pay prices considerably higher than the norm. Because customers reduce consumption in response to these prices, distributors and retailers do not have to buy as much generation as they otherwise would to fill the gap between demand and their contractual supply.

That lowers the peaks and reduces peak prices.

Reducing peaks has a simultaneous effect on the grid, lowering the need for capacity to service peak use.

In electricity, Demand-Response programs are a primary driver behind Smart Metering. Their success with large industrial and commercial customers is proven and popular, and their use with residential customers is growing.

Outage Detection and Grid Efficiency

Communications from the meter permit utilities to identify outages rapidly and to pinpoint the location of outages and nested outages.

They also permit utilities to follow up to check that outages have been resolved at every meter location.

Analyses of interval meter data avoid grid over-engineering, and refine load balancing and forecasting. They help engineers identify and resolve bottlenecks and other inefficiencies, thus increasing overall throughput. This, in turn, lowers the need for additional capital investment in poles and wires.

The ability to pinpoint blink-outs can result in marked cost reductions in vegetation management. Similarly, Smart Metering's help in identifying voltage fluctuations permits utilities to resolve these problems rapidly and improve customer satisfaction.

Net metering

Many jurisdictions require utilities to reimburse customers for electricity they produce on-site and feed back into the grid. The mechanism for accomplishing this is generally known as "net metering" because, typically, utilities subtract the amount of electricity produced from the amount of electricity the customer draws from the grid.

The customer then pays (or receives) the "net" of that calculation.

The net metering terminology generally covers programs that spring from the concept of customer-produced energy even when the mechanism is not a "net" bill. Electricity fed into the grid may be monitored separately from the customer's consumption meter, and that generation may be separately reimbursed.

Some analysts posit a future in which batteries from parked cars will feed electricity into the grid.

Smart Metering is not a requirement for net metering. It significantly enhances the utility's ability to use customer production, however, by permitting the utility to monitor its flow into the grid in real time. Interval metering also permits a utility to reimburse a customer at the price prevalent on the wholesale market at the time the customer generated the electricity.

Environmental Improvements

Some environmentalists argue for Smart Metering on the grounds that it will improve the environment. Arguments include the following:

• Consumers who become more aware of their use through on-premises real-time displays will explore ways to reduce consumption.

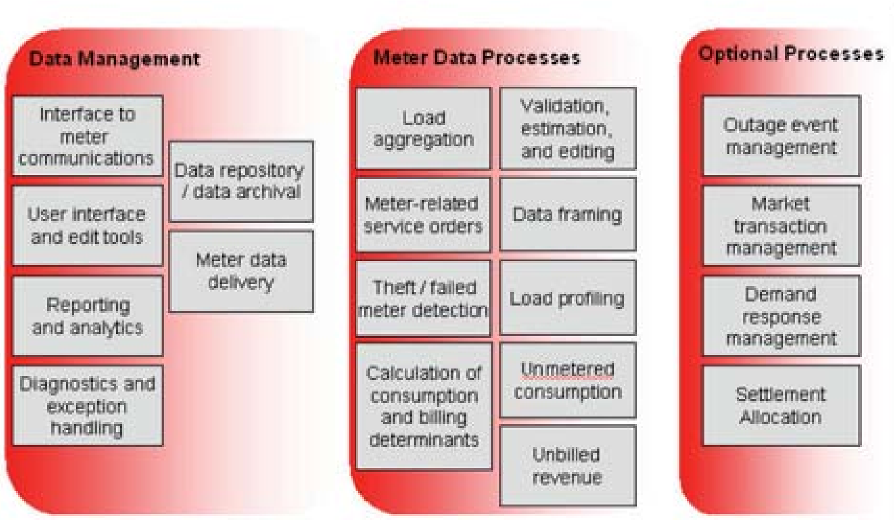
• Time-of-use rates encourage customers to shift use to take maximum advantage of base-load electricity. This reduces greenhouse gas production.

• Time-of-use rates also help even out grid use and thus reduce the need for habitat- and landscape-damaging grid expansions.

• Smart Metering adds additional tools to help maximize use of the existing grid and further reduce the need for environmentally damaging grid expansion. Analysis of interval data, for instance, permits engineers to fine-tune the grid and increase its capacity without running the risk of blackouts or voltage fluctuations. Two-way communications plus additional equipment can, with customer consent, permit utilities to turn down or off household appliances or business equipment when demand rises to clog grids.

Smart metering can also reduce a utility's use of truck fuel that would otherwise be burned to:

- Transport field crews connecting and disconnecting meters.
- Respond to a "no service" call from consumers whose problems are not the fault of the utility.
- Search for the sources of outages.



Meter Data Management typically encompasses a number of related functions.

ISSUES IN SMART METERING

Where Should We Locate System Intelligence?

There is a continuing debate in the utility industry as to whether smart metering intelligence should be distributed or centralized.

Initial discussions of advanced metering tended to assume intelligence embedded in meters. Distributed intelligence seemed part of a trend, like "smart cards", "smart locks", and scores of other everyday devices with embedded computing that empowers consumers.

Embedding intelligence in the meter also made sense in an era when utilities traditionally handled meter data within the billing system. While some of today's robust billing applications are capable of handling the increase in data volume, it may be more efficient to handle the data demands of non-billing departments separately from the billing system.

Of course, placing intelligence in the meter may be equally or more costly.

Industry consensus appears to be coming down on the side of centralized intelligence. Why? Because while data processing for purposes of interval billing can take place in either distributed or central locations, other applications for interval data and related communications systems cannot.

Who Owns the Meter?

In regulated markets, this question rarely arises. Tradition dictates that utilities own the meter and have full responsibility for its proper functioning.

The question is far more difficult in deregulated markets, however. If deregulation is based on a concept of a retailer as "owning" the customer, one must then answer such questions as: How will the retailer recoup the investment when customers can readily change suppliers? How will retailers entice customers to switch to a time-based rate if the customer doesn't know their consumption pattern before the smart meter is installed? Few retailers have been willing to install smart meters in the face of these difficulties, and customers have, understandably, been unwilling to switch to a new supply scenario without an upfront savings guarantee.

One answer might be that retailers would be ordered to implement these meters.

That undermines the concept, however, of a fully competitive market operating under regulations similar to those governing all businesses within a jurisdiction. It also begs additional questions like a retailer's ability to "recover" the cost of the new meter from the customer — a concept foreign to most competitive businesses.

A second alternative requires customers to buy and install interval meters. But the question then becomes: who is prepared to deal with millions of customers calling on an individual basis to order and pay for such a meter and to make arrangements for its installation? The complex logistics and costs of such a plan make it seem impractical from the outset.

Might regulators order a still-regulated distribution entity to install interval meters at every customer site and to recover the costs through distribution customer charges?

Many jurisdictions in North America and Europe are actively pursuing this solution.

Who Owns the Data?

In traditional, regulated utility models, utilities generally own meter data and can use it for any purpose approved by regulators, so long as they guard individual rights of privacy.

It is common, however, for deregulating jurisdictions to grant meter data ownership to customers. Customers grant data access to a chosen retailer or supplier as a condition of receiving supply.

Some see customer ownership of data as an impediment to full use of Smart Metering data. In some jurisdictions, advocates argue that customers should have the right to limit access to their data or should be compensated by parties using it.

Jurisdictions moving forward with Smart Metering under both regulated and deregulated market conditions appear to resolve the issue by specifying conditions under which the var-

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Smart Metering

Continued from Page 18

ious entities within the utility industry may access and use customer data.

Can Ownership Arguments Be Resolved?

The arguments above regarding data and meter ownership may seem humorous or trivial. But they can have a significant bearing on the extent to which Smart Metering can incorporate a variety of programs with the potential to conserve water and energy and to reduce utility costs.

One could argue, for instance, that the reason Britain's Ofgem has limited Smart Metering objectives to "reducing greenhouse gas emissions, maintaining security of supply and tackling fuel poverty" is because its system of meter ownership by retailers does not permit the broader programs possible in regulated jurisdictions.

Given this situation, it is difficult to imagine how interval metering and two-way communication between utility and meter could prove cost-beneficial.

HANDLING DATA VOLUME

Smart Metering inevitably increases the amount of meter data utilities must handle.

In the residential arena, for instance, hour-long intervals that replace monthly consumption totals replace 12 annual reads per customer with 8,760. That's a 730-fold increase.

What hardware and software can handle that volume? And what new procedures will ensure that data processing flows smoothly?

The answers to those questions spring, in part, from current utility organizations. In most utilities today, billing departments "own" metering data because the primary use of monthly consumption is to bill customers. While other departments have sought data access, few legacy billing systems were able to provide it in the time or form needed.

Modern billing systems can more easily provide data to other departments. But the pressure to do so in a timely and complete manner increases when a utility moves to interval metering. Departments using the data to address load size and shape, monitor voltage, or receive outage signals cannot wait for days or weeks for the billing system to supply the needed data. At the same time, forcing the billing department to respond quickly to demands of other departments may slow bill production and the associated utility cash flow.

Meter Data Management

An alternative way to handle data volume and multiple data requests is to offload it into a stand-alone meter data management (MDM) application.

MDM gathers and stores meter data. It can also perform the preliminary processing required for different departments and programs. Most important, MDM gives all units equal access to commonly held meter data resources.

Meter data management provides an easy pathway between data and the multiple applications and departments that need it. It can more easily consolidate and integrate data from multiple meter types. It can reduce the cost of building and maintaining application interfaces. And it provides a place to store and use data whose flow into the system cannot be regulated, such as the flood of almost simultaneous messages from tens of thousands of meters sending a "last gasp" during a major outage.

MDM's independent service function may be further refined through the addition of a meter data warehouse. In situations where both exist, the MDM typically manages real-time, transactional processing while the warehouse handles data extraction, reporting, and analytical processing.

Separating the MDM from the billing solution has clear advantages. It maintains bill production efficiency while providing even-handed data access to all departments.

It permits a utility to add security to meter communications and data without complicating customer access to bill payment and analysis websites. And it lets utilities change the source of the meter data with no negative effect on other IT systems and architecture.

The IT Implications of Meter Data Management

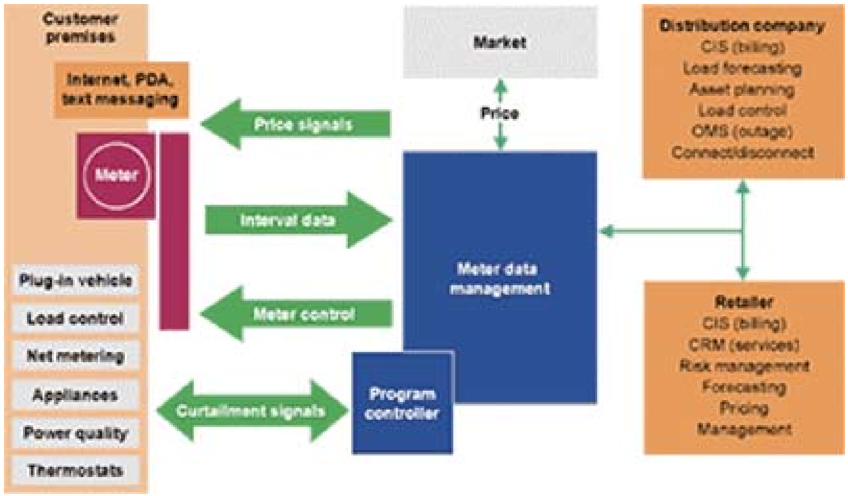
MDM is, for most utilities, a new type of application. It shatters the typical utility IT model in which each department "owns" its own set of applications.

MDM treats every department as its "owner". It thus forces departments to work together. If MDM is to serve all equally efficiently, then the various stakeholders must share information. They must agree to application configurations that serve all needs optimally.

This process of information sharing is proving eye opening to departmental heads.

Suddenly, sharp minds have the knowledge and tools to propose better, more efficient program administration.

In other words, MDM is becoming an avenue for rethinking utility business processes independent of existing departmental boundaries. It is the first major utility silo-breaking application.



Smart metering is an entire system that supports many customer and utility uses. Source: Energy Insights, Smart Metering Update, June 2007.

Adoption of MDM

The MDM concept is rapidly catching on. A new Chartwell study finds that 15 percent of utilities with fewer than half a million customers and 17 percent of those with more are already using MDM as metering data repositories. Even more startling for such a relatively new idea, 47 percent of the largest utilities are in the planning stages of MDM, and another 35 percent are considering the approach.

Movement toward MDM is considerably less marked at smaller utilities. The same study shows that 89 percent of utilities with fewer than 100,000 customers currently use their billing/customer care (CIS) systems as meter data repositories and that most (62 percent) are not even considering a change at this point.

Chartwell provides an explanation when it compares cooperatives in its study with large investor-owned utilities: Cooperatives are smaller and therefore have fewer metered end-points. They have smaller budgets and fewer back-office business requirements and needs.

A larger IOU with more than one million customers typically will have several departments staffed with specialized

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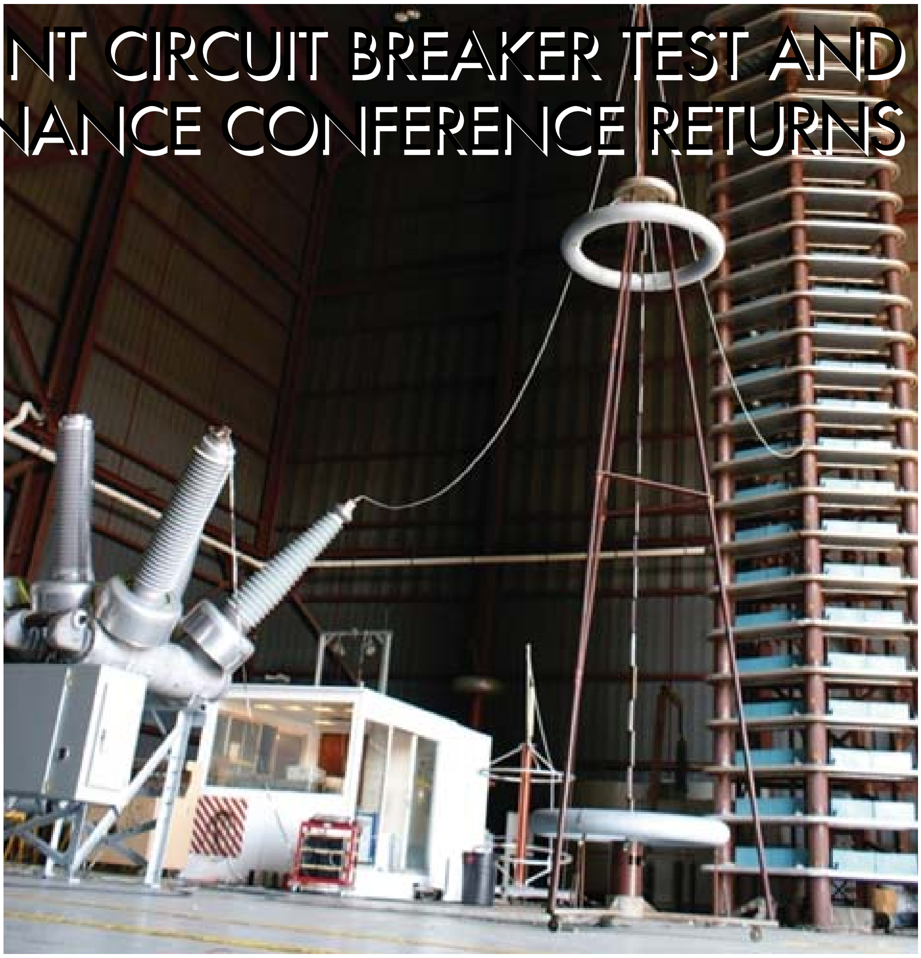
FINEPOINT CIRCUIT BREAKER TEST AND MAINTENANCE CONFERENCE RETURNS

By Don Horne



Factory Day - a full-day tour at a circuit breaker manufacturing plant - has been a unique feature of the conference since 1996. This year's conference runs from October 6-10 in Pittsburgh, Pennsylvania

In 1994 Finepoint inaugurated the annual Circuit Breaker Test & Maintenance Conference, the electric power industry's premier event for substation/switchgear maintenance personnel.

Participants receive practical training from users' perspectives, learn factory authorized test and maintenance procedures, network with their peers, and view cutting-edge products at the supplier exhibits each evening in the hospitality rooms. Over 600 delegates attended the 2007 conference, representing 239 different companies, 46 states, and eight countries. The conference provides attendees, speakers, and exhibitors with a high quality, low key opportunity to exchange information with their peers and learn from the experts.

Many conference topics focus on low-, medium-, and high-voltage circuit breakers. However, related substation and switchgear topics such as power transformer maintenance, oil testing and filtration, SF6 gas handling, safe work practices, and asset management issues are also covered. Finepoint's objective is to provide useful, unbiased, non-commercial, and positive information that can be immediately applied to substation and switchgear maintenance work. One unique aspect of the conference is that most speakers are the electric utility and testing company delegates themselves, not suppliers.

The four-day conference begins the first Monday of each October with a welcoming reception that evening. The factory day is on Tuesday. The expo of supplier exhibits debuts Tuesday evening and is also open to participants Wednesday and Thursday evenings. The conference presentations and training seminars are scheduled each year on Wednesday, Thursday, and Friday.

FACTORY DAY

The conference includes a day at the AREVA T&D facilities in Charleroi and the Mitsubishi Electric Power Products facilities in Warrendale, over a dozen useful substation/switchgear presentations, a Siemens BZO oil circuit breaker maintenance seminar, an outdoor air disconnect switch maintenance seminar, demonstrations of advanced testing procedures, and 90 supplier exhibits each evening in the hospitality rooms.

The full day at a circuit breaker manufacturing plant has been a unique feature of the conference since 1996. Participating manufacturers are ABB (Greensburg/Mt. Pleasant PA in 1996, 2000, 2005, and 2007), AREVA T&D (Charleroi PA in 1997, 2001, 2006, and 2008), HVB AE Power Systems (Suwanee GA in 2004), Mitsubishi (Warrendale PA in 1998, 2002, and 2008), Pennsylvania Breaker and Pennsylvania Transformer Technology (Canonsburg PA in 2007), and Siemens (Jackson MS in 1999 and 2003).

HALF-DAY TRAINING SEMINARS

In addition to more than a dozen presentations, each year the conference features two half-day training seminars at no additional charge. The 2008 conference will include seminars of vital interest to the electric utility industry. The "Siemens BZO Circuit Breaker Maintenance" seminar presented by Siemens is on Wednesday afternoon, October 8, and the "Maintaining Outdoor Air Disconnect Switches" seminar presented by Pascor Atlantic is on Friday morning, October 10.

Siemens PTI will be presenting the half-day training course on BZO6/6C Breaker Maintenance. Changes in workforce demographics have heightened the need to provide hands-on training in the installation, operation, and maintenance of power transmission and distribution equipment. The Siemens type BZO6/6C 121-145kV power circuit breaker maintenance training program is tailored to increase the knowledge of personnel responsible for the installation, operation, and maintenance of this equipment. Practical, rather than theoretical, training is emphasized, with actual involvement by attendees in problem solving. The training course will be taught by Jim Bradshaw who shares his 30+ years of field experience. Bradshaw has extensive experience with Siemens BZO, SDO, SP, SPS, SPS1, SPS2, TCP, LPO, and 3AT power circuit breakers.

Pascor Atlantic will be presenting the half-day seminar on the restoration of 30- to 40-year-old air disconnect switch equipment. Paul "PJ" Catron Pascor Atlantic Marketing and Customer Service Manager will delve into the advantages of bringing older equipment on systems around the world back to "like new" condition. This half-day session will be unlike any other given, as it will include the actual disassembly and rebuild of a set of switch "live parts". Catron will cover the process, procedure and materials required as well as insights on how to avoid missteps along the way to ensure a smoothly run refurbishment project. Catron has 25 years of experience in the outdoor air disconnect switch industry and has served as quality manager, materials manager, parts & service manager, engineering manager, field service technician.

He specializes in air disconnect switch application history. As the average age of EHV disconnect switches rapidly approaches 45 years, you will find this information useful in extending equipment life, while maintaining lower budget expenses and preventing unscheduled outages on your systems.

APPRENTICESHIP TRAINING RECOMMENDATION

Alliant Energy is a public utility holding company serving more than 1.4 million customers in Iowa, Illinois, Minnesota and Wisconsin. The company has an internal four-year substation apprenticeship program that relies significantly on the Finepoint Conference. If Mike Welsh of Alliant Energy had his choice of only one conference to send his company's apprentices to, it would be Finepoint's Circuit Breaker Test and Maintenance Conference. In fact, it is the main conference that Alliant's apprentices and journeymen attend for training and for continuing education.

"We feel the amount of knowledge that comes from the presenters and the conference in general make it useful as a training facility" said Welsh, the substation electrician foreman at Alliant. "It's the best one around the country we have found; Finepoint covers the gamut of everything inside the fence - everything that deals with substations." Each year the conference host asks for feedback in order to serve the attendees. Bill Myers, the president of Finepoint, continues to move the conference forward by listening and responding to suggestions. As a result, Alliant has been sending people to the conference for many years. Welsh said that they appreciate the total access to the session speakers. "They have the people there to answer your questions."

ASSET MANAGEMENT RECOMMENDATION

Knowledge about circuit breakers declines at most electrical utilities each year because of people in the industry retiring and because of the extended maintenance intervals of equipment, according to Charles Currin, senior engineering technical support specialist for Progress Energy. That's why Currin attends the Finepoint Circuit Breaker Test and Maintenance Training Conference each year. He has attended 11 of the 14 past Finepoint conferences and plans to participate again. His current role is in the Asset Management Department, Component Engineering Unit, serving as the transmission breaker component engineer for the Carolinas and Florida transmission grids for 69 kV and above voltage class equipment. His responsibilities include the development and implementation of maintenance procedures and programs, equipment repair and troubleshooting information, technical guidance and support to field maintenance organizations and other engineering units.

Currin says that many of the people he has met at the conference have become friends who are not only resources of information in the industry, but also people he can call on in times of need. He highly recommends the conference to all of his colleagues. Currin says, "This conference is a good tool for enhancing your breaker skills, learning about breaker issues, maintaining your breaker assets, and collaborating with other utility employees. You need to be willing to look and ask for information from other attendees. Interaction with peers is the biggest source of information at any conference. The nightly exhibits sponsored by various vendors offer great opportunities for interaction and conversation as an added benefit."

> This conference is a good tool for enhancing your breaker skills, learning about breaker issues, maintaining your breaker assets, and collaborating with other utility employees.

SUBSTATION MAINTENANCE RECOMMENDATION

As a substation maintenance engineer at FirstEnergy, Bob Sicker had attended seven Finepoint conferences to learn more about his field of expertise, transmission substation maintenance. In 2006 he was on the other side of the podium as a speaker at the conference. Bob does not usually do presentations at conferences, but he likes the focus of the Finepoint Conference. He started out as a substation maintenance engineer in 1980 at The Ohio Edison Company now a part of FirstEnergy. He spent a lot of time in the field, and eventually progressed to supervisor. FirstEnergy is headquartered in Akron, Ohio, and is the nation's fifth largest investor-owned electric system, serving 4.5 million customers within 36,100 sq miles of Ohio, Pennsylvania and New Jersey.

"My area of specific interest is substation major equiment, particularly breakers and transformers, and this is one conference geared specifically to that equipment," he said. "Probably 80% of the topics are circuit breakers, and the rest are transformers or related equipment." He says that broader-based seminars try to "be everything to everybody" and so there are always several subjects that don't interest him. He can maximize his time at the Finepoint Conference because the topics are on target, and the vendors are focused on the same subjects. "It's where I generally update my card index every year because the majority of the breaker manufacturers are there, and the related companies or test equipment and services are all there at one place at one time.

"I recommend this conference to anyone in the utility industry who has involvement with transmission substations, because it is focused on that and because of the utility people that you will meet."

NUCLEAR POWER STATION RECOMMENDATION

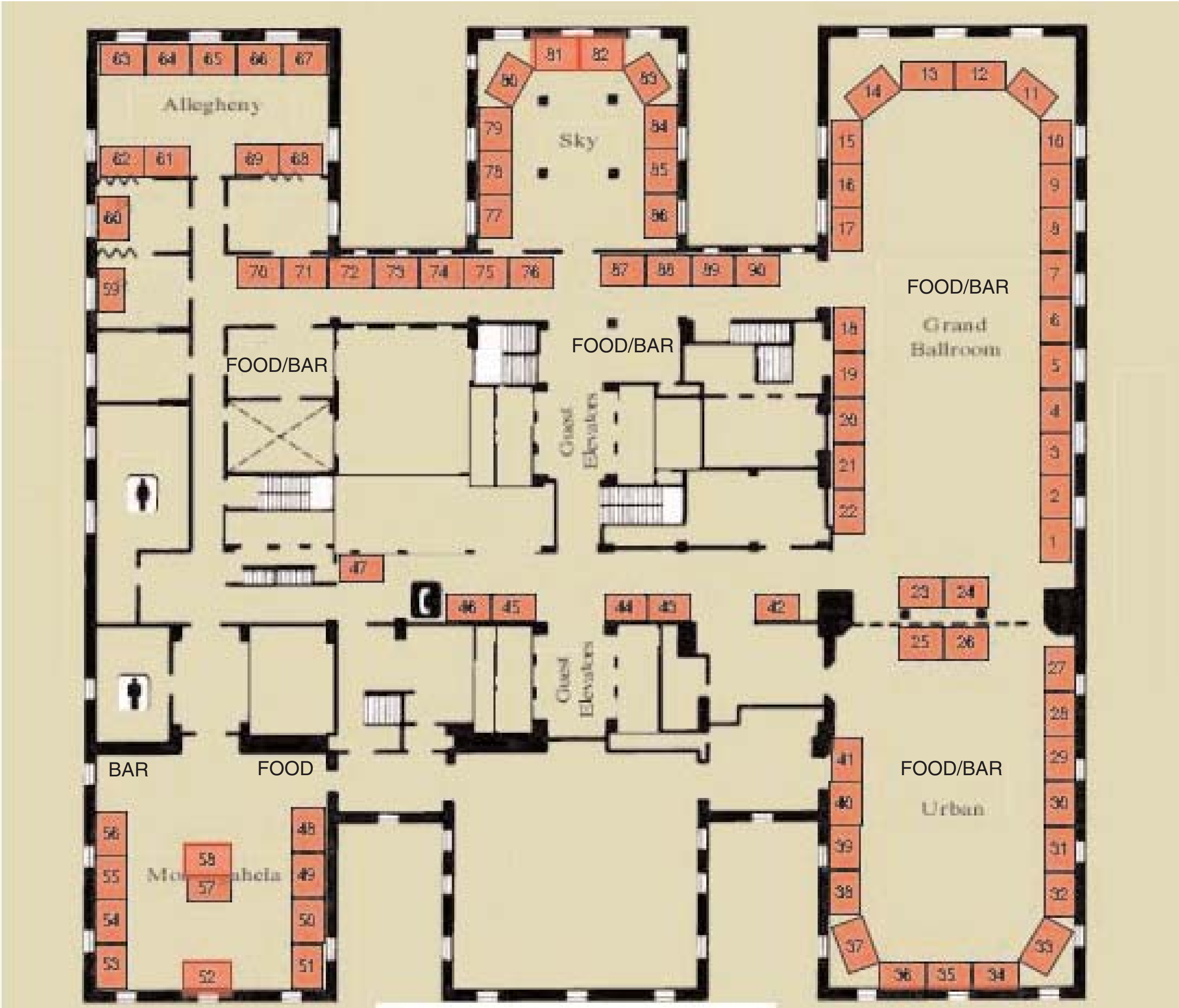
The nuclear side of the electric power industry is represented at the Finepoint Conference. Dennis Hudson, nuclear maintenance supervisor at Duke Energy, has attended several of the conferences and has presented papers on circuit breaker timing. He is one of the maintenance supervisors of a crew responsible for the inspection, maintenance, and repair of the Duke Energy nuclear switchyards' HV circuit breakers, GSU and auxiliary transformers, bus, switches and associated switchyard apparatus.

He has attended several other conferences and says that "the Circuit Breaker Test & Maintenance Conference is by far the most informative conference available and has been since 1994." One of the greatest benefits of the conference for him is that many of the people attending the show are field technicians who have the hands-on expertise. He said that much information is shared among the technicians from various utilities worldwide. "I've spent many hours in the evening after the presentations, networking, swapping stories and sharing tricks of the trade, so to speak," he said. But the best attribute of the conference is the information presented in the sessions, according to Hudson. He feels the presentations are understandable and the knowledge can be applied to his own maintenance practices.

"Never, have I failed to bring something back from this conference that I can't apply to my job." Hudson continues to attend the conference even though it is held in the fall, the busiest time of year for nuclear stations. Duke's nuclear stations are in refueling outage, and the plant-related apparatus maintenance has to be performed during shutdown.

Booth and Exhibitor List

Booth -	Exhibitor				
		10-	Normandy Machine	21-	Vanguard Instruments
		11-	Albarrie	22-	Waukesha Electric Systems
1-	E Manufacturing	12-	CZAR	23-	Phenix Technologies
2-	Filmax	13-	PCORE Electric	24-	DILO
3-	Enervac	14-	Voyten Electric	25-	Siemens
4-	Delta Instrument	15-	PEARL	26-	Siemens
5-	Power Substation Service	16-	ABB Mt. Pleasant	27-	ROHE International
6-	Megger	17-	Concorde Specialty Gas	28-	Breaker Service
7-	Megger	18-	Omicron	29-	Trantech Radiator Product
8-	COSA Instrument	19-	Southwest Electric	30-	Vacudyne
9-	National Breaker Services	20-	Filtration Solutions	31-	AREVA T&D



Finepoint's 15th Annual
Circuit Breaker Conference
October 6-10, 2008

32- Polar Technology
33- Vacuum Electric Switch Co.
34- FLIR Systems
35- Velcon Filters
36- WIKA Instrument Corp.
37- Mitsubishi
38- Satin American
39- Solon Manufacturin
40- HVB
41- Reinhausen
42- Pascor Atlantic
43- UE Systems
44- ISA Test – ProgUSA
45- TEAM Industrial Services
46- American Electrical Testing
47- Trojan Dry-Out System
48- HICO America
49- Lambda Americas
50- Southern Switch & Contac
51- Noram-SMC
52- XEGsys
53- Square D Company
54- TJ/H2b
55- Qualitrol Company
56- FirstPower Group
57- InsulBoot
58- Pennsylvania Breaker
59- Jaker Engineering
60- ABB
63- Kelman
64- Parts Super Center
65- ProTec Equipment Resources
66- Solidification Products International
67- NRECA
70- Circuit Breaker Sales Co.
71- KoCoS America
72- Olympus
73- BCS Switchgear
74- Dow Corning
75- Adwel
76- FKI Switchgear
77- Shermco Industries
78- NETA
79- Powell Electrical Systems
80- AVO Training Institute
80- American Polywater
81- Ox Creek Energy Assoc
82- Doble
83- Kinectrics
84- North American Switchgear
85- Telogy
86- Thomas & Betts
87- Colt Atlantic Service
88- Electric Power Systems
89- Serveron
90- INCON

Smart Metering
Continued from Page 21

Likely Benefits	Benefit accrual of AMR systems (✓,✓✓, ✓✓✓ - Low, Medium, High)							
	Customers	Energy Supplier	Meter Operator / Management	Distribution	Transmission	Generation	National Governments	EU
Improved energy use visibility	✓✓✓	✓✓					✓	✓
Reduced metering costs		✓✓	✓✓✓					
Streamlined switching process	✓✓	✓✓✓					✓	✓
Reduced customer services / billing	✓	✓✓						
Better debt management	✓✓	✓✓						
Improved outage & demand management		✓✓		✓✓	✓✓	✓	✓	✓
Improved customer analytics		✓✓		✓	✓	✓	✓✓	
Improved load forecasting				✓✓	✓✓	✓✓	✓✓	
Improved investment decisions	✓		✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓
CO2 Reduction		✓		✓	✓	✓✓	✓✓	✓✓

Source: Datamonitor DATAMONITOR

In a study done for the European market ("The impact of smart metering on the Energy and Utilities market", June 2007), Datamonitor finds that advanced metering provides significant benefits across all energy-industry stakeholders.

employees that, with the advent of advanced metering, now have a stake in the data. On the other hand, a cooperative with 17,000 members will have fewer departments staffed with employees who have extra-departmental duties and tasks.

Expanding the Concept

Independent applications serving multiple departments are not, of course, the only software approach to breaking down departmental barriers. Application integration has long played a role, though its expense has prevented utilities from developing a full complement of data interchanges that could better pierce departmental barriers.

Far less successful were attempts to develop composite applications, popular a few years ago. Composite applications, consisting of individually addressed functional modules, were touted as a major breakthrough to cross-organizational business processing. Advocates foresaw a significantly lower total cost of ownership.

Software developers soon realized, however, that multiple applications calling on each other's functions more or less randomly were unlikely to facilitate cross-organizational business flow. A more probable result was computing resource chaos.

MDM avoids that chaos while also moving beyond simple software integration.

It did not originate as a conceptual computing innovation. Its origins were strictly pragmatic — the need to handle efficiently a potentially huge increase in data volume. It has evolved, however, into something much larger.

MDM, by providing both unique and common resources to multiple applications, has the potential to advance the quest for multi-departmental business process orchestration. If it succeeds in this role — as it very likely will — other functions may quickly follow suit. Scheduling, for instance, might be pulled out of asset management, field management, and appointment setting and consolidated into a single instance that serves multiple departments.

Multi-departmental applications like MDM, owned cooperatively among departments rather than individually, could thus be the "missing link" to facilitate the smooth flow of business processes across the organization. They could prove a process orchestration concept that increases the efficiency with which utilities serve all stakeholders.

WEIGHING SMART METERING'S COSTS AND BENEFITS

While discussion of smart metering abounds, many utilities hesitate when they see the large financial commitments involved and the uncertainties of customer response. Will they be able to recover the costs? Will they find themselves on the bleeding rather than leading edge of technology?

There are ways, however, to mitigate the risks involved.

Including All Potential Benefits

Smart metering may be hard to cost justify if it rests solely on customer acceptance of demand response. It is easier to cost-justify when it includes, for instance, the value of:

- Meter polling during outages.
- Remote programming that enables customers to use new products that might be offered by the utility or by a third party.
- Fewer meter readers, which means lower total costs for salary, benefits, and workers compensation.
- Remote rather than expensive and occasionally risky on-site disconnects.
- Less wasted time in attempts to pinpoint the size and source of an outage.
- Lower risk to public safety from downed power lines and lack of exterior safety lighting during outages.
- Better accuracy in the actual meter readings, resulting in fewer calls to the contact center.

Evaluating Pilots

Utilities normally test customer response to proposals like demand-response programs through pilots. Unfortunately, technology annuls are full of stories about successful pilots followed by unsuccessful products.

It's difficult to narrow the gap between a test and real life.

Pilots frequently protect participants from harsh financial consequences. And it's difficult for utility personnel to avoid spending time and attention on participants in ways that encourage them to buy into the program. Real-life program rollouts must include customers with sufficient customer support to successfully recruit customers.

Complicating the problem are likely differences between long-term and short-term behavior. The history of gasoline conservation programs suggests that while consumers initially embrace incentives to car pool or use public transportation, few make such changes on a permanent basis. As utilities travel this path, they must also include customer retention expenditures as a cost item.

Examining the experience of utilities in Italy or the U.S. states of California, Illinois and Idaho, which are gaining experience with large-scale Smart Metering and demand response programs, will provide additional information.

Developing the Business Case

Determining the cost-benefit ratio of Smart Metering is challenging. Some costs — meter prices, installation charges — may be relatively easy to determine. Others require careful calculations; when interval meters replace time-of-use meters, how does the higher cost of interval meters compare with the fact that they do not require time-of-use manual reprogramming?

As in any business case, some costs must be estimated:

• What is the break-even point for customers agreeing to a specific demand-response program? Will that number of customers sign up?

• How long will meters last under our specific conditions, and how well will they operate? How will we handle an unexpectedly large number of customer requests for meter testing?

• Will we undertake retraining of current meter readers, and what will that cost?

• Will Smart Metering help us retain customers we might otherwise lose?

• Can we offer new services, such as equipment efficiency analyses, and how much can we charge for them?

Because some utilities are already rolling out Smart Metering programs, it is increasingly easy to obtain real-life numbers rather than estimates to plug into your business case.

Considering Alternatives

Interval meters with two-way communications networks may not be the only solution for some Smart Metering objectives. Utilities may find it valuable to try lower-cost routes to some results, for instance:

• Customer charges to prevent unnecessary "truck rolls." Such fees are common among telephone service providers and have worked well for some gas utilities that found themselves responding to repeated false alarms from householder-installed carbon monoxide detectors.

• Time-of-use billing with time/rate relationships that remain constant for a year or more, giving consumers opportunities to make time-shifting a habit.

• Urging customers to use the time-shifting features on their appliances as a contribution to the environment. Most consumers have no idea that electricity goes to waste at night. Keeping air clean and transmission towers out of the landscape could be far more compelling to many consumers than a relatively small saving resulting from an on- and off-peak pricing differential.

• Month-to-month rate variability. One study found that approximately a third of the efficiency gains from real-time interval pricing can be captured by simply varying the flat retail rates monthly — and at no additional cost for metering. While a third of the efficiency gains might not be enough to attain long-term goals, they might be enough to fill in a shorter-term deficit, permitting technology costs and regulatory climates to stabilize before decisions must be made.

• Multi-tier pricing based on consumption. Today, two-tier pricing is common. Three or four tiers might capture the attention of at least some customers with particularly high consumption — owners of large homes and pool heaters, for instance—without burdening those at the lower end of the economic ladder. Tier structures, however, have proved difficult to explain, and month-to-month variability in consumption may hide the benefits from the average consumer.

CONCLUSION

There is every reason to believe that Smart Metering will replace most of today's electromechanical metering approaches within the foreseeable future. At today's prices, many utilities are constructing conservative business cases that foresee a relatively short five- to six-year payback period for Smart Metering investments.

Rapidly falling prices and the multiple advantages to both customers and utilities should make the systems even more compelling.

As a result, prudent utilities worldwide are increasingly factoring Smart Metering into long-term IT and customer-program strategies.

COMMITTEE CHAIRMAN MIKE DOHERTY EXPLAINS THE BIRTH OF CSA-Z462

By Don Horne

Canadian electrical workers are exposed to many daily hazards in the course of their work. Even so, until now there have been very few Canadian (i.e. Federal or Provincial) guidelines, Standards or Acts published to assist employers and employees to more effectively manage the electrical safety hazards or even to determine who is qualified to perform electrical work," according to Mike Doherty, Chairman of The Canadian Standards Association's (CSA) Z462 Technical Committee on Workplace Electrical Safety.

For this reason, since 2006 CSA has been developing CSA-Z462 - "Electrical Safety in the Workplace". CSA-Z462, which will be finalized in September 2008, will be released in December of 2008 and will eventually become a long-awaited Canadian national voluntary standard on electrical safety work practices for certain sectors.

CSA-Z462 specifies requirements for and provides guidance on safety management systems and safe work procedures for persons working on electrical equipment and electrical systems. It also provides direction on the selection of personal protective equipment and other safety devices for electrical workers and maintenance personnel. In addition, this standard sets out criteria for the identification and training of qualified electrical workers and for determination of hazardous work to be performed only by those qualified individuals.

CSA-Z462 has many additional features that are instructive and helpful to Canadian electrical workers and their companies who are responsible and liable for their health and safety.

There is more detailed information on:

1. Lockout
2. Detailed annexes (for information only) covering such things as hazard risk evaluation which provides an assessment of hazards and work practices in order to better understand and evaluate direct contact and arc flash/blast hazards.
3. Wearing of protective clothing.
4. Electrical Hazard labels and Arc Flash Shock labeling.
5. Details of simplified 2 Category clothing, PPE systems.

CSA-Z462 specifies requirements for and provides guidance on safety management systems and safe work procedures for persons working on electrical equipment and electrical systems.

6. New Annex – Documents in CSA-Z462 the importance of using recognized Occupational Heath and Safety Management Standards.
7. More detailed information on Arc Flash clothing which gives better guidance on Clothing, PPE requirements, and other electrical safety equipment such as insulated tools.
8. It is user friendly - user compatible with expanded information in how to determine Hazard Risk categories based on defined work practices and arc flash hazard levels.
9. It complements CSA-Z460, Canada's standard for Lockout and Hazardous Energy Control and has a new annex on Lockout and concepts surrounding a comprehensive Lockout and Hazardous Energy Control program.
10. Additional definitions covering workplace electrical safety with many revisions to existing definitions.
11. Important information on the layering of PPE clothing.
12. Metrification of all measurements.
13. Available in a French version in the Spring of 2009.

"CSA-Z462 has been developed in parallel with the 2009 Edition of NFPA 70E, and, based on an agreement with NFPA, an attempt will be made to harmonize Z462 with NFPA 70E as much as practicable for Canadian workplaces. As agreed with NFPA, CSA will be using the 2004 Edition of NFPA 70E as the "seed document" for the development of Z462. This common basis will help ensure that, right from the start, CSA-Z462 is harmonized with NFPA 70e. In addition, CSA-Z462 has been created in harmonization with the Canadian Electrical Code, as well as 'CSA Z460, Control of Hazardous Energy – Lockout and Other Methods', as well as with 'CSA-M421, Use of Electricity in Mines'," Mr. Doherty said.

"Once it has been published in both French and English, CSA-Z462 will be submitted to Standards Council of Canada for approval as a National Standard of Canada. As with any other CSA standard, the first edition of CSA-Z462 will initially be recognized as a voluntary best practices standard for use anywhere in Canada. In the future however, as CSA-Z462 gains acceptance, each province and the federal government may chose to reference it in occupational health and safety regulations, and thereby make it mandatory," he added.

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- September 22, 2008 - Dartmouth, NS
- September 23, 2008 - St. Johns, NL
- October 15, 2008 - Toronto, ON
- November 13, 2008 - Toronto, ON
- December 8, 2008 - Toronto, ON

CSA Z462 specifies requirements for and provides guidance on safety management systems and safe work procedures for persons working on electrical equipment and electrical systems. It also provides direction on the selection of personal protective equipment and other safety devices for electrical workers andmaintenance personnel. In addition, this Standard sets out criteria for the identification and training of qualified electrical workers and for determination of hazardous work to be performed only by those qualified individuals.

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CSA Z462 sets a new standard for Electrical Safety Training in Canada. It states that electrical safety training "applies to workers who face a risk of electrical hazard not adequately reduced in accordance with the electrical insullation requirements contained in Part 1 of the Canadian Electrical Code (CAN/CSA-C22.1) and, for mining operations, CSA-M421. Such workers shall be trained to understand the specific hazards associated with electrical energy". And that electrical workers "shall be trained in afety-related work practices and procedural requirements as necessary to provide protection from the electrical hazards associaed with their respective job or task assignments. Workers shall be trained to identify and understand the relationship between electrical hazards and possible injury".

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CANADIAN ELECTRICITY FORUM TO LAUNCH CSA-Z462 TRAINING

Canadian Electricity Forum is offering Canadian companies an advanced look at Canada's new Arc Flash/Electrical Safety Standard with a series of cross-Canada CSA-Z462 technical courses this September, based partly on NFPA70e and the final Draft Version of CSA Z462.

"This will be the first chance Canadian electrical professionals have to review the actual content of CSA-Z462 and see the differences and additions that have been made to NFPA 70e and how these changes and additions will impact on their electrical work practices. The Canadian Electricity Forum is a recognized provider of continuing education to Canada's electrical industry and serves the educational interests of Canadian electrical workers," said Randolph Hurst, president of The Canadian Electricity Forum.

"For Canadian companies, compliance with CSA-Z462 will not only help to prevent injury to their electrical workers, it will also protect them from potential legal action in the event of an accident investigation. Any investment in electrical safety is a bargain when compared to the cost of a legal defense in provincial court. In addition, if an electrical accident is serious enough to warrant criminal charges, a company may find itself in Canadian Federal court, charged under Bill C51 where it will need to prove it did everything possible to ensure the safety of its workers. The objective of compliance through training and integrating CSA-Z462 is to exercise "due diligence", Mr. Hurst added.

CSA-Z462 sets a new standard for Electrical Safety Training in Canada. Such workers shall be trained to understand the specific hazards associated with electrical energy."

And that electrical workers "shall be trained in safety-related work practices and procedural requirements as necessary to provide protection from the electrical hazards associated with their respective job or task assignments. Workers shall be trained to identify and understand the relationship between electrical hazards and possible injury."

CSA-Z462 also recommends that qualified electrical workers "be trained and knowledgeable of the construction and operation of equipment or a specific work method and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method. Also, that these workers "shall also be familiar with the proper use of the special precautionary techniques, personal protective equipment, including arc flash, insulating and shielding materials, and insulated tools and test equipment."

CSA-Z462 clearly states: "Such persons permitted to work within the Limited Approach Boundary of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:

(i) The skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment

(ii) The skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts

(iii) The approach distances specified in Table 1 and the corresponding voltages to which the qualified person will be exposed

(iv) The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.

(v) A worker who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those duties.

(vi) Tasks that are performed less often than once per year shall require retraining before the performance of the work practices involved

(vii) Workers shall be trained to select an appropriate voltage detector and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the worker to understand all limitations of each specific voltage-detecting device that may be used."

"The Canadian Electricity Forum's Arc Flash/Electrical Safety training course will instruct students in the importance of these skills and how to properly recognize the potential for electrical hazards and how to properly protect themselves from possible arc flash burns and injuries," Mr. Hurst added.

Basic CSA Z462 Arc Flash Awareness Tutorial 1-Day Course Dates

September 8, 2008 - Toronto, ON
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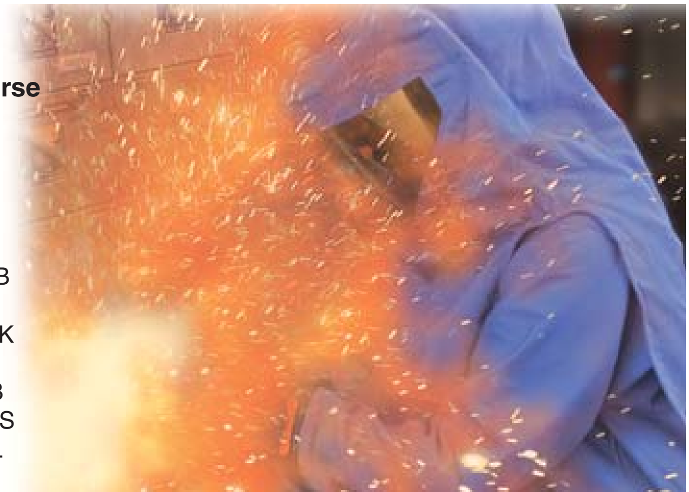
September 9, 2008 - Victoria, BC
September 10, 2008 - Ottawa, ON
September 11, 2008 - Edmonton, AB
September 15, 2008 - Calgary, AB
September 16, 2008 - Saskatoon, SK
September 17, 2008 - Regina, SK
September 18, 2008 - Winnipeg, MB
September 22, 2008 - Dartmouth, NS
September 23, 2008 - St. John's, NL
October 15, 2008 - Toronto, ON
November 13, 2008 - Toronto, ON
December 8, 2008 - Toronto, ON



CSA Z462 Arc Flash/Electrical Safety Training 1-Day Course Dates

September 8-9, 2008 - Toronto, ON
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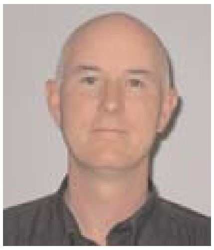


CSA-Z462: CANADA'S NEW ARC FLASH STANDARD IS YOUR ELECTRICAL SAFETY PROGRAM READY?

Q&A With Mike Doherty, Chairman of The Canadian Standards Association's (CSA) Z462 Technical Committee on Workplace Electrical Safety.

ET: What are the general areas of difference between NFPA 70e 2004 version and NFPA 70e 2009 version?

MD: Chapter 4 has been completely deleted. As well there have been many, many improvements and clarifications. Task Tables have been updated and improved. It will be one of the most significant upgrades in the cycles of NFPA 70E.

ET: Why is there a CSA Z462?

MD: There was a need expressed by different stakeholders across Canada to have a Standard that was more suited to the Canadian workplace in regards to referencing applicable Canadian Standards, etc.

ET: What are the main areas of difference between CSA Z642 and NFPA 70e?

MD: Basically as follows:
a) CSA formatting and style guide will give CSA Z462 a different look and feel than 70E.;
b) Article 120 on Lockout (OSHA) in 70E will be replaced by Clause 4.2 (Establishing an Electrically Safe Work Condition) in CSA Z462 based on CSA Z460 (Control of Hazardous Energy - Lockout & Other Methods);
c) 5 new Annexes (for information only) added to CSA Z462 that will not be in 70E.;
d) Many references to Canadian Standards are now included in CSA Z462;
e) The CEC will be referenced in CSA Z462.

ET: What will the impact of CSA Z462 be on Canadian electrical workers and their work practices?

MD: An increased awareness of the importance and rigor required for "Electrical Safe Work Practices" in Canada. It will be heightened and strengthened for those that have been using 70E and may in fact be something new for those that weren't using 70E.

ET: Will CSA Z462 become "law" in Canada. Many companies are confused about what CSA Z462 will mean to them.

MD: CSA Z462 is clearly a "national voluntary standard of Canada". Regulators in individual provinces will decide how to apply it across their jurisdictions as time progresses. Legislation is the "shall", CSA Z462 is really the "how". Due diligence and best case practices are the expectations for companies who perform electrical work. CSA Z462 offers a comprehensive "template" to accomplish that.

ET: Why should companies who have already been trained on NFPA70e also receive training on CSA Z462?? What will they learn that is new?

MD: They will receive all of the new NFPA 70E - 2009 changes which are substantial and impactful. Even without Z462 it would be critical to get this information. Z462 will impart the Canadian standards and references required to fully implement leading edge and comprehensive "Electrical Safe Work Practices" in a neat, organized and important package within the concepts of Canadian culture.

PLUGGING IN THE CONSUMER - PART I: DOES YOUTUBE INFER YOUENERGY?

By Michael Valocchi, Global Energy & Utilities Leader, IBM Global Business Services

Thanks to technology advances and a contagious groundswell of empowerment, industry by industry, "consumers" are taking on much broader, more involved roles than that term implies. Not only are they increasingly vocal and decisive about what they will or will not consume, they are, in many cases, moving back in the supply chain – becoming designers, producers, marketers and distributors of the products they once just purchased.

If it's difficult to imagine that trend moving to the energy industry, consider the changes in the media and entertainment business in recent years. Although these two industries are very different in many ways, consumer involvement in the energy business could follow many parallel paths.

Looking back, consumers in both industries started out as passive participants. Energy consumers used whatever type of energy their utility sent to the premises without worrying about how it was generated or the consequences of their consumption. Television viewers acted just as passively – watching whatever programs networks happened to be broadcasting on one of the few limited channel options at any given time. Control sat firmly in the hands of utilities and broadcasters.

But, in recent decades, the media and entertainment business has changed dramatically.

Cable and satellite provided viewers with hundreds of additional channel choices and niche programming. More recently, options such as digital video recorders, video on demand, video programming on mobile devices and online libraries of content have emerged, giving consumers more control over what, where and when they watch. Now, pockets of media enthusiasts are taking on new, more participatory roles – even producing their own content. The evidence of this evolution is quite clear in media – and, with the right conditions, a similar pattern could unfold in the utility industry (see Figure 1).

We believe the next five years will be pivotal for the energy industry. Consumer needs and roles are expanding, influenced to a large extent by the part consumers are now playing in other industries like media and entertainment. For utilities, this means revisiting long-held beliefs about how best to serve customers and making fundamental changes

Figure 1.
The rapid increase in consumer choice in industries like media and entertainment will shape consumer expectations for electricity providers.

	Television consumer	Electricity consumer
Passive	• Passive receipt of content • Limited sources of content generation • Major media companies exclusively control content • Provider-customer relationship one-to-many, driven by demographics and geography	• Passive receipt of power • Limited sources of power generation • Incumbent utilities exclusively control power generators • Provider-customer relationship one-to-many, driven by demographics and geography
Active	• Consumer interest drives new and more targeted choices in content • More interest in and leverage of information on quality indicators for content (e.g., TV program rating systems) • Broader choice of providers drives more active role in provider selection • Consumer does not control content, but has stronger influence via choices • Introduction of time-shifting technologies enables more active selection and management of content at individual level	• Consumer interest drives new and more targeted choices in power supply • More interest in and leverage of information on quality indicators for content (e.g., green energy standards) • Broader choice of providers drives more active role in provider selection • Consumer does not control generation, but has stronger influence via choices • Introduction of residential time-of-use programs and green power options enables more active selection and management of generation deployment at individual level
Participatory	• Interactivity and involvement with content and service providers increases • Consumers active in producing content and influencing content distribution • Rapid creation of new content types as technology change causes explosion in capabilities • Dynamic, value-based pricing of content • Provider-customer relationship dynamic is increasingly customized to specific entertainment and information interests, with consumer analytics a key driver	• Interactivity and involvement with generation and service providers increases • Consumers active in generating power and influencing generation planning decisions • Rapid creation of new power supply options as technology change causes explosion in capabilities • Dynamic, value-based pricing of power (e.g., time-of-use) • Provider-customer relationship dynamic is increasingly customized to specific energy management goals, with consumer analytics a key driver

Source: "The end of television as we know it," IBM Institute for Business Value, January 2006; IBM Institute for Business Value analysis.

to their strategies and operations in preparation for a more participatory market.

CONVERGING CATALYSTS

Climate change concerns, technology advances and consumer involvement are the key factors driving the industry toward this new environment. Collectively, these drivers are overturning traditional assumptions about energy consumers and the fundamental value proposition of the industry itself. Though each of these trends has progressed independently for a time, they have all now reached a point of convergence where each is fueling the others and the entire combination is catalytic.

CLIMATE CHANGE CONCERNS

In recent years, the debate over climate change has become much more public.

Messages about the potential for dramatic climate change, at least in part due to greenhouse gas (GHG) emissions, have started to resonate with the average consumer.

This drumbeat has increased rapidly to near-deafening levels. In 2003, 119 articles on climate change appeared in the top 50 U.S. newspapers. By 2005, that number had skyrocketed to more than 1,800. And in just the first seven months of 2007, more than 3,400 such articles have been published.

Around the world, governments are responding with new energy policies, programs and legislation. Governmental and regulatory pressures on utilities are particularly intense in Europe and North America (where 79 percent of executives rated the pressure as moderate to strong). In Asia Pacific, firms are feeling less pressure (only 38 percent indicated pressure was moderate to strong) – but this may change as sentiments from other regions spread through the global marketplace.

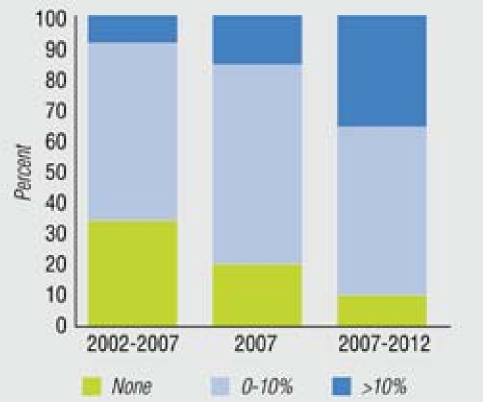
Consumers are clearly interested in the environmental practices of those they do business with, from consumer brands to energy providers. Seventy percent of the consumers we surveyed said environmental considerations were already an important factor in choosing products other than energy, and these concerns also influence the energy products they buy. One in five consumers knew about renewable energy options available to them through their current electric providers; of those, almost 40 percent purchased some or all of their power under such a plan. Among those who currently do not have (or are not aware of) the option of choosing renewable power sources, more than 60 percent expressed interest in doing so.

Outside the United States, one out of every four consumers we queried had computed the climate change impact of their energy usage.

The message is clear – more people are willing to take personal responsibility for their own energy consumption consequences.

Utilities are making major investments and operational changes to respond to climate change concerns and policies. Within five years, both the percentage of utilities devoting at least 10 percent of their capital expenditures to environmental compliance and the percentage of generating companies securing more than one-tenth of their power from renewable sources will double (see Figure 2). And where consumers are less inclined to take steps to limit the impact of their energy consumption on the environment, utilities may be increasingly forced by regulators to take on that responsibility – through better demand response, higher efficiencies, extending the lifetime of existing infrastructure through better asset management, and other system-wide improvements.

FIGURE 2.
Industry executives' estimates of total sales from renewable power sources – five years ago, now and five years from now.



Source: IBM Institute for Business Value/Economist Intelligence Unit 2007 Utility Industry Executive Interviews.

TECHNOLOGY ADVANCES

To make these improvements, utilities will likely deploy advanced energy technologies such as smart metering, sensors and distributed generation. Many of these have been available in some form for years, but their business cases have been rather lackluster. However, during the last three to five years, the technologies have continued to advance, and their benefits have strengthened dramatically.

Several contributing factors are prompting greater interest in advanced technology deployment:

• The combination of energy price increases and consumers' increased sense of responsibility for the impact of their energy usage on the environment have generated serious interest in managing consumption.

• The frequency and extent of recent blackouts are driving consumers, politicians and regulators alike to demand assessment and upgrade of the industry's aging network infrastructure. In addition, the steady flow of retirements resulting from the industry's aging workforce makes it difficult to retain the skills necessary to maintain today's labor-intensive network.

• Climate change concerns have invigorated research and capacity investments in small, clean generating technologies. At the same time, rising and unpredictable fossil fuel prices are making these technologies more cost-competitive.

• Technology costs have generally decreased as lower-cost communications, more cost-effective computing and open standards have become more prevalent.

Given this backdrop, we see smart meters, network automation and analytics, and distributed generation driving the most industry change, from a technological perspective, in the near term.

Smart meters can provide motivated consumers with the decision-making information they need to better manage consumption and energy costs. When combined with programs that leverage this information (e.g., time-of-use pricing), shifts in consumer behavior can be significant. In addition, remote control of energy-consuming devices offers consumers an extra measure of convenience and control. Smart meters also benefit utilities in several ways, such as providing better demand management/load response capabilities and allowing companies to turn on or shut off service remotely, reducing labor requirements.

The movement toward an intelligent network that leverages network automation and analytics in conjunction with grid data devices such as smart meters provides further benefits to both utilities and consumers. Sensors and automated monitoring mean fewer outages and faster restoration. Optimized transmission of power can shorten transmission paths and reduce losses, which lowers overall generation needs – all of which amounts to lower GHG emissions. A more sophisticated network also enables new products and services that take advantage of real-time consumer information and two-way interaction as these become available.

Utilities are also adding smaller, renewable distributed generation facilities to their supply mix in an effort to further reduce the impact of power generation on climate. But the potential for consumers to begin to generate power locally is what truly positions distributed generation as a technology that can dramatically change the way both utilities and consumers meet their energy, environmental and economic goals. Once meaningful numbers of consumers and utilities incorporate these units into the overall supply infrastructure, availability will increase, and outage risk will decrease.

Among our industry executive respondents, 64 percent believe at least one small, clean, advanced generation technology will become widely deployed among residential and small commercial customers within ten years.

However, we believe regulatory incentives and support may be necessary to accelerate deployment in the short term; where they exist, adoption has been impressive.

CONSUMER INVOLVEMENT

The move to renewable self-generation seen under Germany's EEG is but one indication that consumers are striving to level the playing field with their energy providers. They are looking to a combination of four activities to make this happen: leveraging provider choice options, more actively managing their usage, moving toward self-generation of power and making their opinions heard through multiple channels, not just regulators.

CONTROLLING THEIR PURCHASES

In some regions with competitive markets, consumers are exercising the right to select their energy providers. In Great Britain's market of 48 million electricity consumers, for instance, more than 20 percent are switching per year.

However, even where competitive markets are in place, most countries still lack adequate mechanisms to encourage movement.

Poorly implemented regulatory policies can complicate the process for consumers and new competitors. Other barriers include: charges levied for switching, limited number of competitors in a particular geography, lack of consumer interest (often from inadequate information and education) and long notification periods (some countries require customers to notify providers of their intent to switch more than one year in advance).

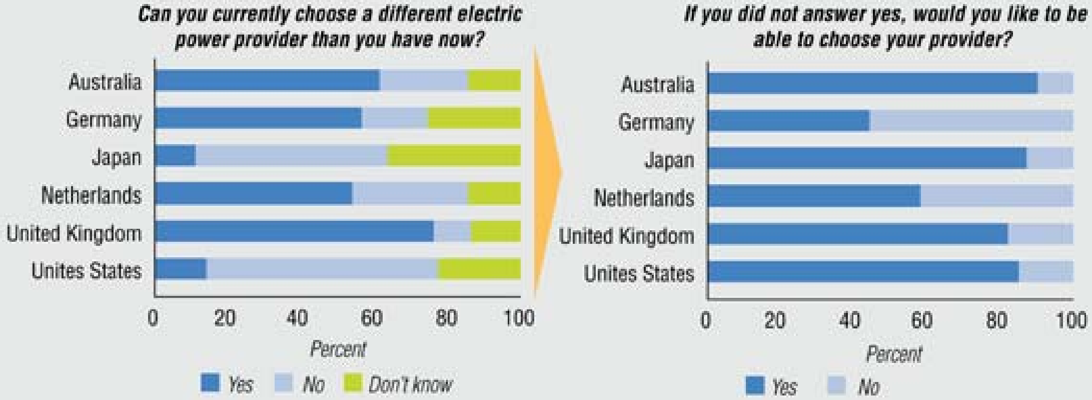
In addition, our survey shows that a basic lack of awareness may still be holding consumers back. Across our worldwide respondent sample, one out of every five consumers did not know whether they could choose an alternative electricity provider.

Nevertheless, consumers were clear about wanting a choice. Among those who could not change providers or were not aware of their ability to choose, the vast majority (84 percent) wanted the option (see Figure 3).

While price will always be a factor, competition is also bringing to the fore a host of decision-making criteria that consumers may not have even thought about before. Our survey results indicate that consumers now consider a utility's ethical reputation, alignment with community values, and environmental actions on par with traditional "buyer values" like customer service and reliability.

Along with choosing a provider, consumers have more choices about the type of energy they buy. One-third of our respondents were not interested in paying more for cleaner power, but over 40 percent would agree to pay a slightly higher price (5 percent more). A significant minority – one in five consumers – indicated willingness to pay at least 20 percent more for an environmentally friendly product.

FIGURE 3.
Consumer interest in provider choice.



Source: IBM Institute for Business Value 2007 Utility Consumer Survey.

CONTROLLING THE SWITCH

Only 30 percent of the consumers we surveyed expect their electricity use to increase over the next five years – and yet 60 percent expect higher electricity bills. In times of rising energy costs, the motivation for conservation is high.

But with many consumers also assuming their share of the responsibility for protecting the environment, finding new ways to reduce consumption has become a top-of-mind issue.

Although consumers have always been able to reduce usage through "brute force" measures – adjusting thermostats, switching off lights and the like – they are just now gaining the ability to truly manage consumption through greater awareness and better tools. As smart meter deployment allows more consumers to obtain real-time usage data at the device/appliance level, households and small businesses will know which conservation actions really make an impact. This will enable better decisions and more permanent behavior changes.

CONTROLLING SUPPLY

When providers are not willing or able to satisfy their needs, consumers have an increasingly viable alternative… the technological means to generate their own electricity.

As consumers weigh the self-generation option, cost is clearly a significant driver, but not the only one (see Figure 4). If self-generation could reduce energy costs by 50 percent, well over half of the consumers we surveyed would be motivated to install, maintain and operate their own power generation systems.

And yet, among those same respondents, reliability and environmental impact seemed to matter more than a small (10 percent) cost reduction.

Interestingly, getting paid for surplus power received the most favorable reaction from our respondents. Besides offering a financial payback that helps offset upfront investment and operational expense, we suspect that this response also reflects an underlying desire to assert more control and influence over a purchase for which the conditions have historically been dictated to them.

Many of the industry executives we interviewed agree that widespread adoption of self-generation is not that far off. More than half believe that the value from a low-cost, low-emission generating technology could move a significant percentage of residential and small commercial customers to self-generation within the next decade.

CONTROLLING THEIR OWN DESTINY

Blackouts affecting millions of people, price hikes driven by factors not understood by consumers and the pursuit of mergers and acquisitions without clear customer benefits are all contributing to growing consumer skepticism – not only about utilities and their motives, but also about the regulatory process that's been put in place to protect the public. Consumers are increasingly unwilling to wait for regulators to act "in their best interests". Frustrated, they are going directly to lawmakers, the press and special interest groups to force change.

For example, in January 2007, a 1997 Illinois deregulation bill expired, ending a ten-year rate freeze. As the shock of a sudden and dramatic rate increase set in, public pressure caused legislators to intervene – ultimately driving the state's primary distribution utilities to provide a multi-year, billion-dollar rate relief package to help reduce the financial burden on ratepayers.

INDUSTRY IMPACTS

We expect these three converging trends – climate change concerns, technology advances and growing consumer involvement – to have far-reaching consequences for the utility industry. Companies will be forced to look at their residential and small commercial customer population in discrete segments instead of as a largely uniform block of ratepayers.

Engaged consumers and advanced technology will pull the industry toward a participatory network model in which information flow will multiply. This, in turn, will create a host of opportunities for achieving greater efficiency, providing additional products and services and pursuing new business models.

A NEW KIND OF SEGMENTATION

Historically, residential and small commercial customers were generally viewed as homogeneous groups, distinct from large commercial and industrial customers, but not typically categorized any further. Our research, however, suggests this practice may no longer be appropriate.

In our consumer survey, two main attributes were associated with the greatest variances in consumers' behavior patterns:

• Personal initiative – The willingness of a consumer to make decisions and take action based on specific goals, such as cost control, reliability, convenience and climate change impacts.

• Disposable income – The consumer's financial wherewithal to support energy-related goals; in early adoption phases, only those with sufficient resources will be able to implement new technologies and buy more expensive products.

Using these two differentiators, we divide the residential and small commercial customer set into four main consumer segments (see Figure 5):

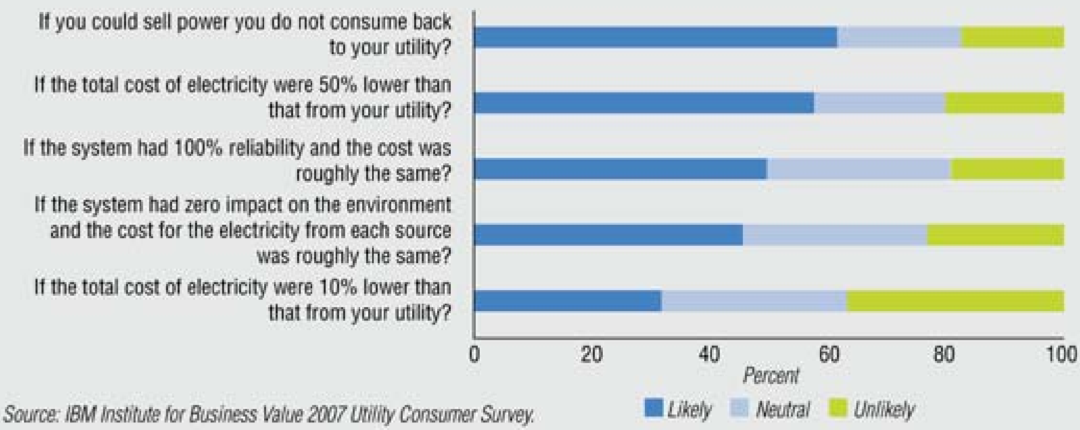
• Passive Ratepayers – Consumers who are relatively uninvolved with decisions related to energy usage and uninterested in taking (or unable to take) responsibility for these decisions.

• Frugal Goal Seekers – Consumers who are willing to take modest action to address specific goals or needs related to energy usage, but are constrained in what they are able to do because disposable income is limited.

• Energy Epicures – High-usage consumers who have little or no desire for conservation or active involvement in energy control; these consumers are more likely to own a large number

Continued on Page 41

FIGURE 4.
Consumers interested in installing, maintaining and operating their own power generation systems.



Source: IBM Institute for Business Value 2007 Utility Consumer Survey.

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KEEP CONNECTIONS "TIGHT" AFTER DIFFERENTIAL THERMAL EXPANSION

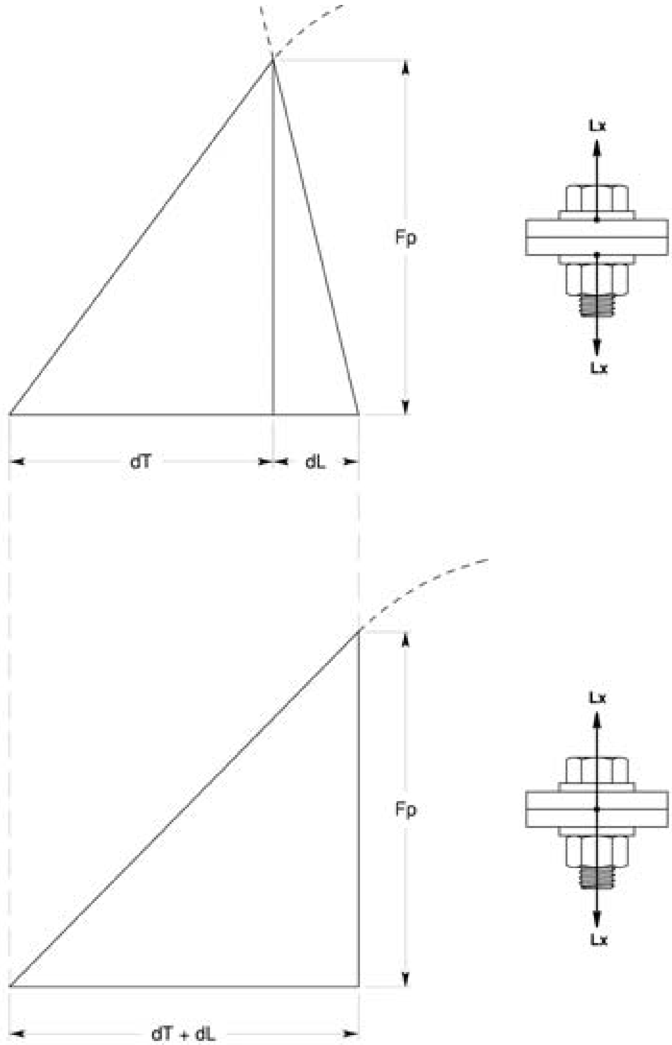
Belleville springs are commonly used on electrical connections. Electrical connections are often made up of materials that have various coefficients of thermal expansion. In addition, the joint materials also carry more current than the bolts. This causes the joint to heat up more than the bolts. The resultant differential thermal expansion (DTE) results in an increase in bolt load, possibly causing the joint material to yield.

This yielding of the material causes a decrease in load holding the joint together which in turn increases the electrical resistance during the next thermal cycle. Eventually, enough heat may be generated to result in what is referred to as a "hot spot".

"Hot spots" are produced at bolted electrical joints when there is more heat generated by current passing through the joint than can be effectively dissipated. This can result in catastrophic failure of the joint. Belleville springs counteract the effects of differential thermal expansion by maintaining sufficient load on bolted electrical connections to prevent "hot spots" during and after temperature cycles.

A bolted joint without a Belleville spring relies on the bolt stretch to produce the load at the contact joint. Bolt stretch produces small amounts of movement at very high spring rates. Creep of the material making up the joint can cause significant loss of load at the joint with little movement of the material.

A Belleville spring's deflection to flat is seven to ten times the stretch of a bolt for the same load. The combined deflection of the Belleville spring and the stretch of the bolt produce a much lower spring rate for the same load on the contact joint. Thus, for the same creep of the joint material, there is little loss of load at the contact joint. After the initial loss of load due to creep and relaxation, the Belleville spring acts as a shock absorber and stabilizer by maintaining a constant sufficient load on the bolted joint.



Figures 1a and 1b
Shows joint diagram with different loading plane positions. When the loading plane is moved to the center of the joint, the diagram has only one side because a change in Lx has the same effect on all of the joint components. In other words, as Lx increases, the bolt, joint, flat washers, and Belleville springs are loaded.

The most common materials used for Solon Belleville Springs in this application are 301 Stainless Steel, 17-7PH Stainless Steel, 6150 Alloy Steel, 1074 Carbon Steel, 718 Inconel and 510 Phosphor Bronze. The 6150 and 1074 materials are available with a mechanical zinc plating to resist corrosion.

Installation procedures should follow manufacturers' recommendations with regard to tightening methods and lubrication. There are no industry standards for bolt size/bolt load. Recommended bolt loads or torques should be obtained directly from either the connector manufacturer or the utility.

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Plugging in the Consumer

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of high-consumption devices for gaming, computing or entertainment.

• Energy Stalwarts – Consumers who have specific goals or needs related to energy usage and have both the income and desire to act on those goals.

Passive Ratepayers were the most populous group in our sample – and will likely remain so in most countries for the foreseeable future.

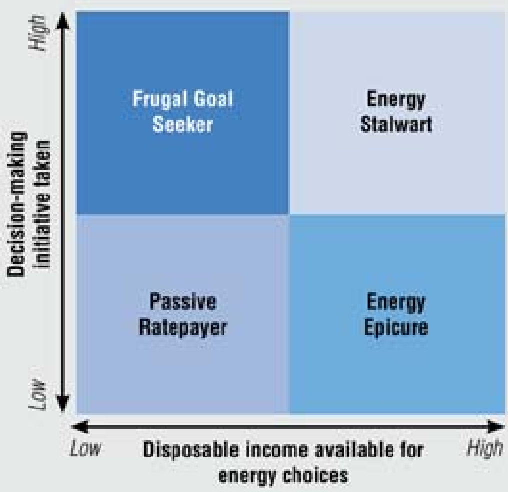
This group has the highest percentage of “don’t know” answers by far. They also have the most pessimistic outlook about future price increases; while only 24 percent believe their usage will increase over the next five years, 51 percent expect to see their monthly bills rise.

This could be because their “passivity” makes them feel powerless to hold energy prices down. These two results, in combination, seem to suggest significant opportunities for educating this segment of consumers.

Frugal Goal Seekers value short-term conservation as a means to achieve some energy-related goals (e.g., reduce carbon footprint), but only when it can be achieved at little or no expense. By default, many low-income consumers fall into this category, but environmentally focused middle-income households end up here as well because of the high cost of renewable energy options. Understandably, because of income constraints, the respondents in this group were the least likely to consider installation of a distributed generation unit, regardless of the benefits posed in each question.

Energy Epicures have little motivation to limit consumption. In fact, over 75 percent of this group expects their consumption to increase over the next five years, as compared to 25 to 35 percent in other segments. More than half of this group falls into the typically higher-spending age bracket of 25- to 44-year-olds.

Figure 5.
Emerging segmentation among residential and small commercial electric power customers.



Source: IBM Institute for Business Value analysis.

Look in the September issue of Electricity Today for Part II.

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ANALYSIS USING BELLEVILLE SPRINGS ON ELECTRICAL CONNECTIONS

The following assumptions will be made for this analysis:

1. The bus bar will be fabricated from two 1/4" thick sections of EC-H13 aluminum.

2. For the first analysis (where no springs are used), the fastening system will consist of a 1/2" stainless steel bolt and two 1/8" thick stainless flat washers. In the second case, two 1/8" thick stainless Belleville springs will be used along with the flat washers. The flat load of the springs will be 7,100 lbs.

3. The temperature at assembly will be 70°F. With the conductor in service, the bus temperature in the vicinity of the bolt will reach 220°F. Since the bolt carries no current, its temperature will only reach 150°F.

4. For simplicity, the assembly preload will be equal to the flat load of the Belleville spring, 7,100 lbs.

If the loading plane is the joint interface between the Belleville spring face and the bus bar, the diagram would look like the one shown in Figure 1a[1]. On the left side is the joint with a deflection of dT at load Fp, while the right side is the bolt with stretch dL at Fp. The dashed line represents the continuation of the elastic curves for the bolt and the joint at higher loads. Note that the elastic curve for the joint begins to "flatten out" above Fp. This is because the soft joint material yields at relatively low levels of stress. The drawing to the right of the joint diagram shows a load (Lx) that is applied at the loading plane. As Lx is increased, the joint is unloaded while the bolt is loaded. In other words, Lx will reduce joint deflection and increase bolt stretch. Now, for a bus conductor connection, the load at the joint interface of the two sections of the bus bar is of greatest interest. This load is directly related to the contact resistance (and efficiency) of the joint. Therefore, the loading plane used for this analysis will be shifted to the center of the joint (see Figure 1b). There will no longer be two "sides" to the joint diagram. This is because any load Lx will increase load on both the joint and the bolt. Since Lx increases bolt stretch and joint deflection, these values should be on the same side of the joint diagram. When the preload Fp is applied, the horizontal leg of the diagram will equal the sum of the deflection in the joint and the stretch in the bolt = dT + dL. For this example, the assembly preload is 7,100 lbs. Since the joint had hardly yielded at this point, the diagram is basically a right triangle. At this preload, the deflection of the joint is .0052" and the bolt stretch is .0017". Therefore, the horizontal leg of the triangle is .0052" + .0017" = .0069".

As stated earlier, when current begins to run through the conductor, the assembly begins to heat up. Using the assumed service temperatures and material properties, the change in lengths ΔL of the bolt, joint, and flat washers can be determined using the following equations:

$$\Delta L_B = \rho_B \cdot L_B \cdot \Delta T_1$$
$$\Delta L_J = \rho_J \cdot L_J \cdot \Delta T_2$$
$$\Delta L_W = \rho_W \cdot L_W \cdot \Delta T_1$$

Note that the joint expands more than the bolt does. This will cause an increase in preload. The change in load caused by the differential thermal expansion FT can be found using the following equation1 [see reference 1]:

where, ρ_B = coefficient of thermal expansion of the bolt material

= 6.4×10^{-6} in/in/F

ρ_J = coefficient of thermal expansion of the joint material

= 12.8×10^{-6} in/in/F

ρ_W = coefficient of thermal expansion of the washer material

= 6.4×10^{-6} in/in/F

L_B = grip length of the bolt = 1.25 in.

L_J = thickness of the joint = 1.00 in.

L_W = thickness of the washer = .125 in.

ΔT_1 = change in temperature of bolt and washer = 150°F - 70°F

ΔT_2 = change in temperature of joint = 220°F - 70°F

therefore, $\Delta L_B = 0.0006$ in.

$\Delta L_J = 0.0019$ in.

$\Delta L_W = 0.00005$ in.

$$F_T = \frac{K_B * K_J}{K_B + K_J} * (\Delta L_J + 2 * \Delta L_W - \Delta L_B)$$

where KB and KJ are the spring rates of the bolt and the joint, respectively[2]. Using the figures for the spring rates and expansions calculated earlier, the increase in preload FT is 1,425 lbs. This increase is reflected on the joint diagram in Figure 2. Remember that the elastic curve is non-linear above the preload because the joint begins to yield at 7,000 lbs.

When the temperature returns to 70°F, the residual preload will be lower than at assembly (represented by dashed line in joint diagram). Note that the load on decrease is parallel to the linear portion of the elastic curve. This is because yielding in the bus bar material had effectively shifted the joint diagram. For this example, an increase of 1,425 lbs. will result in a yield of 0.0015". A 0.0015" shift will cause residual preload to fall to 5,550 lbs. (a 22% decrease). Since the lower preload will increase contact resistance, as current runs through the conductor more heat will be generated. This will not only increase the differential thermal expansion, but may also cause the joint material to unload even more due to creep. Each time the bus conductor is cycled, more load will be lost until the connection eventually fails. Now consider the case where Belleville springs

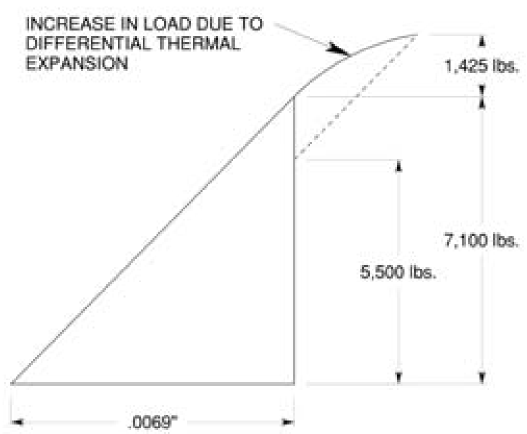

Figure 2
Joint diagram showing the yielding of aluminum as load is increased by 1,425 lbs. due to differential thermal expansion. The dashed line reveals that preload will fall to 5,500 lbs as temperature returns to 70°F.

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Keeping Connections "Tight"

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are used. Assume that two springs in series with .019" of deflection (h) are used. The load applied to the bolt is the same as when no springs were used. Therefore, the vertical leg of the joint diagram in Figure 3 (page 4) is the same (7,100 lbs.). However, the two Belleville springs have added 2 X .019" = .038" to the horizontal leg. This decreases the slope of the elastic curve by a factor of 6.5. Since their materials and thicknesses are the same, the change in length of the Belleville springs will be the same as the flat washers (.00005"). Now, the change in load can be computed:

$$F_T = \frac{K_B * K_J}{K_B + K_J} *(\Delta L_J + 4 * \Delta L_W - \Delta L_B)$$

Note that this formula is virtually the same as the one used for no Belleville springs. The only differences are that the change in length of the Belleville spring is multiplied by four rather than two and the bolt length is 1/4" longer. This accounts for the two Belleville springs. The spring rates of the Belleville springs are not in the equation because they are in the flat position when the preload is 7,100 lbs. Plugging in all of the numbers yields an increase in preload FT of 1,347 lbs. The increase in load is shown by the solid line on the joint diagram in Figure 4. Note that when load is raised above 7,100 lbs., the slope of the elastic curve increases. This is because the springs will no longer deflect beyond their flat load. The joint material will yield as if there were no Belleville springs. However, as the components return to their original temperature, preload falls quickly until the flat load of the springs is reached. Then the Belleville springs begin to unflatten slightly to "absorb" some of the change in load. This is why the unloading line changes slope (see the dashed line in Figure 4) at the flat load of the springs. For this example, the differential thermal expansion resulted in only a 3.4% decrease in preload. This is a substantial improvement over the 22% lost when no springs were used.

The next time the bus conductor is cycled, the increase in preload will be much smaller. Because the Belleville springs are no longer flat, their spring rate can be incorporated into the formula for change of load due to differential thermal expansion:

$$F_T = \frac{K_S * K_B * K_J}{K_J * K_S + K_S * K_B + K_B * K_J} *(\Delta L_J + 2 * \Delta L_W - \Delta L_B)$$

where KS is the spring rate of two Belleville springs. In this case, the differential thermal expansion will cause an increase of 237 lbs. Such a small increase in preload should not lead to any yielding of the bus joint. Therefore, when the assembly cools to ambient, preload will return to the same level. This is why many plant procedures call for the technician to tighten the bolt until the Belleville springs become flat, and then "back-off" 1/4 turn. Backing off allows the spring to unflatten by a small amount so that any differential thermal expansion will be "absorbed" by the Belleville spring. The example reveals that this practice is unnecessary. After a single thermal cycle, the spring unflattens slightly anyway.

REFERENCES

1. Bickford, J., "An Introduction to the Design and Behavior of Bolted Joints," Marcel Decker, Inc., New York, 1995.

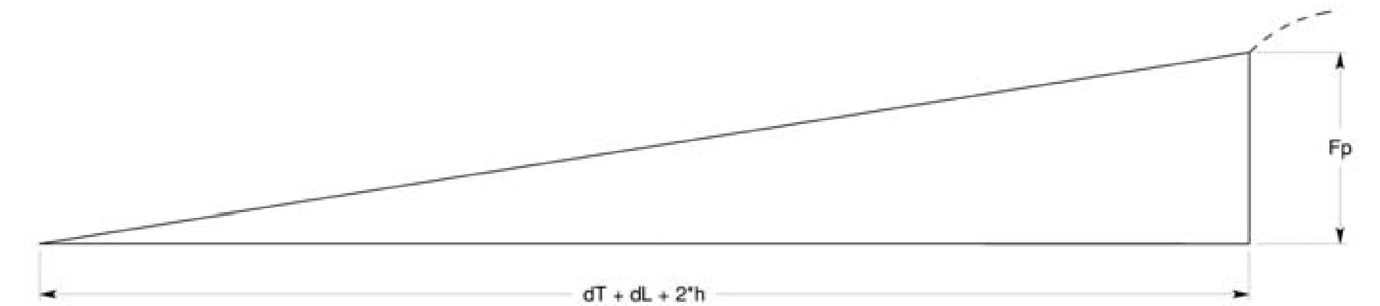

Figure 3
Shows the joint diagram using two Belleville Springs with the loading plane at the center of the joint. Note the elastic curve changes slope (dashed line) if load is increased beyond 7,100 lbs. This is because the springs are flat at this point.

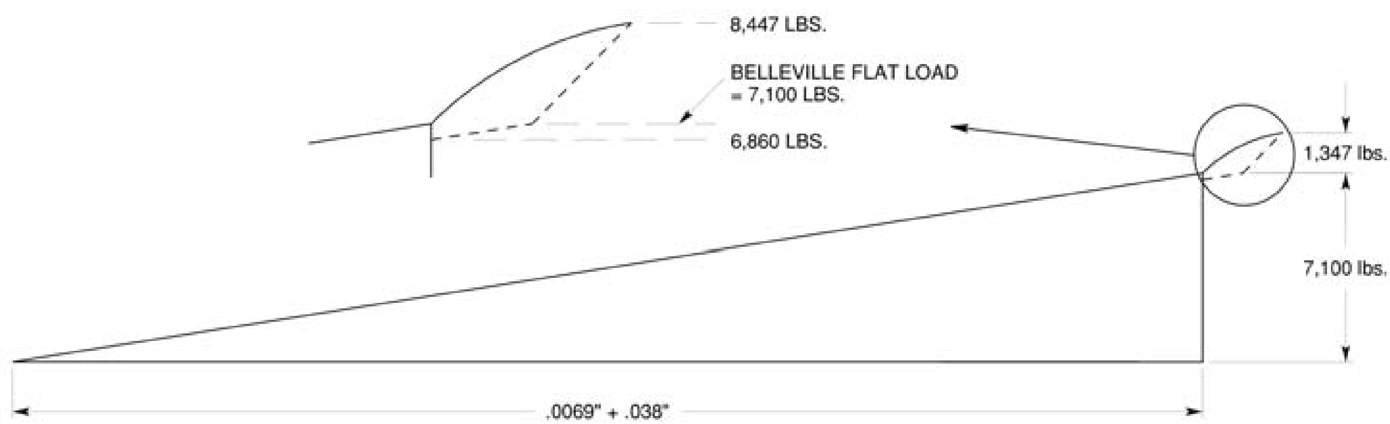

Figure 4
With Belleville springs, the differential thermal expansion causes a 1,347 lb. increase in load. However, when temperature returns to 70°F, the joint unloads (along the dashed line) at a steep rate until the flat load of the springs is reached. Then the Belleville springs begin to "absorb" some of the change in the load so that residual preload only falls to 6,860 lbs.