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ELECTRICITY Transmission & Distribution TODAY

THE ELECTRICITY FORUM

June 2008
Volume 20, No. 5

California hooks up to renewable biogas

Analyzer Technology Boosts Potential for Converting Biogas to Power

- page 24

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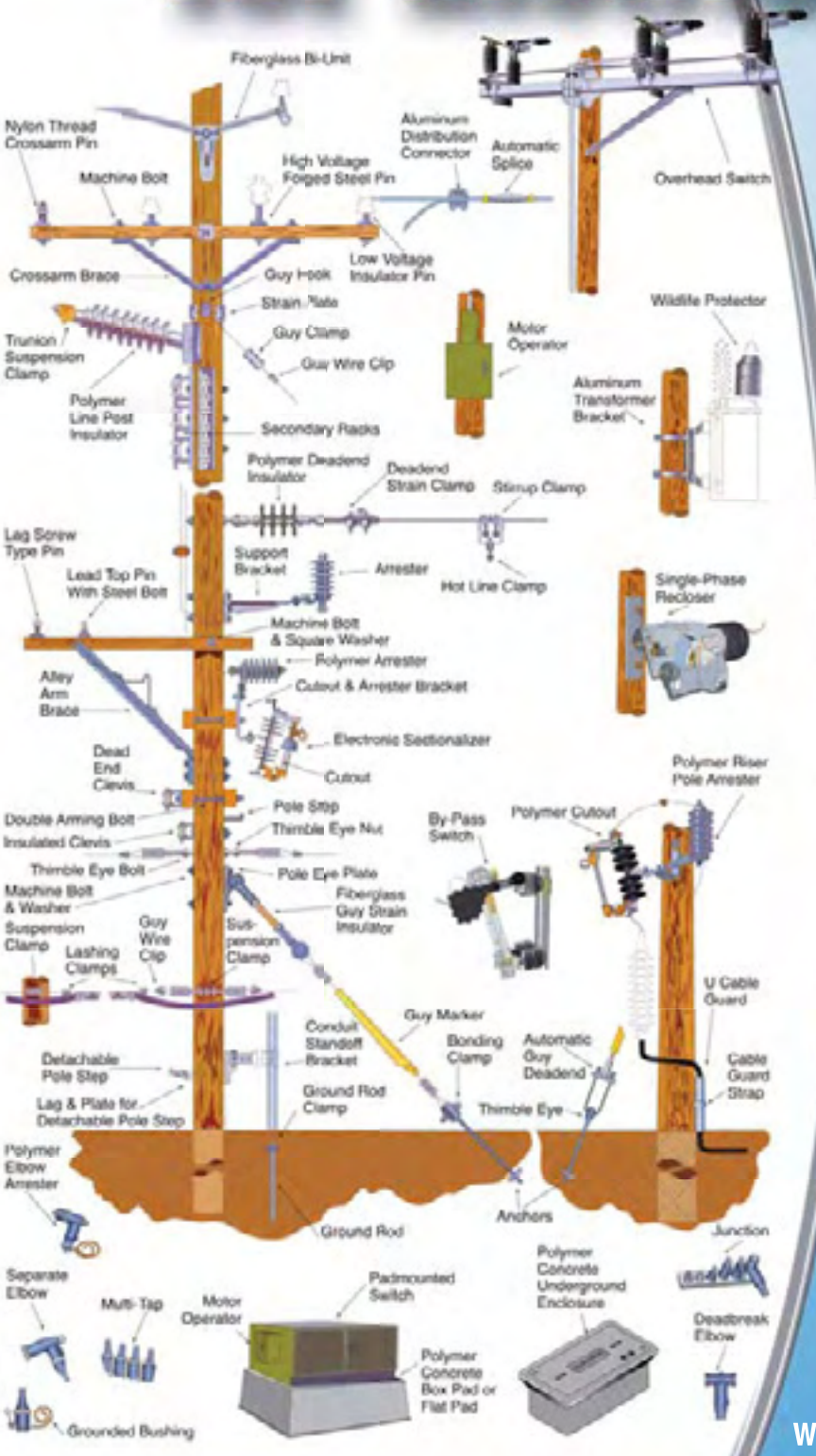

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ELECTRICITY TODAY

Volume 20, No. 5 June 2008

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JUST WHAT EXACTLY CONSTITUTES RENEWABLE ENERGY?

By Don Horne

Just what is "green" generation anyway?

The simple answer is one that doesn't emit any harmful greenhouse gases (carbon dioxide, monoxide, etc.) or pollutants into the atmosphere, without damaging or depleting the resources being used.

That question is becoming all important when it comes to meeting the various renewable portfolio standards from state to state.

The Edison Electric Institute says that some states have made their standards too high, leaving utilities no other recourse than to negotiate the least expensive penalty payments possible.

In the case of Maine – a state with the highest Renewable Portfolio Standards (RPS) in the United States – their entire northeastern corner of the state is not connected to the ISO New England grid. That creates an incredible headache for those selling electricity to ensure that a certain percentage of their power is renewable.

But again, what is renewable?

Renewable generation, like wind and solar, is seen as clean and green.

Nuclear is also being touted as green generation (no emissions), although there is still some way to go to convince groups like Greenpeace that the radioactive waste from the reactors is not ultimately harmful to future generations.

New technologies like carbon capture and sequestering are making coal a "green" generation option, although many remain dubious as to whether this can be done both successfully and viably.

The oldest form of emission-free power – hydroelectricity – is viewed by many as the greenest form of generation.

But with the headlong rush to find greener, cleaner forms of generation, we are taking a step back and a deep breath to see just how green each of these really are when it comes to generating electricity.

Hydroelectricity. Yes, there are greenhouse gas emissions expelled from the water as it emerges from the turbines and falls to the bottom of the spillway. The instant drop in pressure is equivalent

to one atmosphere, resulting in the immediate release of carbon dioxide.

Then there are water and wildlife concerns. Maintaining minimal reservoir levels during times of drought affects downstream ecosystems.

Nuclear, as mentioned earlier, does produce zero emissions but considerable radioactive waste, creating storage and security problems for successive governments. Yes, the record of nuclear generation is one of great success; but the potential threat from an accident or terrorist attack is very real and very terrible.

Solar looks promising. Although the environmental cost of producing these panels and photovoltaic cells were considerable in the past, today's panels pay back environmentally in one to three years. And in the next five years, those numbers could be reduced by half again. In an urban application, covering the roofs of the cityscape with solar panels leaves absolutely no footprint on the land – but certainly this would make no sense in an agricultural application, where vital farmland would wither and die underneath miles and miles of solar panels covering the landscape.

Although Texas has invested heavily in wind, it does not shine as brightly as solar when you consider that the times of heaviest demand for air conditioning are when the wind has stopped blowing and the sun is shining.

Wind turbines were touted as a great, clean way to generate power. But as they began to sprout up, objections were raised by those who didn't want to see a string of whirring blades atop mountain vistas and spinning in their neighbour's backyards.

In addition to the aesthetic complaints, avian experts were concerned at the large number of bird strikes created by these fast-spinning blades. Although the power being generated was clean, it was creating a graveyard for our feathered friends.

Currently, 26 states are in the process of coming up with some form of RPS, and realizing what is achieveable and what is impractical needs to be addressed before a renewable percentage is codified into law.

With strained transmission grids, increasing levels of loading relief requests and backed up interconnection queues, deciding who should pay for new transmission – and how much that transmission will be – needs to be dealt with in a realistic manner.

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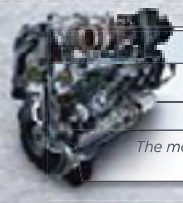

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CHALLENGES AND OPPORTUNITIES IN OPENING ELECTRICITY MARKETS - PART I

By Timothy J. Brennan, Professor of Public Policy and Economics, University of Maryland, Baltimore County and Senior Fellow, Resources for the Future, Washington, D.C.

For nearly three decades, arguably the greatest economic policy success story around the world has been the movement from regulation to competition.

The gains have come not only in relatively obvious sectors such as long-haul trucking, where regulation was doing little more than setting cartel prices and preventing competition, but also in finance, broadcasting and air transport, where concentrated market structures have been replaced by deconcentrated structures with a significant number of suppliers. Telecommunications is another major sector where deregulation has been largely successful, with technological change (primarily Internet-based telephony) paving the way for full deregulation, as recently ordered for most Canadian metropolitan areas.

Despite some adverse distributional effects, such as reduced service provision or higher prices in low-volume, high-cost areas, the overall benefits of deregulation have been significant. These include deregulation's direct competitive effects and the substitution of entrepreneurial initiative for central planning. This overall success suggests that the benefits of open markets should be extended to electricity.

Local electricity distribution and, less obviously, long-distance electricity transmission retain scale economies and other monopoly characteristics that preclude significant competition. However, the electrical generation and marketing sectors lack the same scale economies of the "wires" — distribution and transmission — and thus appear ripe for competition, particularly if independent generators have nondiscriminatory access to transmission lines at reasonable prices. Growth of interest in environmentally friendly "green" power and commercial and industrial energy management systems, as well as the opportunity to find ways to sell energy at lower prices, promises opportunities for competition in selling electricity at the retail level.

In Canada, the US, and around the world, with notable initial efforts in Chile and the United Kingdom, electricity markets have been opened with the expectation that these benefits from competition would be forthcoming. Since then, many have questioned whether electricity deregulation has achieved this promise. The purpose of this article is to provide some insight into special characteristics of electricity as a commodity, how it is produced, supplied and purchased, in order to understand why such difficulties may be endemic to electricity and are not the result of idiosyncratic regulatory error or political forces, important as those may be. After looking briefly at the state of electricity competition in Canada and the U.S., the article will focus specifically on the following five inter-related topics:

• Residential consumer reluctance: Do people want to have the ability to choose their electricity supplier?

• Pricing: Will electricity markets be sufficiently competitive to keep prices tracked reasonably to costs?

• Market power: Might individual suppliers possess the incentive and ability to raise prices when demand is at its greatest, without having to collude?

• Corporate structure: Is vertical separation in the industry, considered necessary to foster competition, consistent with efficient short-run operation and long-run expansion of the electricity grid?

• Reliability: Last and probably foremost, do the special characteristics of electricity imply that central control is necessary to ensure reliability of the grid?

Negative answers to all, some, or even one of these questions need not make electricity deregulation unattainable or undesirable in its effects. The conclusion offers policies to mitigate some of the potential negatives. These suggested initiatives include:

• Focus retail deregulation and efforts on commercial and industrial users, who are better able and likely to be more willing to shop for electricity and thus provide incentives to produce and use it most efficiently.

• Encourage real-time pricing, especially for commercial and industrial users.

• Examine supply decisions, rather than price, to try to limit the ability of firms to exercise market power and raise prices by withholding supplies.

• Separate operational control of regulated transmission and distribution from

Continued on page 10

Table 1: Installed Electricity Generation Capacity in Megawatts — Nationally and by Province

	Can.	Nfld.	NS	NB	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Public	90.3	7.1	0.0	4.0	34.6	22.7	5.5	3.3	1.6	11.2
Private	23.3	0.3	2.4	0.4	1.4	8.8	0.0	0.5	8.2	1.3
% Private	21.0%	3.0%	100.0%	8.9%	4.0%	28.0%	0.4%	13.0%	83.4%	10.0%

Note: The provincial figures add up to less than the national figure because the latter includes capacity on Prince Edward Island and in the Territories.

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the ownership of generation, keeping in mind that the degree of separation that best balances protecting competition and maintaining operational efficiency remains an open question.

• Exercise caution in moving to deregulation, as the need to maintain reliability in this crucial, fragile and interconnected sector requires a careful approach.

None of these recommendations may counter all of the potential difficulties in opening electricity markets, but in recognizing their limitations, one needs to remember that the regulatory alternative is also never ideal. Regulators rarely have enough information, operate under legal and procedural constraints and can only adapt slowly to changed costs, technology and demand. Moreover, rewards under the political system may lead regulatory decision makers to promote special interests rather than the public's interest. But the above issues need to be considered in making any assessment of the prospects for electricity competition, which requires a cautious balancing of the costs and benefits rather than a decision rooted in a prior ideological commitment.

Source: National Energy Board.

Figure 1: Canadian Restructuring Status (as of 1 April 2005)

CURRENT EVENTS

Since markets were opened on a large scale in the U.S. in the mid-1990s, the performance of the electricity sector has been far from smooth. In the fall of 2000, about two years after putting into place the first and most extensive market opening initiative in the U.S., the California electricity market imploded with skyrocketing prices, rolling blackouts and utility bankruptcies. In August 2003, a massive blackout paralyzed the northeastern U.S. and Eastern Canada. More generally, instead of falling as competition advocates promised, electricity prices have been rising in much of the U.S., particularly in states that have opened markets. In Maryland, one of those states, the main default service provider, Baltimore Gas and Electric, recently raised its rates about 70 percent. Less dramatic, but unprecedented and politically controversial price increases — particularly during peak periods — have taken place in Ontario, one of the Canadian provinces that have taken the largest steps toward opening electricity markets.

Whether or not these events are the result of opening markets, they reversed the momentum that had built in the 1990s toward having electricity follow telecommunications and other markets into the deregulated camp. In Canada, where electricity markets are controlled by the provinces, only two, Alberta and Ontario, have opened retail markets to some degree, as indicated by Figure 1. Table 1 offers more detailed data on the public/private breakdown.

Of the roughly one-fifth of Canadian electricity capacity held by private utilities, most is in Ontario and Alberta. Other than Ontario and Alberta, the provinces have only opened markets, if at all, for wholesale access — primarily bulk power sales to local monopoly distributors — or, in some cases, to large industrial users. Most of the other provinces (and Ontario) continue to have most of their needs supplied by publicly owned, vertically integrated companies.

In the U.S., at the federal level where jurisdiction over wholesale and interstate markets lies, efforts to facilitate the opening of competitive markets have foundered on both regulatory and legislative fronts. Initiatives to open retail markets, controlled by the states, stopped after the California meltdown, and some states that had opened markets are considering reversals. Figure 2 shows the status of state restructuring efforts; notable are the many states that had started to deregulate and then reversed course following the California crisis and run-up in electricity prices.

Whether these crises, outages and price increases were idiosyncratic or would have taken place without open markets is a good question. In California, high wholesale prices turned into a disaster when regulators kept retail prices from rising to match purchase costs. Keeping prices low kept demand high, throwing the distribution companies into or near bankruptcy. This exacerbated the situation, as wholesale prices rose even

Continued on page 12

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Source: US Department of Energy, Energy Information Administration. "Status of Electricity Restructuring by State." April 2007, http://www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html.

Figure 2: Restructuring Status by State

further to incorporate the significant chance that generators would never get paid.

The 2003 Northeast blackout resulted from actions in the regulated sectors, distribution and transmission, and not a failure among competing generators. Finally, as everyone who has been to a gasoline station or paid a heating bill knows, prices have skyrocketed over the last few years throughout the energy sector, not just for electricity. It should not be surprising that there is a connection between energy prices in general and electricity rates, since combustion of fossil fuels, particularly natural gas, is the technology of choice for new entrants in generation, especially for plants used at peak periods.

Despite the availability of explanations having nothing to do with inherent shortcomings with bringing more competition into the electricity sector, these events have raised doubts among the public and policymakers as to the future role of competition in electricity markets. At the root of the confusion is the public's seemingly ambivalent attitude towards competition in this area.

RETAIL COMPETITION: DO CONSUMERS REALLY WANT IT?

One of the central tenets of the economist's view of the world is that more choice is better. The benefits of competition arise from having multiple providers of products that attract consumers by offering lower prices and more desirable features. Yet, the residential electrical consumer seems largely immune to these benefits. With some exceptions (Ontario; Texas and Ohio in the U.S.), North American households have exhibited remarkable reluctance to switch from the incumbent electricity supplier. Recent data from Maryland indicate that as of October 2006, new electricity suppliers provide less than 2.5 percent of peak load to residential customers.

New competitors are much more able to flourish in other segments of the retail electricity market. To illustrate the relative difficulty of attracting residential consumers, competitive suppliers in Maryland provide 69.1 percent of all commercial and industrial (C&I) peak load and 94.1 percent of peak load for large customers in the category.

Numerous factors could explain this reluctance of residential consumers to switch to new entrants. The political processes that opened retail markets often included retail price controls over a transition period. Sometimes, this resulted in lower prices, reflecting in part the expectation that electricity prices would fall with competition, rather than rise along with energy prices generally. In addition, large commercial and industrial users are more attractive to new energy suppliers, with the prospect of larger sales and, as noted below, better ability to price for contingencies such as peak power use and allowing for interruptions. Simply put, the costs of searching for and evaluating proposals from new entrants are proportionally smaller and more likely to be worth undertaking for buyers that use large amounts of electricity.

The experience of deregulation in the U.S. and Canada suggests that switching suppliers entails greater costs in evaluating suppliers and making decisions than many residential customers are interested in bearing. Alberta provides a useful illustration. The Alberta Utilities Board provided a chart to help consumers compare alternative suppliers by showing them the information they should gather and how to make use of it.

One might not be surprised to find that few residential consumers would volunteer to undertake this assessment with multiple suppliers just to shave a few dollars off their electricity bill. The Alberta Electricity Board has since dropped this form, but now supplies a multistage website from the Utilities Consumer Advocate providing extensive instruction on how to read and evaluate service contracts and make price comparisons. As University of Alberta Energy Policy Professor Joseph Doucet has observed, "Residential consumers don't understand restructuring and don't appear interested in switching retailers".

In Ontario, the other province with open retail markets, low-volume buyers can and largely do still obtain electricity at a regulated fixed price.

Look in the July/August issue of Electricity Today for part II

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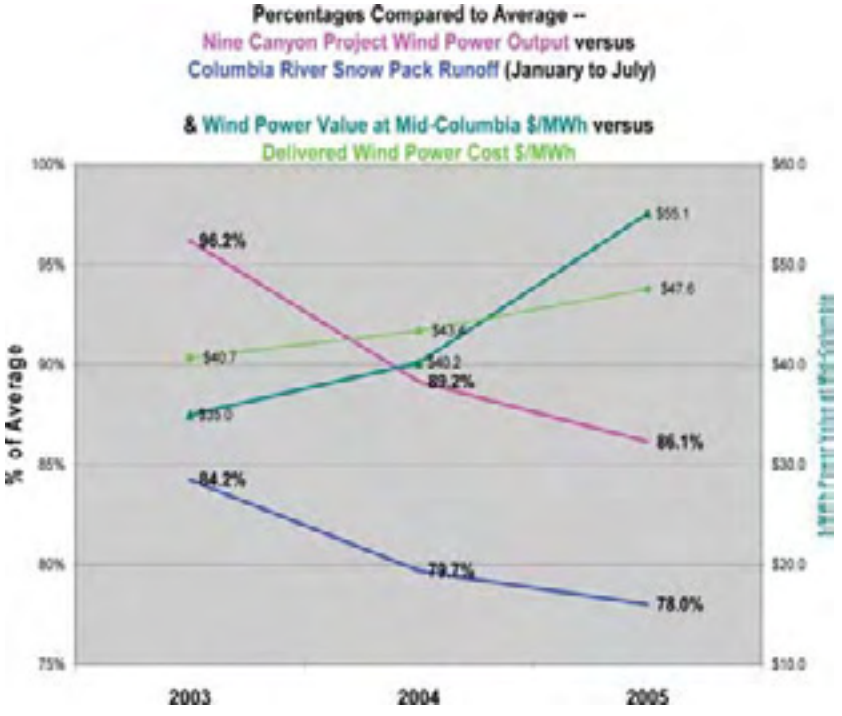
INTEGRATING A WIND FARM INTO A HYDROELECTRIC POWER SYSTEM

By Larry Felton, ENW



You are the power manager of a small public electric utility located in Washington State, USA. Several small public utilities, including your own, have been invited by a public power resource developer to purchase power from a proposed wind power project. You have been asked how much of this wind power your utility is interested in purchasing, if any.

Your utility has enough hydropower generation capacity to meet its peak load, but lacks enough water flow to produce all the required energy all the time. In drought periods your utility must buy power from the market to supplement its generation. Periods when your utility sells its surplus power into the market are roughly as common as drought periods.

Your options are to continue buying power from the market when needed, or to acquire additional resources to supplement your utility's hydropower. By acquiring wind power, you assume your utility would have more power during drought periods to protect it from purchasing power from the market when prices are high.

SITE DESCRIPTION

The site proposed by the developer is in southeast Washington State. Located in wheat fields on a high bench overlooking Kennewick, Washington, it is about 175 miles (340 km) east of Portland, Oregon, along the Columbia River Gorge. The bench is roughly perpendicular to the dominant winds, which are channelled through the Columbia River Gorge from the southwest.

A 64 MW wind farm consisting of forty-nine 1.3 MW Siemens Bonus turbines is planned for the site placed in four rows to intercept the prevailing southwest wind. An engineering analysis based on monitored data and the proposed turbine layout suggests that the farm would have a capacity factor of 31.4%.

The developer has options to lease the necessary land from the area's wheat farmers. The leases would cover 5,100 acres of land (2,070 hectares), of which only 50 acres (20 hectares) are taken up by turbines, project facilities, roads, etc. The lease guarantees local wheat farmers an annual income for the life of the project.

About 19 miles (10 km) of underground power cables would be constructed to connect the four rows of wind farms to a new power substation near a major 115 kV transmission line.

Your utility is located 150 miles (280 km) away from the proposed site. Contractual arrangements with a large power transmission agency to transmit the wind power would have to be arranged. Your utility will also need to set up a revised service agreement with your utility's Load Control Area (LCA) operator to integrate this wind power into your utility's resource portfolio and to balance loads and resources on a real-time basis.

The project under consideration is the Nine Canyon Wind Farm that when completed would be the largest wind project by public power utilities in the United States. Several public power utilities have signed a letter of interest with the developer, with the biggest interest being made by your utility for 25% of the project's output, or roughly about 7% of your utility's annual energy requirements. This relatively large amount of power would diversify the utility's primarily hydropower resource. You have to decide based on the following information whether your utility should commit to 25% of the project.

FINANCIAL INFORMATION

The developer proposes to develop the site in two phases with total financing of $92 million. The purchasers are all non-profit public utilities. The project would be financed by tax-exempt bond issues carrying an estimated 6% interest rate.

The developer proposes to charge $35/MWh initially; this price would escalate at 3% per year through the life of

Continued on Page 16

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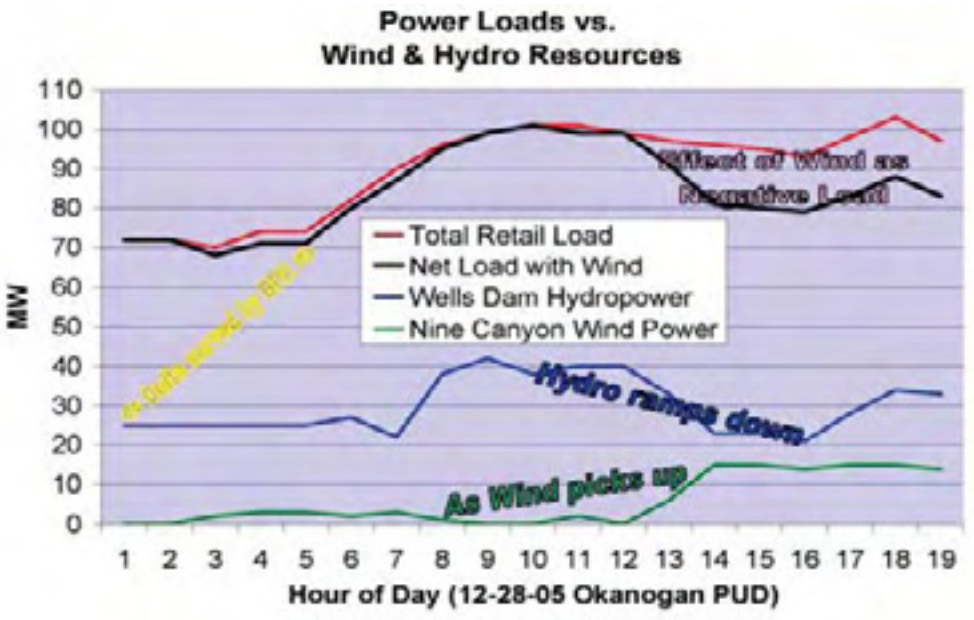

a 22-year power purchase contract. This would result in an average cost to the purchasers of $50/MWh over the life of the contract.

In addition, a nominally $18/MWh federal government Renewable Energy Production Incentive, or "REPI" credit, is available to the developer for the first 10 years of project operation. In past years, the United States Congress has not fully funded the REPI, so the developer estimates that the actual realizable benefit is only $15/MWh. The US federal government has not fully funded the REPI, such that it can provide revenues for public power in lieu of the federal tax incentive that for-profit utilities receive for wind power projects. Ultimately, the project financing plan may have to adjust upwards the cost in a future year to make up for the REPI shortfalls that have occurred so far.

The developer's pre-feasibility annual cost estimates including operation and maintenance, land lease, insurance, etc., is around $2,500,000 per year. The developer uses a 7% discount rate.

Your analysis indicated that your utility would benefit by purchasing 25% of this wind power project. Your forward market price projections showed the market price of power was likely to exceed the net price of power from this wind resource over time, after factoring in the renewable energy credits and green tag sales available to the Project. You therefore recommend to your utility's management they approve the purchase of 25% of the Project's output. The following details the actual experience of integrating wind power into your primarily hydropower based utility in the first three years of the Project's operation.

CORRELATION BETWEEN DROUGHT PERIODS AND LACK OF WIND

Data from this Project indicate that in the Pacific Northwest region drought periods tend to coincide with low wind periods. The following chart shows a very good correlation between the Nine Canyon Wind Project's output, in terms of percent of forecast average levels, and the Columbia River's snow pack runoff from January to July, also as a percentage of the average. The Columbia River normally has about 107 million acre-feet (132 billion cubic metres) of snow pack water runoff during this period. This runoff is closely watched by local utilities since the Columbia River's January to July snow pack runoff is used as a gauge of the area's hydropower energy capability for that water year.

HIGH PRICES CORRELATED WITH PERIODS OF LOW HYDRO AND WIND RESOURCES

This project has shown that market prices in the region tend to be high during drought periods. The above chart suggests that lower stream flows can be a major factor in causing higher power prices in the Pacific Northwest region. As the stream flows fell from 2003 to 2004, there was a 22% rise in non-firm power prices, and a 37% rise from 2004 to 2005. It should be noted that this price movement cannot be attributed solely to low stream flows. Power prices were high throughout the United States in 2005, affecting regional prices.

PROJECT - RESULTS

This project's results and analysis are based on the experience of the Okanogan Public Utility District (PUD) in Washington State USA for integrating wind and hydro power systems. Okanogan PUD did decide to purchase a 25% share in the 64MW Nine Canyon Wind Farm starting in 2002. The PUD's hydro resources with their flexible ramp rates and access to storage are particularly effective at firming the energy output of wind production.

The developer, Energy Northwest is a joint operating agency created to develop generation resources for its member Public Utility Districts in the State of Washington, USA. Energy Northwest, financed the Wind Farm project in two phases: Phase I involved a $70 million tax-exempt bond issue in 2001 to cover the first 37 wind turbines with commercial operation in September 2001. Second phase 12 turbines were financed with a $21.7 million bond issue in 2003 and was completed by December 2003.

The Wind Farm's purchase agreement assumed a 3% per year annual increase in the power purchase price over the life of the 22-year contract. If the rate of increase in market power prices were to be 3% per year also, then the purchase from the Energy Northwest would be expected to cost the same as purchasing from the market.

SYSTEM DESCRIPTION

The project uses forty-nine 1.3 MW turbines from Bonus Energy of Denmark; it has a capacity of 63.7 MW and a predicted 31.4% average capacity factor. Thus, the project should produce about 175,000 MWh/year at the turbines with average capacity of 20 MW.

The project's underground 34.5 kV power lines and 115 kV substation were constructed by one of the purchasers,

Benton County PUD and interconnects with the Bonneville Power Administration's (BPA) 115 kV system. Okanogan PUD's share of the Project's output is transmitted over BPA lines to Douglas PUD's Load Control Area (LCA)2. The LCA operator uses Okanogan's 65 MW's of hydropower capacity at Wells Dam on the Columbia River to smooth and make available for future use Okanogan share of the project, essentially eliminating the need to purchase additional ancillary services.

This is done by simply integrating wind power against power load every few seconds. The LCA operator balances this new "net" load against available hydropower resources on "real-time", "within hour" and "day ahead" timeframes. The experience so far is that using the hydropower resource's capacity to follow the "net" load isn't much more difficult than following the actual load without the wind resource. The chart on the previous page shows this concept of hydropower adjusting to wind power according to the primary goal of serving the instantaneous power needs of the utility's customers.

Notice that the top red line is the utility's load without wind power, and the black line is the "net" load with wind power as treated as negative load. The bottom two lines show as the wind power's green line picks up, and then the hydropower's blue line ramps down according to the primary objective of following the "net" load. Of course, the opposite is true as well if the wind power was ramping down, then the hydropower would pick up the difference.

However, to acknowledge that there are times when the wind resource stretches the hydropower's capacity to follow the "net" load, the case study uses an internal cost of $0.9 / MWh3 for Okanogan PUD as a proxy for additional unknown balancing costs. By comparison, if this balancing service were purchased from the Bonneville Power Administration (BPA) the price would be $4.50 / MWh4 in part BPA treats wind integration differently than Okanogan PUD.

LESSONS LEARNED

1) First three years wind production

Total delivered wind power to the Okanogan PUD over a three year period was a little over 106,500 MWh, or 90% of expected "normal" production. This still provided roughly 7% of the utility's energy requirements. For example:

- In 2003 actual power production was 5% less than forecast with a negative net value (market value of purchases minus purchase cost) of $174,000.
- In 2004, 10% less was produce with negative net value for 2004 of $120,000.
- For 2005 production was 13% less than forecast with a positive net value of $273,000.

2) First three years financial results

Okanogan PUD's average net delivered cost for wind energy was about $44.1/MWh, including an average cost of $3.2/MWh for transmission. If this electricity had been purchased at market rates, the cost would have been $43.9/MWh).

The net actual value (without any assumed balancing costs) of the Okanogan PUD's wind power for the 2003 through 2005 period was negative $21,000. However, in the second half of 2005, the utility sold Renewable Energy Credits5 (RECs) for over $58,000 at a market price of $3 / MWh, (or a rate equal to $5.36/tonne of CO2 base on GHG analysis with 0.559 tonne of CO2 / MWh). This REC sale led to a net positive value for wind power of $37,000 over the three-year period.

3) Green Power Benefits

Over the life of the project, the Okanogan PUD will reduce greenhouse gas emissions, on average, by 22,000 tonnes of CO2 per year, through the displacement of fossil fuel-powered generation. The project profitability has been improved by providing monetary benefits from these emissions reductions. The utility will certainly continue selling RECs in future years.

4) Correlation between drought periods and lack of wind and high prices

Data from this project located in the Pacific Northwest region of the U.S.A. suggest that drought periods tend to coincide with low wind periods. The Columbia River normally has about 107 million acre-feet (132 billion cubic metres) of snow pack water runoff during this period. This runoff is the "fuel" from winter storms and spring rains that make up the majority of the area's hydropower supply.

Since September 2002, in general there has been less precipitation and less wind than normal. This apparent correlation does not help the financial feasibility of wind power in the area because drought periods are normally also high cost power periods. This project has shown that market prices in the region tend to be high during drought periods, when wind power also tends to be lower than normal.

5) Equipment Design Flaws or Malfunctions:

The Nine Canyon Wind Farm has had a number of problems with its turbines. Broken gearbox teeth and bearing problems have plagued the project. There have been a total of 12 such events since commercial operation began in September 2002. There is concern that if this problem is not resolved, project profitability will be affected once the warranty has concluded.

6) REPI Credit Revenues:

Revenues from the Renewable Energy Production Incentive (REPI) credit are supposed to be $18/MWh for non-profit public utilities. However, the U.S. Federal Government's REPI program has only provided about 80% of these funds in its annual budgets. The effective REPI renewable energy credit is about $15/MWh amounting to ~$2,428,000 annual savings for Energy Northwest and the eight participating PUDs. The project would not be profitable if REPI credit program was not available.

7) Integrating Wind Power into a Hydropower-Based Utility

The Nine Canyon Project experience has demonstrated that a small amount of wind power can be integrated into a hydropower based Load Control Area (LCA) fairly easily. There is little, if any, energy imbalance capacity devoted to following wind power swings beyond that required by a utility simply following its natural load swings. This suggests that there is minimal need for additional ancillary services. For the case study, Okanogan PUD's internal balancing costs are assumed to be $0.9/MWh (~$145,000 per year); however, this price would increase to $4.5/MWh (~$728,000 per year) if this service had to be purchased from Bonneville Power Administration.

8) Limits on Wind Power Penetration

There is significant debate on the penetration limit of wind energy that a small utility with hydropower resources can absorb. No serious problems arise at a 11.4% power penetration level (i.e. 16 MW of wind power on a base of 140 MW of total hydropower capacity), but at some point there could be shortcomings in the ability of hydropower to back up, shape, and accommodate the wind power without unencumbering hydropower capacity to serve load.

THE BIG PICTURE

The State of Washington passed an initiative in November 2006 which requires utilities with more than 25,000 customers to obtain 15% of their electricity from "new" renewable energy resources by 2020. Okanogan PUD is currently at about 7% of this target on an energy basis with its share of the Nine Canyon Wind Farm Project.

As energy prices continue to increase in the future, Okanogan PUD's wind power is expected to supplement its hydropower resources at below market prices. Although drought periods tend to be associated with lower average wind speeds, there is some wind power during these times with relatively high value which tends to compensate for the lack of wind.

Okanogan PUD is pleased with the purchase of wind plant resources to date and wind power's ability to be competitive with the market. Okanogan PUD also sees benefits in the project's ability to complement its hydropower base. The PUD will certainly consider adding more wind power to meet future power load growth, especially since the PUD's ratepayer surveys indicate they prefer cost-effective renewable energy resources over other generation resources.

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HOW INNOVATIONS IN DEMAND RESPONSE ARE SHAPING A NEW ENERGY FUTURE

By Peter Kelly-Detwiler, Constellation NewEnergy

According to estimates from the United States Energy Information Administration, in just two decades U.S. energy consumption will increase by about one third. The majority of this new generation will go toward meeting the needs of our built infrastructure. Whether this increase in demand is accompanied by a corollary increase in greenhouse gas emissions has a great deal to do with the energy decisions we make today. Against this backdrop, Constellation NewEnergy, an experienced energy advisor to several hundred megawatts of load response customers across North America, is driving innovations in demand response that have the potential to significantly alter the energy landscape.

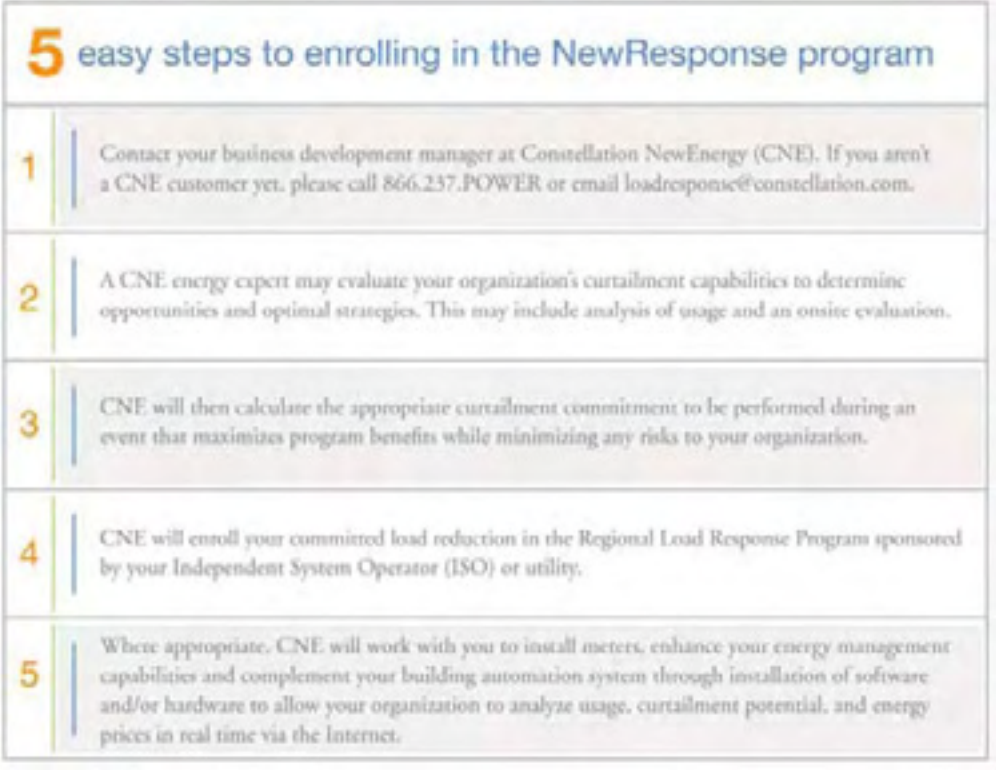


Figure 1: There is an annual deadline for enrolling load into the demand response program and the minimum commitment is for one year. Getting started takes five easy steps.

TRADITIONAL DEMAND RESPONSE PROGRAMS

Traditionally, demand response has been a program designed by independent system operators (ISO) to help prevent blackouts and brownouts on the hottest or coldest days of the year when energy is at peak demand. Commercial and industrial customers, who demonstrate an ability and commitment to curtailing at least 100 kilowatts of electricity, can sign up to participate in an ISO-directed demand response program through a competitive energy supplier such as Constellation NewEnergy. For smaller businesses or facilities that cannot solely meet the 100 kilowatt minimum requirement, it is possible to aggregate load reductions across multiple locations. There is an annual deadline for enrolling load into the program and the minimum commitment is for one year. Getting started requires that a facility be equipped with an interval meter capable of reading consumption in hourly increments and communicating with the ISO or responsible utility.

In this way, the ISO harnesses the energy conservation efforts of its customer base rather than bringing older gas, oil or coal plants on-line to meet demand. At the individual facility level, these conservation efforts often reflect dimming lights and raising the set point on thermostats, or changing production schedules in some cases.

Participating customers commit to curtailing their energy usage for a designated amount of time during these peak events. This is a win/win for business and the environment as 1) participants avoid purchasing energy when it is at its highest costs, and 2) it avoids the need to have older, greenhouse gas emitting peaking plants come online. In addition, participants earn year-round financial benefits for committing to reduce energy consumption from the grid when called upon.

For businesses seeking a real-time return on investment, enrolling in a demand response program is a smart business decision. The payback for participating can be measured in immediate savings. In exchange for enrolling load into the program, a participating company or facility can begin earning compensation in the form of recurring monthly capacity payments simply for committing capacity to the program. In addition,

participants receive an energy payment for their participation during an actual ISO-initiated event. This payment reflects either the going market price or a minimum price per megawatt-hour of the electricity curtailed during the event.

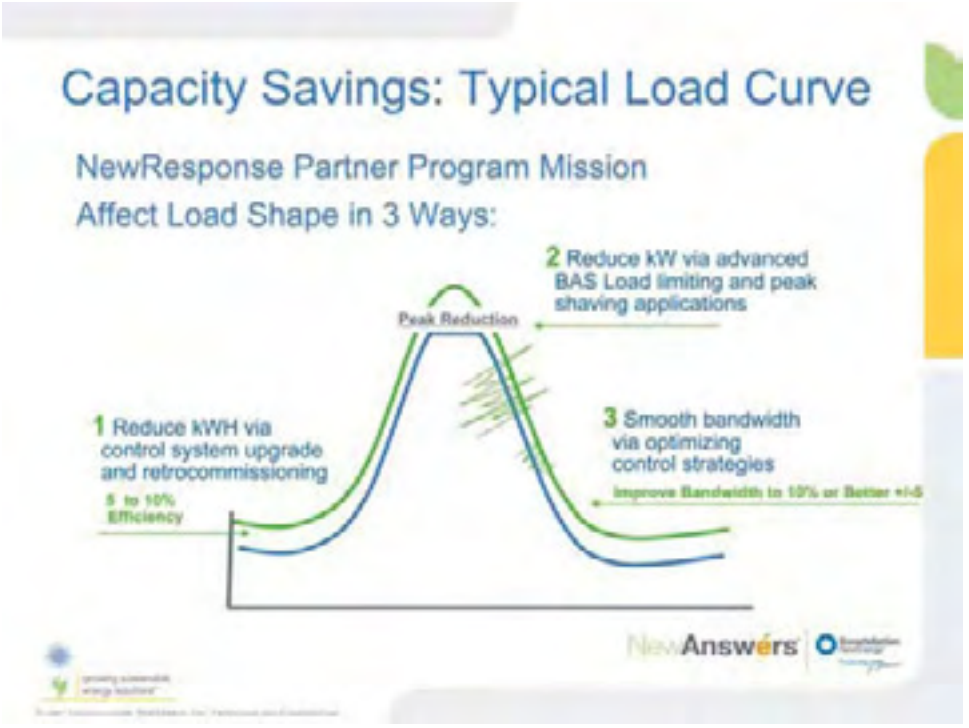


Figure 2: Potential capacity savings as seen in a typical load curve.

A NEW APPROACH TO DEMAND RESPONSE

What is important to recognize is that until recently, demand response has been primarily a reactive program and the typical response to an ISO-initiated directive to curtail energy load has been to fire up the back-up generators – a fairly blunt instrument with its own air emissions issues. Today, thanks in large part to innovations introduced in the deregulated energy market, the fundamentals of demand response are changing rapidly, bringing increasingly more sophisticated and environmentally sound ways of limiting energy consumption to the table. These opportunities, which go well beyond dimming lights and adjusting temperature, can be leveraged during peak times and all year.

When deploying a load response solution, it is imperative to actively engage facility managers from companies of all sizes to keep a wide range of systems operating efficiently and effectively under a myriad of conditions, including a volatile energy market and a steady increase in capacity costs. To advance this approach further, Constellation NewEnergy is partnering with multiple systems integrators to develop a holistic load response solution that incorporates energy supply and demand information and knowledge onto one comprehensive and open IT management platform.

Systems integrators already utilize building automation systems to manage the lighting, HVAC, and air conditioning infrastructure within a facility. In fact, open platforms are proving to be the most successful foundation for integrating once disparate control processes and infrastructure. This ability to bridge and consolidate information on one platform has focused on introducing efficiency and conservation efforts such as automated lighting, internet access, phone systems and heating and ventilation control. These integration efforts have required significant capital investments but improved efficiency and enhanced decision-making at the building management and operations level of an enterprise. Even so, today's buildings are still not realizing their full potential. Constellation NewEnergy is leveraging the opportunities that have come about as a result of a more competitive energy market to change this paradigm.

Load management and energy efficiency strategies are most effective when all elements of the energy chain are linked together for the customer. Integrating load response programs onto existing open platforms brings the supply side of the picture into perspective, putting facility managers, business own-

ers and building management in a position to leverage both the demand and supply side of the equation. This holistic approach allows an energy team to take full advantage of opportunities in an ever-evolving energy marketplace. As illustrated in

Figure 2, these opportunities include:

1) Reducing load via control system upgrades and retrocommissioning.

2) Reducing load via advanced BAS load limiting and peak shaving applications.

3) Smoothing bandwidth via optimizing control strategies.

Enhancing the flexibility of a company's facilities is fundamental to reducing future energy demand. Just as importantly, it reduces stress on the power grid today. By incorporating load response metering and real-time market pricing into existing energy management techniques and multiple building systems, a business is able to elevate its energy management and conservation efforts well beyond dimming the lights or adjusting the thermostat.

Access to real-time metering and price information systems, which allow up-to-the-minute views of energy usage and costs and the ability to employ this information to better shape and control usage patterns, puts a business in the driver's seat of a smarter and more energy responsive building. Fully integrated and intelligent buildings do more than respond to mandatory curtailment demands.

These buildings are capable of reacting to changes in the energy marketplace at anytime by shedding load and adjusting consumption to maximize economic efficiency. As a result, intelligent buildings are able to shift electricity consumption from periods of high prices to periods of low prices and reduce overall energy costs in the process. In this respect, the initial commitment to enroll load in a region's ISO-directed demand response program represents only the first step on a path to participating more fully in the restructured energy market.

Overlaying the new demand response onto existing open platforms makes it possible to more successfully harness and shape load whether the load is distributed across a single facility, college campus, or retail chain with multiple locations throughout a large geographic area. At Constellation NewEnergy, we think this ability to shift and shape load across multiple buildings is going to reveal itself to be the smartest and most efficient way to create the virtual peaking plants and intelligent buildings of the greener energy grid of the future.

FUTURE INNOVATIONS AND OPPORTUNITIES

Looking to the future, buildings of all sizes will be flexing and pulsing in response to energy prices and elasticity in the marketplace. Imagine a big box retailer shifting load among 30 of its stores based on inputs such as day-ahead pricing, customer patterns and weather. From there, it is a short distance to a future in which the ebb and flow of electricity will not solely be from the grid but rather among the individual and collective enterprises which comprise the built landscape.

Innovations of this magnitude in our built environment, by virtue of its role in consumption, have the potential to shift our understanding of energy generation, demand and load allocation in an entirely new direction.

This shift in understanding is already underway, as recently evidenced by the success of DR-Expo which took place October 16 -17 in Chicago, Illinois. DR-Expo brought together over 200 building owners, energy and facility managers, systems integrators and building automation contractors to discuss the benefits of demand response and other efficiency programs as both a short-term business proposition and as a route to the significant future market in sustainable energy. A renewed commitment to deliver the perspective and tools required by the industry to incorporate innovations in demand response into existing building automation efforts is perhaps best demonstrated by the creation of the NewEnergy Alliance, of which Constellation NewEnergy is a founding member.

Formally announced at DR-Expo, the NewEnergy Alliance is bringing together leaders from the retail energy and building automation industry. Alliance members are intent on developing and advancing innovative and sustainable business solutions for successfully integrating advanced demand response opportunities into existing efforts to reduce the carbon footprint of the established building environment.

The NewEnergy Alliance brings together the technologies, manufacturers, engineers, and service providers from across the energy, IT, and building systems industries that can collectively help drive pioneering approaches in demand and load response technology for decreasing the energy use in our built environment. The Alliance will work to fast-track innovations in demand response technology that are demonstrated to provide greater building efficiency. This collaborative effort will help empower and create immediate revenue opportunities for all who wish to directly participate in demand response with their products, services and technologies.

Participants in the building automation sector already know that reducing costs by automating functions across a facility is good business. Those that can bring an enhanced intelligent market-based load management product to the table will be well received by customers seeking to leverage existing investments in technology and infrastructure in a way that unites their energy purchasing strategies with corporate responsibility.

In today's competitive business environment, managers and owners are thinking about energy as a strategic asset integral to every aspect of the bottom line. The capacity to actively monitor and manage usage and adjust operations accordingly reflects the increasingly sophisticated energy strategies now available.

Load response solutions are particularly attractive to businesses that have already invested in intelligent building designs, and wish to leverage the full spectrum of the energy chain to maximize these energy investment decisions. Constellation NewEnergy is helping customers adapt successfully to this new energy paradigm and positioning them to make the most of the opportunity to participate in the emerging energy marketplace of the 21st Century.

Peter Kelly-Detwiler is Senior Director of Energy Technology Services for Constellation Energy's Sustainable Energy Solutions Group. He can be reached at Peter.Detwiler@constellation.com

ANALYZER TECHNOLOGY BOOSTS POTENTIAL FOR CONVERTING BIOGAS TO POWER

By Ed Sullivan

The ability of advanced, laser-based sensors to detect moisture, hydrogen sulfide and other contaminants in gases can smooth the way for biogas as a resource for electric utilities.

Wouldn't it be great if some of the expensive Green Power programs you hear about actually worked? Experts and financiers are predicting it will take billions of investment dollars and decades to get any meaningful quantity of energy from alternative resources.

Maybe not. One of the oldest and most widespread forms of potential energy – methane gas – promises to give those efforts a sizable boost – right now.

The main component of "natural gas," methane is found in abundance in many places other than subterranean gas wells. Landfills, oil pipelines, pasturelands, forests and waste treatment plants all contain methane or the biomass from which methane can be formed.

"Although methane gas contains plenty of energy, until recently the gas available from many sources has been considered economically unviable as a source of energy," explains Sam Miller, a senior official with SpectraSensors, Inc. (Rancho Cucamonga, California). "Whatever the source of methane, you have to get it to market, which often means getting it into a pipeline that delivers gas to users such as power plants and industrial companies."

Transporting and marketing methane through pipelines requires that it meet safety and quality standards, Miller explains, since virtually all biogas contains significant amounts and varieties of impurities that must be removed before pipelines will transport it and customers will accept it.

Such impurities can disrupt the flow of gases, damage pipelines and contaminate the air with toxins that can be deadly to breathe.

BioEnergy Solutions (shown above, President David Albers) will deliver up to three billion cubic feet of renewable natural gas a year to PG&E. Using SpectraSensors' laster-based gas analyzer technology, this is the first project in California to deliver pipeline-quality, renewable biogas to a utility.

PG&E HARNESSES COW POWER

This spring, BioEnergy Solutions (Bakersfield, California) launched that state's first biogas-to-pipeline injection project in Fresno County, central California. The project is using renewable natural gas derived from animal waste at a PG&E site.

"With nearly two million dairy cows in California, there is great potential for the state's agriculture and power sectors to work together to address the challenges of climate change," said Roy Kuga, vice president of energy supply at PG&E. "This project is yet another example of our company's commitment to add innovative forms of clean renewable energy to help meet our customers' future power needs."

PG&E is one of California's largest investor-owned utilities. The state's recently enacted Renewable Portfolio Standard (RPS) Program requires each utility to increase its procurement of eligible renewable generating resources to achieve a goal of 20 percent of load by 2010. The RPS Program was passed by the California Legislature and is managed by the CPUC and California Energy Commission.

Under a long-term contract approved by the California Public Utilities Commission (CPUC), BioEnergy Solutions will deliver up to three billion cubic feet of renewable natural gas a year to PG&E. Using SpectraSensors' laser-based gas analyzer technology, this is the first project in California to deliver pipeline-quality, renewable biogas to a utility.

"We are using these analyzers to monitor moisture in the methane," explains David Albers, BioEnergy Solutions president. "And of course we're checking for hydrogen sulfide content and carbon dioxide content. We're also sampling any pathogens, although we haven't found any and don't expect to. But we will test for them just the

same."

Albers says that the project, located in the town of Riverdale in western Fresno County, will use manure from the Vintage Dairy's 5,000 milk-producing cows and calves. The waste is flushed into a covered lagoon – equal in size to the area of nearly five football fields and over three stories deep – that traps the methane gas produced as the manure decomposes. The biogas is upgraded, or "scrubbed," to remove corrosive materials to meet PG&E's industry-leading environmental standards for power plants and then delivered to PG&E through the utility's pipeline.

PG&E uses the natural gas to deliver renewable electricity to its customers in central and northern California. The methane production system also reduces emissions of methane, a greenhouse gas 21 times more potent than carbon dioxide, by 70 percent.

Albers says SpectraSensors moisture analyzer offers assurance that the project will continually meet PG&E's high standards. He adds that in addition to offering the highest reliability of gas analyzers, this technology also has a track record for considerably lower maintenance costs in both labor and consumables.

PG&E, a leader in utilizing biogas, is also a user of SpectraSensors technology. In addition to the utility's contract with BioEnergy Solutions, it is working to cultivate the next generation of biogas technologies through its biomethanation research project.

Depending on what impurities might be contained in "polluted" gas – substances such as H2O, H2S, CO2, unsaturated hydrocarbons and glycols – it is vital to use monitoring equipment that can accurately read the levels of contaminants in gas streams.

The "gas analyzer" technology needed to quickly and accurately measure a wide variety of contaminants and background gases. It was advanced to new heights by SpectraSensors, Miller's company, which makes him highly optimistic about the safety and economic viability of using non-standard sources of methane and other biofuels.

"There has been a significant rise in activity in production and distribution of 'green gas' as an alternate fuel," Miller says. "Our company considers this a growth market. And while a primary market for our analyzer instruments include pipeline-quality natural gas from traditional producers, we can also help non-traditional producers deliver clean methane to various power generation customers."

In the traditional natural gas production and pipeline market, the SpectraSensors gas analyzer line has become the de facto standard for ensuring consistently accurate readings in gas streams, without expensive labor and replacement costs.

Miller cites several examples of sources for methane, which together could amount to a very sizable reduction of greenhouse gases as well as renewable resource for generating electric power for a grid that every year experiences added demand and will soon have to accommodate plug-in passenger cars.

"Waste-to-energy methane from human and livestock digesters has the potential to become a major source," he says. "But other, smaller sources are becoming increasingly viable. For instance, the methane gas pockets present in pipeline oil has traditionally been burned off when it reached the oil refinery. Now, it is economically feasible to feed that gas into a gas pipeline and use it to generate electricity."

The patented technology that SpectraSensors employs in its gas analyzers is tunable diode laser (TDL) based absorption spectroscopy. This is an optical measurement technology used to detect moisture (H2O), Carbon Dioxide (CO2), Hydrogen Sulfide (H2S), Ammonia (NH3), Oxygen (O2) and more.

In the traditional natural gas production and pipeline market, this technology has become the de facto standard for ensuring consistently accurate readings in gas streams. Not only is it in use among many leading pipeline operators, but is also the technology of choice among leading utility companies.

FAST, ACCURATE AND LOWER IN COSTS

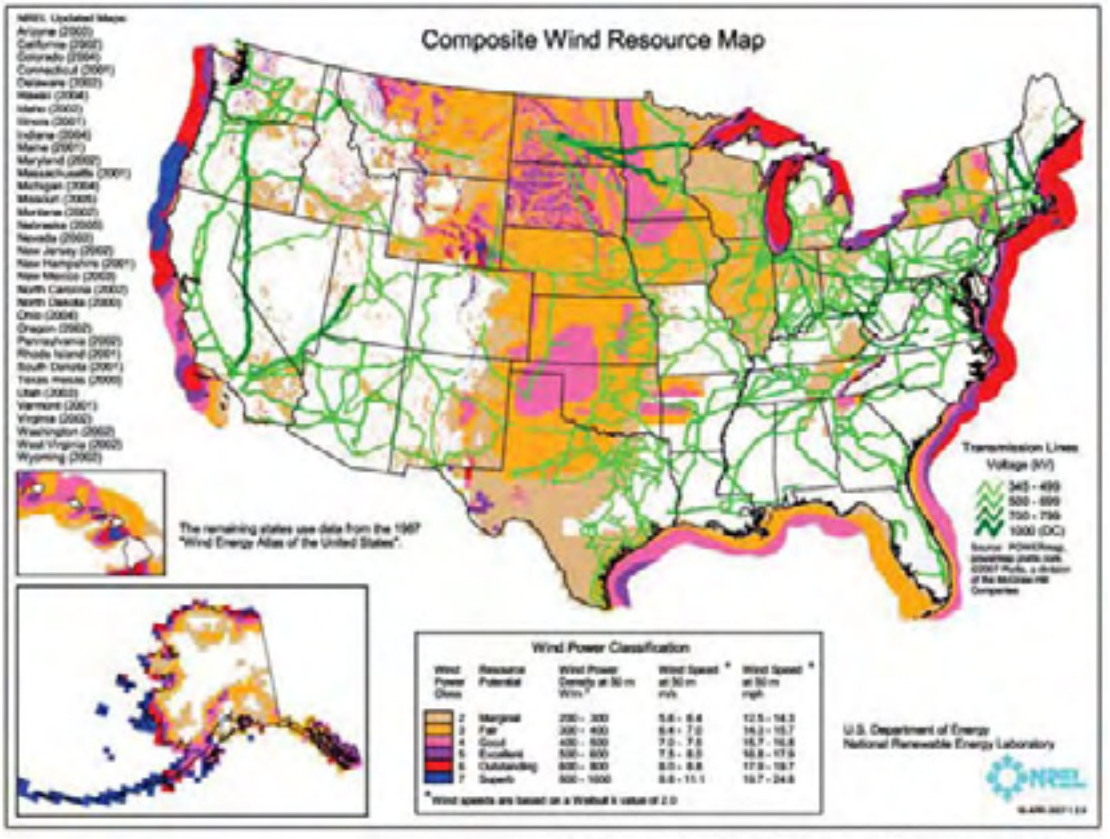
Essentially, the SpectraSensors TDL-based gas analyzer uses laser (light) absorption spectroscopy to identify and measure one or more gases in a flow of mixed gases. This type of analyzer is typically "tuned" to monitor a target gas (e.g. H20, CO2, H2S) by monitoring the absorption of light at wavelengths specific to the target gas.

The SpectraSensors gas analyzer line is designed to provide extremely fast and accurate readings without expensive labor and replacement costs. That is because the gas is analyzed away from the stream in a sample cell. As the laser light passes through the gas sample in the cell, the presence of any target gas is detected and its concentration measured.

"This design is very process worthy," says Miller. "The TDL-based analyzer technology has proven to be so reliable and trustworthy that it is the new standard in the natural gas pipeline industry, and is being adopted by oil refineries, petrochemical plants and process industries all over the world."

ACCOMMODATING INTERCONNECTION AND INTEGRATION OF WIND POWER - PART I

By Sandy Smith, Utility Wind Integration Group



Source: National Renewable Energy Laboratory

Over the past few years, wind power has been recognized as a significant emerging source of electricity. According to the American Wind Energy Association (AWEA), in the United States alone, during 2006, 2,454 megawatts (MW) of nameplate capacity was installed, bringing total capacity to 11,603 MW. There are several key drivers for this expansion, including many states adopting rules requiring a certain percentage of electricity to be generated from renewable resources, effective tax incentives for building wind plants, and increased concern about the production of greenhouse gases from fossil generation. Late last year, AWEA and the U.S. Department of Energy (DOE) introduced a 20% by 2030 Vision Scenario for Wind.

One major obstacle for achieving that goal is the inadequacy of the national transmission system as it currently exists. Put simply: where wind is, transmission generally isn't. The chief contributor to this is the fact that the areas with the best wind resource are remotely located from load centers. Construction and/or expansion of transmission systems is a complicated and expensive undertaking, with costs running into the millions or billions of dollars and the process including siting, permitting, acquisition of right of way, environmental impact assessments, and numerous other steps. On top of all of this is the fact that there is a clear "Not In My Backyard (NIMBY)" mindset when it comes to opposition to siting and construction of transmission lines.

TRANSMISSION AS A NATIONAL ISSUE – NATIONAL INTEREST ELECTRIC TRANSMISSION CORRIDORS

The Energy Policy Act of 2005 directed the U.S. Department of Energy to conduct periodic national electric transmission congestion studies and to designate National Interest Electric Transmission Corridors if deemed appropriate. Under the Energy Policy Act of 2005, the Federal Energy Regulatory Commission (FERC) can issue, under certain circumstances, permits for new transmission facilities within a National Corridor. If an applicant has not received approval from a state regulatory body to site a proposed new transmission project within a year of application, FERC may consider whether to issue a permit and to authorize construction of the project. In May of last year, DOE announced two draft corridors – the Mid-Atlantic Area National Interest Electric Transmission Corridor consisting of potions of Ohio, West Virginia, Pennsylvania, New York, Maryland, Virginia, and all of New Jersey, Delaware, and the District of Columbia – and the Southwest Area National Interest Electric Transmission Corridor including portions of California and Arizona. The initial draft of the Southwest National Corridor also included a part of Nevada, which was excluded in the final version.

Continued on Page 42

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AERIAL THERMOGRAPHY SURVEYS FIND INSULATOR AND OTHER PROBLEMS

By Derrick Brydges, Hydro One

This article will examine the application of aerial thermal imaging surveying on a transmission electrical system, and new applications involving insulator failure detection and new research in wood arm deterioration.

The goal is to show the approach to an aerial survey from pre-planning the actual patrol to follow up reporting. The blackout of 2003 has placed more emphasis on proactive preventive maintenance programs. An identified component repair can be performed at 25% of the cost, versus a reactive unplanned approach. This excludes the loss to generators due to bottleneck flow. My analogy to this is similar to a toll highway. When open the client is profiting when closed the clien is not.

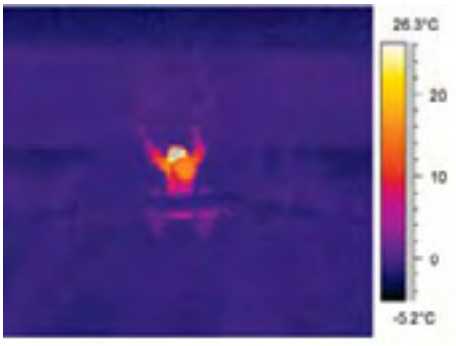
Photos show the Gimbal mounted under the Aircraft. Notice the two monitors so the Pilot and Thermographer can work together. (At right) Work station for the Thermographer. A screen monitor and a field tablet as a second monitor and data collector.

INTRODUCTION AND HISTORY

Hydro One (formerly Ontario Hydro) owns, operates and maintains 30,000 km of transmission lines in a province of more than 400,000 square miles (50% bigger than the state of Texas).

These 500-kV, 230-kV and 115-kV assets are valued at over 5 billion dollars.

Our mandate is to ensure public safety, system security and asset protection. Our infrared camera program helps to achieve these goals by continuously monitoring the transmission system. Circuits are selected for patrols on a priority basis and we maintain the flexibility to react to a system configuration that may increase the load on circuits. Power Line Surveys represent a moment in time, to guarantee future performance is risky. We attempt to obtain minimum load requirements before a survey is carried out and this is part of the pre-planning. System outages are monitored along with seasonal weather patterns to help achieve these goals. Ontario, due to its geographic location, experiences cold winters and hot summers. In winter, home heating load is predominant in the Northern Province while in summer, air conditioning load is experienced in the South. Hence, surveys are performed in the North during the winter and late fall time frames while the South is monitored in the summer. There is a period in warmer spring when the snow melts and the Northern hydraulic dams are maximized for generation to the South.



IR image of a Skywire hardware anomaly.

Once an anomaly is detected, a closer view can be established.

EQUIPMENT

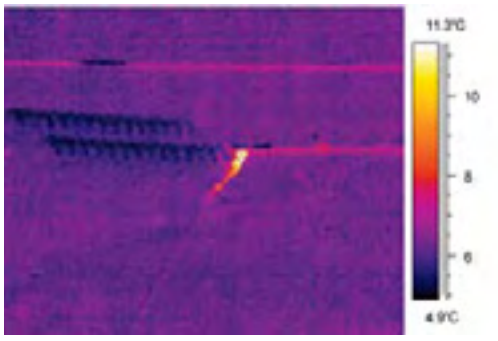
Hydro One owns and maintains a fleet of helicopters for many applications, thermal imaging camera scans included. Surveys are carried out utilizing the Polytec Kelvin 350 Gyro stabilized Gimbal. This unit was produced as per our specifications and contains the THV 570 infrared camera (12 degree lens), along with a Sony FCB-780 Video camera and a 5 mega Pixel Canon Power shot G5 frame camera. The THV 570 is calibrated annually which includes the factor for transmission effects with the gimbal infrared glass. The infrared cam-

era is removable from the Gimbal with ease. All IR cameras operate at the same time and two can be monitored at once as per requirements.

COMPONENT ANOMALIES

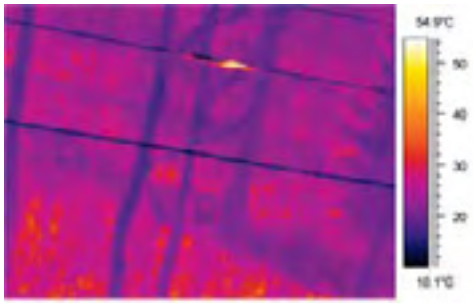
Hydro One helicopter pilots spend their days continuously close to utility wires, therefore they are comfortable being close to these structures and wires. Regulation dictates that a minimum of five feet must be maintained between the main rotor and tail rotor from any solid object. This permits us to fly the circuit's low level at app. 60 knots (70mph). When an anomaly is detected we will close in and capture the image. The issue of down wash cooling the component is not a major factor as the time on station is very quick. With the two monitors the pilot can reference himself on the initial pass move in quickly and the infrared and digital cameras capture the image.At the end of the day the data is analyzed and quantitative reports are generated and sent to the local representative. All Hydro One activities are supported by documents including the thermal imaging program. Ratings are based on documented data that has been developed in conjunction with Hydro's research department.

The most common anomaly detected is the bolted pad, which consists of two separate aluminum pads which are connected together with steel bolts and a spring loaded Belleville washer which are tightened with a pre-set torque value. This setup applies the proper pressure between the two aluminum pads. When the proper force is no longer available to the two pads, a resistance will generate heat. There are two detailed articles of this phenomenon in the Maintenance Technology magazine. The titles are "The Trouble with Torque in Electrical Connectors" and "Creating Reliable Electrical Connections".



IR image of 230 kV bolted connector

230 KV Dead end tower



Conductor sleeve anomaly.

Aluminum conductor sleeve with Inner Steel Core sleeve.

500 KV Dead-end string.

115 KV Suspension string.

Another component that commonly shows up as an anomaly is conductor splices. These are used to connect the two ends of wire where the reel ends. In the transmission lines, due to the size and tension requirements of these wires, a steel core is found inside the aluminum sleeve.

In preparation for installing one of these splices, the steel sleeve is pressed onto the small diameter steel core, then the larger aluminum sleeve is installed over the top. The steel is used for strength and the aluminum for current transfer. During the preparation process, a joint compound is applied. This thin film of black compound is applied after cleaning the aluminum and may extend past the end of the connector. Without the proper settings on an IR camera, this product can give a false image of an anomaly.

INSULATOR ANOMALIES

Over the years, we have detected many insulator anomalies during aerial surveys. These would show up on transmission circuits utilizing porcelain insulators and on transmission/distribution circuits utilizing NCI (non-ceramic insulators). It was due to the high frequency of these insulator anomalies that Hydro One, in conjunction with Kinectrics (formerly Hydro Research dept.), decided to perform some lab studies utilizing IR technology. These tests were broken down into two parts, one to study the effects of the NCI, and the other to address the Porcelain failures.

PORCELAIN:

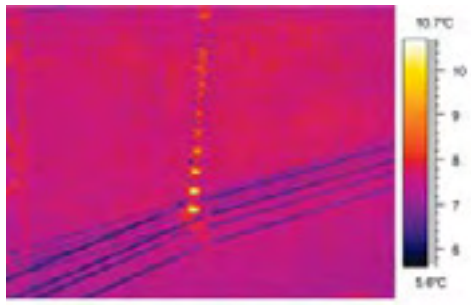
Insulators are designed to insulate the energized wire from the structure supporting it. Different voltages require different lengths of insulated distance.

Each insulator string has a set number of acceptable defec-

tive insulators. Once this number has been reached, the insulation value of the string has been compromised and replacement will be scheduled. If the infrared camera survey records a few anomalies, there will be a follow-up visit from a crew to test the rest of the string with the Hi-test insulation tester. The Hi-test insulation tester is a 10 kV di-electric device that is isolated from the line allowing the insulators to be tested while energized. If the infrared survey detects the minimum number of suspect insulators, the string will be replaced immediately without a follow-up Hi-test insulator program.

Under operational conditions, the porcelain skirt can crack which may not be detected by the naked eye. This results in causing an undesirable leakage. A good insulator behaves as a resistor and capacitor, hence any resistive leakage current will cause the metal hub to rise in temp. Once this happens, the infrared camera will detect an anomaly.

Through trial and error we have found that the best time to perform this type of survey is in a humid air climate.



IR image of a 500 kV insulator string.

Cracked insulator skirt.

This accelerates the electrical activity much more than a dry day but it is still possible to detect an insulator anomaly with any type of weather conditions. This is a non-radiometric application, as once the thermal signature is detected, we know from case studies the steel hub has a temp rise due to electrical forces concentrating on it.

NCI INSULATORS:

Non-ceramic insulators consist of a rubber material for insulation, with an internal fiberglass rod for strength. When manufactured, the rubber is bonded to the fiberglass rod to eliminate voids. From the lab tests performed, it was determined that lack of bonding between the rubber housing and the fiberglass rod contributed to failure.

Other methods that were tested to help identify a suspect NCI:

- Visual Inspection - not helpful
- UV inspection - not helpful
- Ultrasound EM - not precise

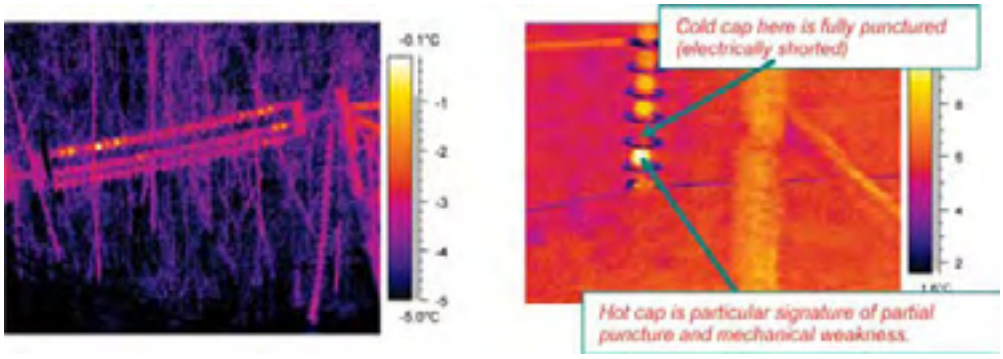
From these trials, it was determined that inspection by thermal imaging cameras is the best.

ThermoVision Measurements on NCIs.

Examples of Hidden NCI Damage.

NEW RESEARCH:

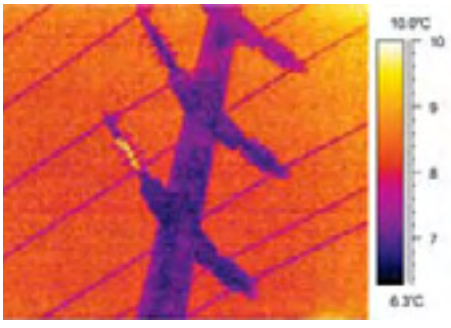
We are always on the lookout for ways to improve our processes to maximize the utilization of our resources. We are in the process of performing field trials with the University of Waterloo, Ontario. Once again, with the assistance of Kinectrics, we are going to study thermal signatures on wood components and correlate the data with cross section cutting. This will enable us to identify priority repairs on Gulf Port Spar arms while on helicopter patrols.



Percentage of the total string voltage across each unit.

CONCLUSION:

Hydro One has always maintained an aggressive pro-active approach to monitoring their grid systems. Aerial thermography has played a constant and vital role in detecting anomalies in the system, enabling repairs to be initiated before failures occur. This inevitably helps to ensure system security and reduce capital costs.



Double circuit distribution line.

Flashed Insulators.

230 kV pole structure showing suspect locations of high failures

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ACKNOWLEDGEMENTS:

The author wishes to thank the support team of Flir (Burlington Ontario Canada) and Kinectrics for always supporting my program.

FUELING INNOVATION AND TRANSFORMATION IN THE ELECTRIC UTILITIES INDUSTRY

By Peter Ruppert, Energy & Utilities, IBM Global Business Services

The utility industry is undergoing dramatic and fundamental changes as power system and computer convergence, new business and consumer-driven models are motivating companies to more efficiently and effectively integrate, access, retrieve, exchange and analyze information and data faster, easier and at lower costs.

In order to respond to this new collaborative era, utilities companies are turning to open industry standards as a catalyst for innovation and transformation.

Every utility company has important data buried throughout the enterprise and its extended partner network — useful data about operations, skills, supply, demand, quality, consumer behavior and more. All that information, regardless of its form, can potentially be integrated, analyzed and exploited in innovative ways, thanks to open standards. As such, information created today can be made easily accessible and able to be processed in the future to benefit the energy industry and consumers alike.

A movement already exists across the electric utilities industry to secure open industry standards through new integrated initiatives such as the Intelligent Utility Network.(IUN), which tie together smart grid investments and strategies across a common framework. IUN technologies are aimed at enabling more real-time operational intelligence, connectivity and visibility into the technology infrastructure and across the electricity supply chain.

Cross-industry collaboration is paramount to further establishing IUN technologies based on open industry standards, as exhibited by the DoE-convened GridWise Architecture Council's efforts to foster an industry-driven Interoperability Framework for smart grids. These standards need to be created where information interfaces already exist. For example, smart metering will never be given the opportunity to flourish if manufacturing and utility industry automation groups do not collaborate.

> For example, smart metering will never be given the opportunity to flourish if manufacturing and utility industry automation groups do not collaborate.

Standards are being established in developing technologies to support individual appliances, but in order for a smart meter to display appliance usage in real-time and be monitored through a network portal, new standards must be agreed upon. Some utility IT players are establishing collaboration platforms, such as the UCA User Group's (http://www.ucaiug.org/default.aspx) and IBM's EnergyCommons (www.energycommons.com).

And yet, existing standards need more work in order to be truly effective in implementing the electric power grid of the future. For example, Web Services SOAP is not as much a standard as it is a W3C recommendation. The Web Services Interoperability Organization suggests some specific versions to obtain interoperability. See http://ws-i.org/

The IEC's Common Information Model (CIM) is very thorough and complete, and provides a good set of industry standard terminology. It contains a very extensive set of physical characteristics of power system components. However, it originally focused on electric power transmission, not on distribution below the substation level.

This IEC 61968 standard can be found at http://webstore.iec.ch/webstore/webstore.nsf/artnum/031109.

The CIM model for connecting major circuit components is too detailed to support the computational efficiency required to support real-time grid analytics. A look at modifying the perspective from which the original model was developed may be in order. The CIM was developed with a focus more on the needs of asset and maintenance management. Power lines are described primarily in terms of their detailed physical characteristics. Grid analytics require that segments of the power line be categorized in terms of their functional relationships to other segments, e.g., relationships based on sectionalizing switch configurations.

These functional relationships do not need to include all the connectivity detail, e.g., terminals and logical connection points that are included in the IEC CIM. They also do not need to include the segmentation based on changes in physical direction that power lines take, which is included in many geographic information systems (GIS).

Though work needs to be done, open standards are already allowing the utility industry to link disparate systems together faster, easier and at lower costs to deliver a variety of new solutions that will benefit manufacturers and end users alike. Some vendors are already demonstrating IEC 61850 cross-brand communication.

Over the next five years, open standards will shape the way in which the utility industry does business, including:

1. Increased negotiating power and competition will be the norm as open standards make single supplier situations a thing of the past. Interoperability will increase, as was the theme of the GridWise Architecture Council's

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Fueling Innovation

Continued from Page 32

recent Grid Interop Conference (http://www.grid-interop.com/2007/) Open standards will propel a more competitive marketplace for goods and services resulting in lower prices - and more choices for everyone.

2. A new generation of industry-specific standards based on service oriented architecture (SOA) and open infrastructure standards will be created. These will couple technology and business processes to decrease costs, speed time-to-market, expand available options and resources, improve communications, reduce risk and create more durable solutions.

In summary, open standards will increasingly be driving innovation and transformation in the utility industry, by lowering the cost of bringing innovation into the system. As radically new forms of collaboration take hold — within a company, between companies, with online communities of experts and even with previously unknown individuals worldwide — open standards will be the glue that will tie all this together, and give businesses choice.

UTILITY EXECUTIVE COURSE PROVIDES TOP TIPS FOR INDUSTRY

By Joni Kirk

The utility industry is undergoing dramatic changes. Faced with new technologies, aging facilities, baby boomer retirements and environmental pressures, among many other business concerns, it may be difficult to figure out what issue to address first.

Utility leaders will gather at the University of Idaho for the 55th annual Utility Executive Course, the only such educational program in the world that encompasses all aspects of a utility.

"The Utility Executive Course is a comprehensive immersion, training people about how a utility operates end to end," said Jim Kensok, vice president and chief information officer of Avista Corporation. "Finance, pig in the pipe, rating agencies, ITS, smart grids, marketing, carbon sequestration – it's all covered."

A.R. "Skip" Collier presenting "Electric Power Generation, Transmission and Distribution" at the Utility Executive Course. Collier is a course manager for Professional Training Systems, Inc., and is on the faculty for the UEC.

An advisory board comprised of industry executives from around the region analyzes course content annually to ensure it reflects current issues. Kensok, chair of the course's advisory committee, said the course helps participants to learn industry fundamentals from expert faculty, and provides a forum for addressing diverse points of view and facilitates dialogue on key industry issues.

According to Kensok, some of the top issues to address in 2008-09 include:

• Carbon Sequestration and Emission Reduction Through Demand Response. As part of grid modernization, one of Avista's projects includes running "Live Lab" trials to understand how the electric distribution system and customer demand for energy can be influenced based on field trials of new utility, information and consumer technology. The Live Lab required several business units to combine forces to work on a new information technology and operating technology infrastructure.

"We need to know the behaviours of our electric system real-time end-to-end, which will allow us to introduce new products and services to more efficiently manage the grid and meet our customer demand at the right cost," said Kensok.

• Aging infrastructure. Utilities are faced with aging assets, capital constraints and rise in demand of energy. To minimize cost related to line losses, Kensok recommends surgically replacing transmission or distribution infrastructure based on empirical data. "Avista has a strong geographical information system

The College of Business and Economics (on the left) with the Administration Building (to the right and behind it) at the University of Idaho.

that helps – along with our demand response technology – determine where most outages occur due to age and other factors," he said. "By dealing with a specific problem area, we are able to target the greatest efficiency per dollar spent on our electric infrastructure."

• Transparency with customers. In all areas, from rate increases to environmental stewardship, communication with customers is a top priority. Avista turned to the Web to provide instant and personalized information for customers, including power usage, ways to reduce consumption or become more environmentally friendly, comparisons to neighbor use and a potential range of savings. Later this year, the company also plans to have outage information available. "These tools enhance the customer experience and allow the customer to feel more in control of the choices that affect their individual costs," said Kensok.

• Employee retirements. As the current workforce nears retirement, the industry is faced with lack of qualified employees. Kensok recommends companies start training the new generation now to ensure knowledge transfer. "It's not just regurgitating information, but knowing it and practicing it," said Kensok.

Utility leaders also will experience a gap with pending retirements. "That talent can only be addressed through educational programs, like the UEC," said Jack Morris, dean of the College of Business and Economics at the University of Idaho. "Our program is positioned to address the topics relevant to tomorrow's leaders because we're industry driven."

"Our advisory board is tapped into the daily operations of utilities and keeps us on top of important issues in industry," said Morris. "Our curriculum five years ago began to address carbon strategy, noting it as something that industry would be facing in the near future. This year, as an issue that is very significant worldwide, our course will devote a full day to carbon strategy and business models for addressing it."

The Utility Executive Course's international reach has touched more than 17 countries. Canadian companies have participated since 1954. These managers have gone on to be vice presidents, executive vice presidents, presidents, chief executive officers and board chairs.

As Idaho's land-grant institution, the University of Idaho's role and mission includes teaching and outreach. The Utility Executive Course is an example of the university's service to the state and beyond, as well as the College of Business and Economics' commitment to partner with industry. For more information, visit www.uidaho.edu.

EIM IS CRITICAL FOR SUCCESSFUL MOBILE AND GIS PROJECTS

By Bradley R. Williams Gartner,
Research Director, Energy & Utilities Industry Advisory Service

SUMMARY

Utilities must work through data quality issues to leverage more of their IT investments. Utilities will continue to become more dependent on tightly integrated GIS and Mobile applications to drive business performance in an age of aging assets and aging workforce. This paper focuses on the business requirements to develop utility enterprise information management business processes to achieve required data quality to achieve the business benefits of GIS and Mobile applications.

Too many projects do not achieve their desired benefits because they fail to incorporate the lifecycle of asset data management into their projects. Utilities can only achieve desired business performance by working through and managing data quality with defined processes, clear accountability, and KPI metrics tied to performance goals. This paper will discuss specific utility examples of successful EIM strategies in GIS and Mobile Projects. In addition, the paper will serve as a call to action for utility operations, engineering, and IT leaders to implement new approaches to manage data including enterprise information management (EIM) processes and using the common information model (CIM) as a utility integration model standard to support this.

Utility data problems can destroy value gained from Mobile and GIS Projects. Data quality is a corporate issue that must be solved with process and accountability first and technology second.

THE ROLE OF GIS FOR UTILITY INFORMATION MANAGEMENT

Geographic information systems (GIS) have their roots in field automated mapping products that came from linen and mylar drawings that were scanned into raster images. Originally, IT only provided a platform. Utility operations support functions provided drafters to produce maps. Outage management systems (OMS) gave GIS a boost in to manage the required network connectivity model. GIS became the best platform to maintain connectivity data and provide mapping products. Asset management and engineering functions have realized that the rich asset data in GIS can help drive many investment decisions to optimize performance.

By definition, utility must manage geographically diverse assets. Whether it's electric wires, gas pipelines, telecom equipment, water pumps and pipes, or wastewater infrastructure, they all must manage assets spread across their service areas. GIS network models are now being used across energy and utility companies to provide the data infrastructure to drive long-range financial decisions, as well as real-time operational decisions. Most utilities realize the value of GIS but struggle implementing real enterprise-level GIS and related integration. Many utility operations and engineering business units are too busy keeping up with day-to-day customer and stakeholder demands to consider the strategic implications of IT enterprise applications to help drive performance.

Utilities can't solve these issues by throwing yet another application at it. There are already too many stand-alone unsupported applications in utilities IT portfolio. Because utilities must manage geographically dispersed assets, over time, many have developed, maintained and managed geographic-based asset information in many stand-alone applications and databases. Investments in GIS-like projects have been recommended without a clear business unit and IT strategy. An IT strategy should provide a road map where it is going with GIS in terms of priority applications, data consolidation and long-term system requirements. Solving performance issues with new disparate applications has led utilities to multiple databases of record without methods to reconcile or maintain

data quality, in addition to excessive application support costs.

Managing disparate applications is wasting IT and business unit resources in maintaining the applications and managing the underlying data. If utilities are going to use technology to drive performance, they must deal with the underlying data management issues. Enterprise GIS must be an integrated part of the IT fabric. Stand-alone systems can no longer be cost justified, and strategic alignment is critical. Most utilities are talking about geospatially enabling, rather than building, GIS-like applications. In fact, the semantics are changing. GIS is increasingly described as a geospatial or location-based service.

Figure 1, GIS Business Value with Enterprise Integration

As GIS gets extended across the enterprise, there is an increased emphasis on the openness and connectedness of the system. This leads to increased business benefit and value but also an increased dependence on the system and data that drives it (Figure 1), Data is an asset shared by managers, designers, operations and engineering personnel, and customers.

Energy and utility companies need a GIS strategy that incorporates an Enterprise Information Management (EIM) framework, uses core enterprise applications to simplify the IT environment, and delivers effective model-driven integration via enterprise service bus (ESB) and Common Information Model (CIM).

UTILITY GIS APPLICATIONS

Enterprise GIS addresses issues that have constrained the legacy-automated mapping applications. Modern GIS applications provide the capabilities required to extend the GIS to every facet of the utility enterprise. As utilities push more advanced GIS applications, the need for quality data significantly increases. Here are some examples of utility Enterprise GIS enabled applications available today given the data that drives them:

- Core GIS (mapping, network connectivity, layouts, and single-line diagram/schematics)
- Graphic design transmission and distribution design and estimating
- Customer location generation
- Customer-to-network relationship management
- Engineering analysis
- Maintenance and inspection management
- Vegetation management
- Joint-use attachment management
- Streetlight management
- Right-of-way (ROW) management
- Real estate management
- Environmental management and plant relicensing
- T&D asset geospatial financial tracking
- Crew scheduling and dispatching
- Storm damage forecast and assessment
- Spatial land-based load forecast
- Strategic spatial asset management/business intelligence

MOBILE WORKFORCE APPLICATIONS ENABLE FIELD INFORMATION MANAGEMENT

Mobile applications need to support a variety of types of activities, and for some companies this will lead to a diversity of solutions. We believe in the long

term this will become more homogenized so that one technology platform can be used. While some vendors have multiple mobile platforms for different jobs, the direction is to merge these onto one platform that supports all utility related functions if possible;

- Capital construction
- Asset inspection and repair (AKA asset management)
- Work Management (AKA field service or reactive repair)
- Meter reading/install
- Customer related work.

Currently there are vendors who are more specialized in one than the others, and the technology investment decision will need to balance out these competing needs.

Related to the mobile devices themselves but part of the "server side" of mobile workforce application is the scheduling and dispatch of employees who are mobile enabled. There are specialized products for optimized routing and dispatch. Thus far we have seen most of the ERP/EAM vendors partner with, rather than acquire these vendors to provide a full solution. There is also a separate community of actual hardware and device providers on which the mobile applications sit. So currently there is an "ecosystem" of vendors providing mobile solutions;

- Hardware/device vendors
- Mobile applications software vendors
- Telecommunications providers
- Scheduling and Dispatch software
- EAM / ERP solutions to allocate work
- CRM solutions to allocate work

No single vendor provides all this, nor are they expected to emerge. Solutions will be assembled by system integrators or the customers themselves, using the most appropriate technology that falls into each of these categories.

There will be a significant impact on Network Operations as the complete mobile solution will facilitate real-time switching sheet coordination with field crew and make network configuration changes available to operations staff, which will be more timely and accurate. This will allow network operations staff to make safer and more efficient decisions when re-configuring the electrical network.

There is an emergence of field managed inventory applications to supplement the work and asset management solutions, however they are just another form of handheld device software applications. The most important consideration to be given is whether the inventory access is local to the device (i.e. truck-based inventory which is later synchronized) or real-time global access which will give the mobile work crews access to all inventory data and can, in turn, update the records as usage is done in the field. The likely deployment will depend on the availability of high quality network access. Communications will be ubiquitous in urban environments, but could be assumed to be absent for some time in rural areas.

In many utilities, the practice of managing information remains undisciplined and unfocused, as evidenced by complex integration

Mobile workforce technology can enable more efficient field service for workforce/asset management and customer service improvement. In particular, it can bridge the information gap from the field by transferring data over mobile networks more efficient than paper-based systems. GIS vendors provide mobile hardware extensions and integrate to most mobile workforce applications. As part of the GIS strategy, Gartner recommends assessing mobile business processes and rethinking those that involve batch or paper form inputting of information. Business process management and workflow should be considered in wireless field applications to manage actual performance quality. Like desktop support, IT departments will have to support mobile field operations by providing an acceptable support model for mobile and wireless computing equipment that balances responsiveness and flexibility with adequate security and controls.

In addition to optimizing crew work schedule and routing (increased wrench time), mobile workforce applications should fill the gap for field information management. Utility mobile applications should be leveraged to transferring field information (inspection, maintenance, construction red-lines) using mobile computing devices to drive efficiency and reduce errors over manual process of clerks transcribing from paper. When implemented as part of an overall information management strategy, mobile computing will drive greater value from IT systems by improving enterprise Information management and data quality.

ASSET DATA MANAGEMENT REQUIRES A NEW ENTERPRISE APPROACH

As a result of continued focus on operational performance, business units are very focused on day-to-day operations vs. strategic applications. As enterprise applications have modernized utility IT infrastructure, many asset data management business processes have not kept up. Business processes have not been streamlined across the utility, which means asset data gets created and managed in multiple systems. Besides inefficiency, multiple asset data sources results in a number of data issues including: poor quality, reconciliation, compatibility, reporting, confidence, and reliability and accuracy problems. Poor asset data quality limits utility GIS performance and their ability to leverage more-advanced asset management science, business intelligence and analytics.

In many utilities, the practice of managing information remains undisciplined and unfocused, as evidenced by complex integration (for example, high costs and resource lock-in associated with the development and maintenance of redundant and overlapping point-to-point interfaces), an unmanaged glut of information (such as an accelerating volume and velocity of information sources) and an inflexibility of system design, causing a delay in response to evolving business needs. Whether it's information in GIS, a database, or on a fileserver or whether it's about assets, customers, products, financials, employees, vendors or other areas, the needs are the same: Information must be organized, struc-

tured and safeguarded to maximize its value, usefulness, accessibility and security.

New approaches are needed for structuring and managing information as an asset. Information is seen as a strategic priority and a source of competitive differentiation and operational efficiency. However, organizations cannot use their information assets without some plan, framework, structure or model. Indeed, without an information architecture, organizations incur additional cost, complexity and risk. As we move from tightly coupled (self-contained systems) to loosely coupled systems (where we build applications on the fly), knowing the location, format, structure, context and use of information becomes critical. Accordingly, we need better approaches for structuring and managing every type of information from an enterprise perspective.

ENTERPRISE INFORMATION MANAGEMENT (EIM)

Gartner defines EIM as an organizational commitment to structure, secure and improve the accuracy and integrity of data assets and solve semantic inconsistencies across any boundary, thus supporting the technical, operational and business objectives within the company's enterprise architecture strategy. In 2004, Gartner identified EIM as a trend requiring focus and investment. EIM solves many of the issues caused by decades of individualized application development and addresses the underlying complexities that impede cross-boundary attempts at innovation, agility and transformation. However, some organizations have yet to recognize the importance of managing information at the enterprise level and the need to apply the same emphasis as other strategic assets (such as people, real estate and finances). It has taken a number of utilities a major event that caused the systems to fail to perform, leading to regulatory inquiries and subsequently mandated data improvement programs. Although adoption has been slow, the drivers, issues and pressure to deliver EIM in utilities are growing.

EIM is not a technology, it is a corporate commitment to data quality. These are the essential building blocks to implement an EIM strategy:

• Vision — Organizations need accurate, consistent, secure and transparent data that flows seamlessly and continuously.

• Strategy — Organizations make a strategic commitment to EIM, which is operationalized to include projects, budgets, personnel and governance.

• Governance — The organization determines what data governance is needed and how it affects the organization, addressing development, maintenance, communications and the enforcement of data management policies/procedures.

• Organization — Parallel to governance, EIM organization handles enterprise/project-level modeling; metadata management/semantic reconciliation; master data management (MDM); implementation of technology infrastructure; data quality management, such as profiling and data stewardship; enterprise content management; infrastructure for continuous flow (among analytical, operational and transactional systems); and EIM program administration (for example, budgeting, resource management, education and project tracking).

• Process — Stewardship addresses compliance requirements for the increased accountability and transparency of information across the organization. Another process is model management.

• Reference model — This defines the technology components required, including data services, integrated content, metadata management, data quality and profiling, MDM and closed-loop information flow.

• Metrics — Data quality metrics (for stewardship and compliance initiatives), data redundancy metrics (for cost reduction) and standards adoption metrics.

Metrics highlight gains from consistent, accurate master data to improve responsiveness and decision making.

EIM is a process of aligning IT investment strategy with business processes and asset data. Very simply, EIM focus defines and optimizes the data management processes with clear accountability and timely performance metrics. EIM can be thought of as a manual or automated asset data synchronization process throughout the lifecycle of the data assets.

HOW TO START EIM

Getting started requires making sure everyone clearly understands the data management business process. From this point forward, timely and accurate data

management should be part of individual performance and must roll up to department performance. Process optimization should take place, over time, with additional training and updated KPI metrics. Finally, a plan to take care of backlog of data problems must be developed. A major fielding exercise could be hard to justify. However, make data management part of day-to-day work processes. For example, as asset inspection occurs, GIS connectivity validation should take place if the data management tools are simple and straightforward. Field workforce needs to establish an ownership over the data management process and take pride in quality work as they perform work on the assets. Now that work includes EIM asset data quality, back office support staff must likewise commit to timely processing turnaround (with KPI metrics) so the field staff can see the same level of commitment throughout the company and will ultimately see the value of their data quality efforts through performance improvement. Emerging mobile workforce management applications are bridging the gap to enable EIM in the field.

Ultimately detailed asset life-cycle application data analysis will be required to identify where the gaps are in current processes and how to automate and streamline existing processes. Future papers will address best practices for this analysis.

REFERENCE MODEL AND SEMANTICS

The energy industry's collaborative business environment is providing EIM technology tools that will facilitate data and process integration (for example, enterprise application integration [EAI], Web services, UML, XML, business process modeling and Business Process Modeling Language), as well as foster the adoption of common semantics models and industry-specific vocabularies. Common Information Model (CIM) is an International Electrotechnical Commission (IEC) standard (IEC TC57 standards 61970 and 61968) that is used for the integration of IT systems in the electric utility industry worldwide. Although CIM is an internationally adopted standard sanctioned by the IEC, the adoption rate has been lower in Europe and Asia/Pacific, where many utilities are less aware of CIM.

Activities have been aimed at creating common standards across energy domains, resulting in data models, common vocabulary and business processes that facilitate interoperability between line-of-business (LOB) applications and among energy enterprises. The CIM information is typically transported in the utility enterprise through an enterprise service bus architecture (ESB, e.g. WebSphere, MQ, webMethods, Vitra, TIBCO, etc.). MultiSpeak is a similar yet simplified model developed by the National Rural Electric Cooperative Association and is on a path to ultimately harmonize with CIM.

Utility enterprises aiming to achieve operational excellence must look for products that go beyond traditional integration technologies (such as application programming interfaces and EAI) or that are trying to incorporate business process integration by extending the functionality through inclusion on the data-model level. Many energy and utility IT and business leaders are developing their road maps to adopt the CIM and evaluate the impact on their core applications. In addition to vision, IT leaders should select software by the vendor's ability to address product integration that uses CIM-enabling technology and architectural directions.

RECOMMENDATIONS

- Because utilities will continue to depend on tightly integrated enterprise applications to drive business performance, they must realize that information assets, in context, with timeliness and accuracy, are the fuel that empowers IT enablers to deliver desired results.
- Utility IT, operations and engineering leaders must recognize the need to manage asset information to the same level they manage physical utility assets.
- Data must be considered a valuable asset shared by managers, designers, operations and engineering personnel, as well as customers.
- Utility operations, engineering and IT leaders must jointly develop and manage EIM processes to truly achieve expected technology benefits.
- For an enterprise-wide EIM program to succeed, organizational commitment, senior-level sponsorship and metrics tied to specific business goals will be required.
- Utility GIS and mobile applications projects should have EIM as a key deliverable.

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Interconnection and Integration

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DOE, after a comment period and a series of public meetings, finalized the designation of the two corridors. This process and the end result were not without controversy, with condemnation of the action by a number of politicians in the impacted states. A key argument made by many has centered on Federal intervention into matters dealt with traditionally by state governments, as well as NIMBY concerns. As of the writing of this article, it is uncertain what the ultimate end result of this exercise will be – several transmission projects have been proposed in both of the corridor footprints. These projects are now going through state-level permitting processes. FERC issued regulations in 2006 stipulating that only those transmission projects within a corridor that would significantly reduce congestion into or within the congestion area would be eligible for a FERC permit. The location of additional conditional congestion corridors has been identified in the DOE report. The statutory language indicates that mitigation of transmission congestion – not access to renewable generation – will be the key criteria in designating a corridor.

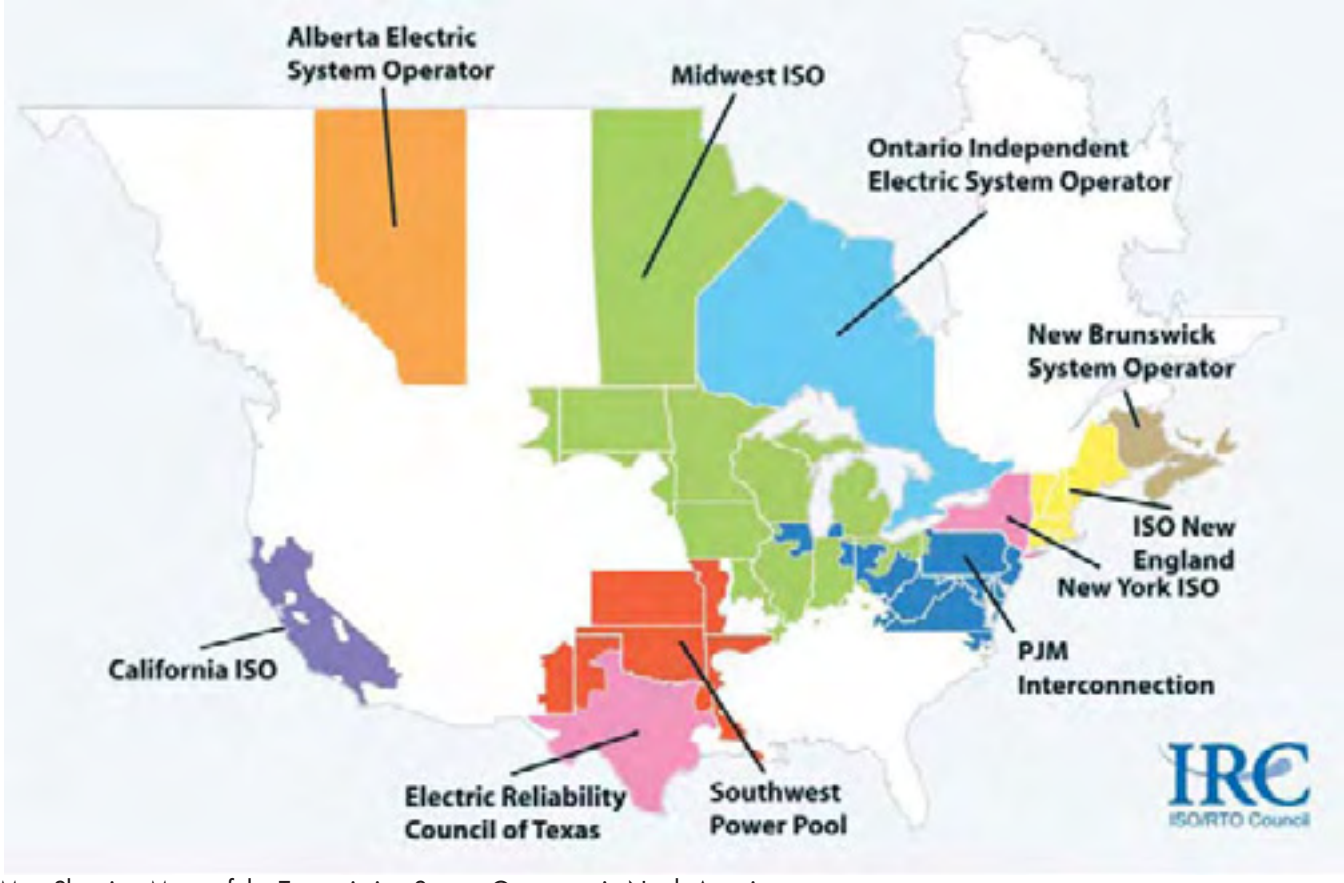
Along with this initiative, the Federal Energy Regulatory Commission, through its Order No. 890, Final Rule: Preventing Undue Discrimination and Preference in Transmission Service, set in place additional guidelines and clarifications for use of the grid. This rule amended FERC's regulations and the pro forma Open Access Transmission Tariff (OATT) adopted in Order Nos. 888 and 889 to remedy opportunities for undue discrimination and address deficiencies in OATT. The key provisions in Order No. 890 include:

- Greater consistency and transparency in calculation of Available Transfer Capability;
- Open, coordinated, and transparent planning on local and regional levels;
- Reform of energy and generator imbalance penalties;
- Adoption of a "conditional firm" component to long-term point-to-point service and reform of existing requirements for redispatch;
- Reform of rollover rights;
- Clarification of provisions in the tariff;
- Increased transparency and customer access to information;

Order No. 890 applies to all public utility transmission providers, including Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs). This rule is playing a significant role in how these entities conduct transmission planning and provide transmission service which affects renewable generation.

SOLVING THE CALIFORNIA TRANSMISSION CONUNDRUM

California has a significant amount – 2,361 megawatts (MW) at the end of 2006 – of wind capacity on line. More than 4,000 MW of new renewable generation has been proposed, which will go a long way toward meeting the state's Renewable Portfolio Standard (RPS), calling for 20 percent of the state's energy to come from renewable sources by 2010. California is blessed with significant wind resources; however; much as with many other portions of the United States, the resources are located in remote areas where the infrastructure to



Map Showing Many of the Transmission System Operators in North America
Source: ISO/RTO Council

transmit the energy to where it is needed does not exist.

A significant concern with construction or expansion of transmission systems is how to finance it. As stated before, construction costs can run into the billions of dollars and as always, someone has to pay for it. Under the system utilized by the California Independent System Operator (CAISO), charged with managing the flow of electricity along the state's open-market wholesale power grid, transmission construction costs are treated in two ways. With transmission for interconnection to generation, known as gen-ties, the costs for network expansion or upgrades are paid up front by the owner of the generator, with the money reimbursed over a five-year period once the facilities are energized. The other transmission category – network upgrades – are controlled by CAISO and costs reimbursed by ratepayers. This two-tier mechanism has proven problematic for developers of renewable generation facilities as they tend to be smaller in size than conventional generators. And as noted previously, they tend to be located in remote areas away from the transmission system and the costs add up. Recognizing this to be a barrier to meeting the RPS goal, as well as preventing the efficient and cost-effective development of transmission infrastructure, CAISO has worked on an alternate means of financing transmission for interconnecting renewable generation.

CAISO filed a petition for a declaratory order with the Federal Energy Regulatory Commission (FERC) in January 2007 requesting approval of a third category of transmission. Targeted towards accommodating renewable generation, CAISO proposed a hybrid financing model where the upfront costs for building transmission would be born by utilities that will be reimbursed at a later date after the renewable projects are online and generating revenue. In order to be eligible for the third category, a transmission project had to meet a set of criteria:

• Transmission is needed to interconnect an area that has significant potential for renewable generation.

• The capacity of the individual interconnecting generation projects would be smaller than the optimal transfer size of the transmission facilities.

• The transmission would not be considered network facilities and the upfront funding required from the generator would be considered a barrier to the generation project being built.

• Demonstration of commercial interest by load serving entities in renewable energy projects in the area.

• The proposed transmission facility could be turned over to the grid operator.

• The proposed transmission would not increase CAISO's Transmission Access Charge (assessed across all users) by more than 5 percent on average over 10 years.

CAISO opted to file the petition for a declaratory order with FERC prior to moving forward with a filing to make tariff changes. This stemmed from a 2005 FERC decision rejecting Southern California Edison's request for a similar category in relation to its Antelope transmission project for connection of three wind projects in the Tehachapi area.

In April 2007, FERC granted CAISO the declaratory order approving the third transmission category in concept. It acknowledged that there is a significant and quantifiable difference between the sites and transmission needs of renewable generation as compared to conventional generation.

FERC announced that it found CAISO's proposal struck a reasonable balance that addresses the barriers impeding the development of location-constrained resources while providing

protection to ratepayers through a rate impact cap and the commercial interest provision. The Commission noted that renewable generation is considered location restrained because it must be built where the resource – wind, geothermal, etc. is located.

FERC noted that the CAISO proposals would initially roll in the cost of the facilities to all users of the system through the transmission revenue requirement of the participating transmission owner constructing the facility, reflected in the CAISO Transmission Access Charge. Each generator that interconnects would be responsible for paying their pro rate share of the going-forward costs of the line. All users of the transmission grid (the ratepayers) would pay the costs of any unsubscribed part of the line through the Transmission Access Charge until the line is fully subscribed. To be eligible, the line must be approved by CAISO as providing needed system benefits and any generator, regardless of fuel type, would be eligible to interconnect and contract for capacity.

The CAISO Board of Governors approved making changes to its federal tariff in October 2007.

In addition to this activity, the state of California has formed a public-private partnership to consider the feasibility of building new transmission lines to access renewable generation. This effort, called the Renewable Energy Transmission Initiative (RETI), will serve as a way to facilitate the development of renewable generation to help meet the state RPS. The goal of RETI is to put in place the infrastructure to deliver energy from renewable generation located in remote parts of the state or in adjoining states. The effort is being spearheaded by the California Public Utilities Commission, CAISO, California Energy Commission and representatives from publicly owed utilities in the state. RETI plans to identify major renewable zones to be developed throughout the state and to rank all renewable resource areas in the state to establish an order for the development of transmission lines.

BUILDING TRANSMISSION FOR RENEWABLES – A TEXAS TALE

Texas, which overtook California in 2006 in the American Wind Energy Association's rankings as the state with the most wind capacity, is implementing a plan to facilitate the development of transmission connecting renewable generation to the grid. In 2005, the Texas legislature passed a bill increasing the state's Renewable Portfolio Standard to 5000 MW by 2015. Realizing that the key component for meeting this objective consists of electricity generated in the wind-rich western part of the state, necessitating upgrades to the transmission system, the legislature called for the designation of Competitive Renewable Energy Zones (CREZ). The CREZ concept flips the existing transmission planning process around by planning ahead for transmission in wind-rich areas so that when new generation is ready to connect to the grid, the lines are already there.

There is plenty of activity related to wind power project development underway in Texas, and more is to come. According to the Electric Reliability Council of Texas (ERCOT), there is 2,992 MW of wind generation currently in operation on their system, with an additional 1,701 MW planned through 2008. This does not include that part of the grid that is not under ERCOT's control, but under the jurisdiction of the Southwest Power Pool (SPP).

On paper, each CREZ is expected to support roughly 1000 MW of generation and the costs for transmission would be paid for by ratepayers. The CREZ enabling legislation covers all transmission in Texas, but transmission to support CREZ areas in SPP territory would be subject to SPP tariffs, over which the Public Utility Commission of Texas (PUCT) has no jurisdiction.

According to the enabling legislation:

- The PUCT will require generation to meet the RPS;
- The PUCT will consider financial commitment of generators;
- An expedited Certificate of Convenience and Necessity process that will take six months;
- Long-term transmission and capacity planning will be met for conventional generation as well as renewables;
- Transmission supporting meeting the RPS will be recoverable in electric rates;
- Transmission will be planned for the zones and built using special provisions.

The PUCT established that 10 percent of the CREZ transmission cost be posted by renewable generators within approximately 12-18 months of following the CREZ designation. A timeline provision was also established mandating that generators commence commercial operation within 12 months of the transmission being built.

A number of companies and organizations expressed interest in the CREZ process, requesting hearings or filing petitions to nominate CREZs. In addition, several companies partnered together to form ventures to build merchant transmission for the CREZs. Electric Transmission Texas LLC (ETT), a proposed joint venture between subsidiaries of American Electric Power and MidAmerican Energy Holdings Company, filed in February 2007 a transmission proposal with the PUCT for the construction of approximately 1,000 miles of transmission lines to support CREZ development. At the same time, ETT proposed for consideration by the PUCT and ERCOT an additional approximately 900-mile, high-voltage, high-capacity backbone transmission system.

On October 3, PUCT issued an Interim Final Order designating five CREZs in West Texas and the Texas Panhandle and authorizing development of transmission lines to deliver electricity out of those areas to customers throughout Texas. A final order, transmission plan, and budget are still pending and expected to be finalized sometime soon.

ERCOT has initiated a transmission optimization study to develop options for delivering wind power from the five CREZs to customers throughout the ERCOT system. The CREZ model is being studied closely by a number of states, and is actually being implemented in Colorado. It has also been proposed as a national transmission development mechanism in legislation proposed by Senate Majority Leader Harry Reid (D-Nev.).

TRANSMISSION DEVELOPMENT TO SUPPORT RENEWABLES: A WESTERN ROUNDUP

Outside of California, quite a bit of activity is ongoing regarding transmission development to support movement of electricity among the Western United States. Several Western states – Wyoming, Colorado, and New Mexico – have established state offices or organizations to facilitate and fund development of transmission infrastructure. The Wyoming Infrastructure Authority (WIA), Colorado Clean Energy Development Authority and New Mexico Renewable Energy Transmission Authority all have authority to issue bonds to fund transmission projects in their states. The WIA's mission was

expanded in 2006 to include infrastructure to support clean coal projects. Montana established an Energy Infrastructure Promotion and Development Division within the state Department of Commerce to help develop transmission within the state.

The Montana office does not have the authority to issue bonds.

There are several key transmission development initiatives underway in the Western U.S including TOT-3 Wyoming/Colorado InterTie, Wyoming-West Project, TransWest Express, and the High Plains Express project. The TOT-3 Wyoming/Colorado InterTie is a 345 kV project running from northeast Wyoming to the Colorado Front Range and is intended to deliver roughly 800 MW of capacity to Xcel Energy/Public Service Colorado. The target date to be online is 2011 or 2012. The Wyoming-West Project would carry electricity from southwest Wyoming to Utah and is being studied with a 345 kV or 500 kV configuration. This project also has a projected completion timeframe of 2011 or 2012. It would provide a means to move power from Wyoming to California via a DC line. The TransWest Express line would go from the Wyoming Powder River Basin to Arizona via Colorado or Utah and facilitate moving power from coal plants in the area to the Southwest. Led by the WIA and National Grid, this effort also has participation from Arizona Public Service, Salt River Project, Southern California Edison, and Tucson Electric. Currently in the feasibility analysis phase, the High Plains Express is a transmission backbone that would run through the eastern plains of Wyoming and Colorado to central Arizona, linking many of the aforementioned projects and providing access to renewable generation. The High Plains Express would either be a 345 or 500 kV line connecting the TOT 3 project, the TransWest Express project, the Eastern Plains Express proposed by Tri-State Generation and Transmission, and several other projects. The project backers, led by Xcel Energy, hope to coordinate the effort with the National Interest Electric Transmission Corridor process and have the line complete by 2017.

The state of Colorado has gone a step beyond in terms of transmission expansion. In Spring 2007, the Colorado legislature passed a bill, which was signed by the governor; requiring utilities to identify "energy resource zones" where transmission constraints hinder the delivery of electricity to consumers or the development of new electric generation facilities to serve the state's consumers. The bill requires utilities to undertake biennial reviews to designate areas in which transmission capacity lags behind generating capacity; for such areas, utilities would submit proposed plans for development of additional transmission facilities. The Colorado Public Utilities Commission would be required to grant or deny any necessary certificates for such development within 180 days.

The legislation would allow utilities to recover costs during construction of new or expanded transmission facilities through a rate adjustment clause. The approach undertaken by this legislation mirrors that of the Texas CREZ initiative.

Look in the July/August issue of Electricity Today for part II: Around the Country – What's Going on in Other Areas

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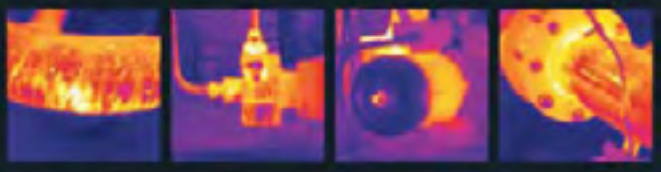

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