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ONTARIO ELECTRICITY REPORT

Ontario Government Launches Tough Actions to Improve Air Quality

Ontario's Electricity Sector and Fossil Fuel Generation

Ontario Should Push On With Deregulation Despite California Disaster

ALBERTA ELECTRICITY REPORT

Power for the People

Making Dollars and Sense of Alberta's Electricity Prices

Deregulation Costs Consumers

INDUSTRIAL ENERGY EFFICIENCY

Benchmarking Energy Consumption to Indentify Opportunities for Conservation

POWER QUALITY

Harmonic Study Analysis Guidelines for Industrial Power Systems

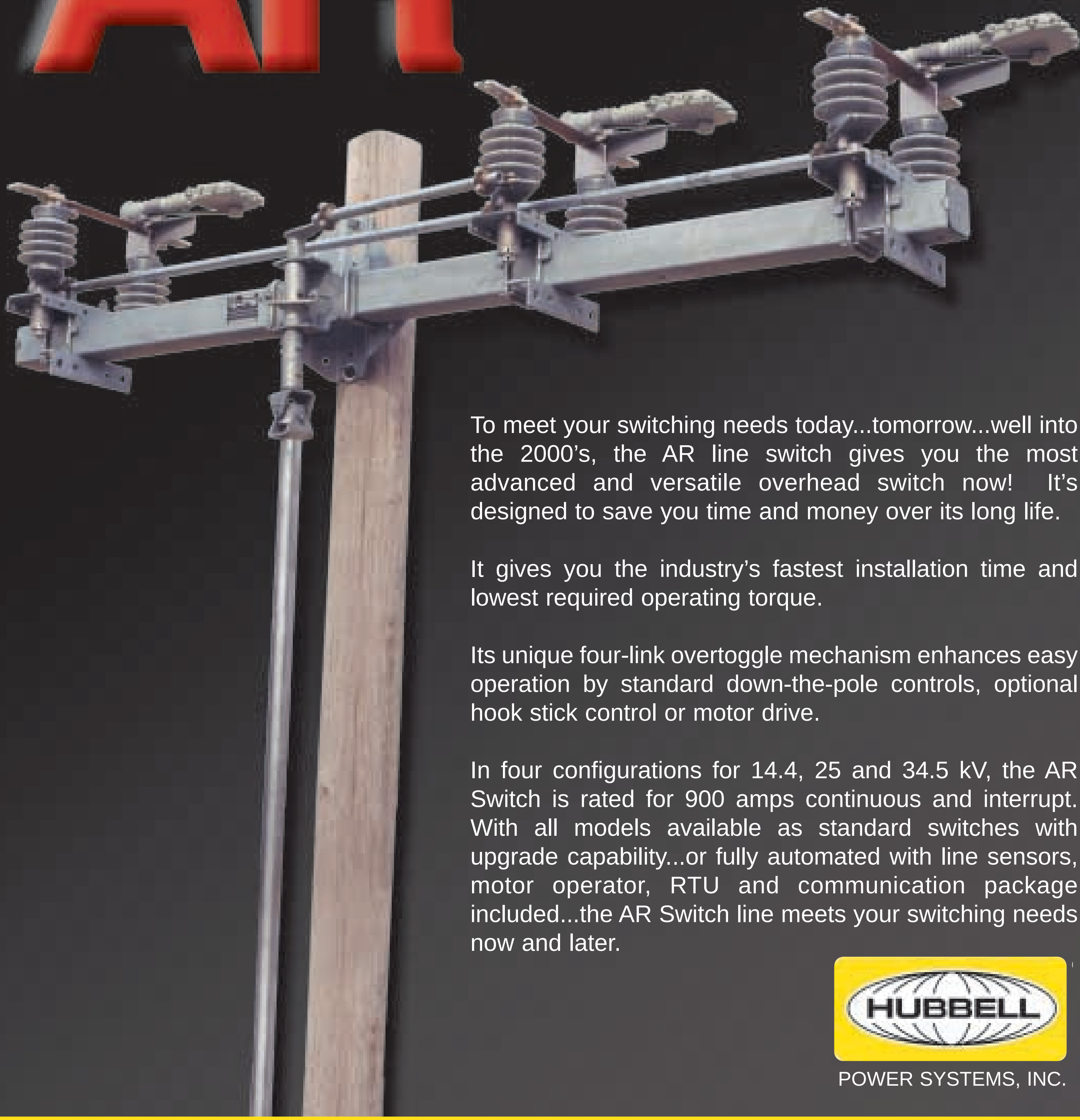
Power Quality Q&A

TRANSMISSION AND DISTRIBUTION

Steel Poles Stand Up to Severe Weather

SCADA

SCADA Network Cloud Enhances Power Distribution Services



Volume 13, Number 3
Issue 3, 2001

ELECTRICITY TODAY

Publisher / Executive Editor
Randolph W. Hurst
rwh@istar.ca

Managing Editor / Production Manager
Kelly Jones-Johnston
kjj@electricityforum.com

Advertising Sales
Donna Gilliland
donna@electricityforum.com
Carol Gardner
carol@electricityforum.com

Web Site Advertising Sales
Barbara John
forum@epix.net

Circulation Manager
Colleen Flaherty
colleen@electricityforum.com

Administrative Coordinator
Nicola Jones
hq@electricityforum.com

Visit our Web Site:
www.electricityforum.com
E-mail: hq@electricityforum.com

Electricity Today is published 10 times a year by The Canadian Electricity Forum. The Canadian Electricity Forum is the conference management and publishing company for Canada's electric power and engineering industry and is a division of The Hurst Communications Group Inc.

Electricity Today is distributed free of charge to Canadian electric utility personnel involved in management, engineering and operations; plant management, electrical engineering and electrical maintenance personnel within major Canadian power consuming industries; and electrical engineering consultants.

Paid subscriptions are available to all others: in Canada - $40.00 per year (10 issues)(GST extra); in the U.S. - $50.00 per year ($US); international - $100.00 ($US) per year. All requests for free subscriptions or changes to free subscriptions (i.e. address changes) must be made in writing. All correspondence should be directed to: Subscription Manager, Electricity Today, Suite 101, 345 Kingston Road, Pickering, Ontario, L1V 1A1

Canada Post - Canadian Publications Mail
Product Sales Agreement 104876
ISSN 0843-7343

Member of: CCAB BPA

IN THIS ISSUE

UPFRONT

ONTARIO ELECTRICITY REPORT

PRODUCT AND SERVICE SHOWCASE FOCUS

ALBERTA ELECTRICITY REPORT

INDUSTRIAL ENERGY EFFICIENCY

POWER QUALITY

TRANSMISSION AND DISTRIBUTION

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EDITORIAL

The "Silent Majority"

The 'silent majority'. When it comes to the electric power industry, the term applies to the bulk of electricity consumers. They who do not have a voice simply live their lives unaware of the product — unless electricity prices are skyrocketing or they are sitting in darkness,. (I consider electricity a manufactured product not just a source of energy.) As long as our modern life continues without interruption, the silent majority really couldn't care less about the loftier issues of power planning philosophy and public vs private ownership, or the technical details and advances of generation, transmission and distribution systems.

I've written several times now about the fact that 99.9 per cent of all electricity consumers don't have a real input into the planning of a power system that governs and drives their lives. The silent majority expects utilities ,and eventually government, to look after power production and maybe even now it's become cynical enough to understand that government looks after its own interest first.

And what is the interest of the silent majority of electricity consumers: Price and reliability and then quality. And what about large power consumers? In Ontario, 100 power consuming companies consume 50 per cent of the electricity and in Alberta, the same percentage of electricity is consumed by less than 40 companies. This is really the group of consumers that rely heaviest on electricity at the least possible cost. As a group, large power consuming companies employ tens of thousands of employees and their competitiveness and financial performance are directly related to the cost of production, and low electricity rates have always been a rationale for investing in Canada.

It's ironic that even though most, if not all, large electricity consumers have time-of-use metering and exercise diligent energy management, spot market prices in Alberta (and soon in Ontario) are determined by peak demand and the peak is driven mostly by small electricity consumers.

For small electricity consumers, low electricity prices and traditional kWh metering have given little or no incentive for energy management because there was no direct, perceived, immediate benefit.

But low electricity prices, and utility responsibility and ownership of meters, have made the average electricity consumer in Canada and the United States unsophisticated consumers; ignorant of what it takes to supply electricity and deliver it and what role he/she can play in how he/she are charged.

And it is the silent majority that is contributing to the crisis in California and Alberta, especially when it is protected and rebated by government through artificial price caps, rate freezes and rebate cheques.

But, this is not a considered, intentional contribution. Electricity consumers, for all the promise of 'greater choice' have in reality little choice because they have little benefit which motivates choice.

Electricity deregulation is good for power producers ONLY if there is a profit to be made and therefore electricity deregulation can only be good for consumers if there is also an economic incentive.

What's needed for power consumers are time-of-use rates and metering in homes and businesses. Then there will be true and honest 'deregulation' because consumers hit by market-driven pricing will be able to respond with a true choice: how and when to use electricity. As it stands, electricity deregulation has meant a loosening of the controls over pricing and rate setting, and the supplier, but not in how electricity is metered and hence consumed.

Personally, the only way that I can best deal with the demand pricing tactics of oil retailers in my town is not to buy my gasoline from Thursday to Sunday. And, for my home, I would like the choice of not only the electricity retailer but also when and how and how much electricity to use and I want to be in charge of the cost savings at my meter.

Are private power producers and deregulated electricity retailers selling meters that will give consumers a real choice? No, because it is not in their interest. They are looking for safety, security, long term contracts, and a guaranteed level of return.

Give a consumer the tool to enact a true choice of when to use electricity when prices go up, then the market will naturally respond and there will be true deregulation. Right now, the electricity market that independent power producers and innovative regulators are promoting is not

Continued on page 6

Continued from page 5

a true market.

The state government of California is protecting electricity consumers from the predatory practices that would otherwise have bankrupted two successful utilities but in the long run this is costing electricity consumers more than had they had to pay real market prices. There is a whole school that believes that the best protection for electricity consumers facing high electricity prices are energy conservation practices, energy-efficient appliances and time-of-use metering — better protection than the billions being spent on government bonds to bail out PG&E and SDG&E and to secure long term import contracts.

In Alberta, the answer for that market may be for both EPCOR and TransAlta to go ahead with their plans to build their future units (a total of 1,300MW) to ensure there will be a greater base load generation and less reliance on small scale, natural gas fired, intermediate and peaking generation. Then the government should give rebates to electricity consumers to purchase time-of-use meters.

Never mind giving them a choice of retailer when all the retailers are buying from the same pool price and there are no long-term wholesale contracts when supply is short. In the California situation, there were many power producers holding back on supply in order to drive up the price. That's the OPEC principal. And in Alberta and eventually Ontario, private electricity producers will never build capacity in a surplus market situation because their will be less economic return for their investment than in a high demand market.

Left to private industry, there will never be a surplus. There will only be enough investment made in electricity production to leave the market short and keep the market wanting more and that will keep the price high enough to make the investment worthwhile. (That's what happened in the natural gas business. Low rates discouraged exploration and production. Today's high prices are driving new exploration and drilling.)

In California, had PG&E and San Diego Gas & Electric had unlimited deep pockets, there would have been no complaint from private power producers outside the state. The only time they complained was when it was uncertain they would get paid their astronomical windfall revenue, and the first thing they did when the cash ran out was turn off the supply. I call it OPEC marketing. Others call it the supply/demand market.

I've had the opportunity twice in the past month to attend electricity deregulation conferences in Alberta and Ontario, both leading Canadian jurisdictions dealing with the latest trends in power planning.

Although both provinces are very different in generation mix and size and demand and supply, there are some striking similarities when it comes to electricity deregulation.

What's striking? First of all, the silent majority of ratepayers and taxpayers who ultimately finance the whole industry were not represented in the same degree as those who have a financial interest in electricity deregulation. I am not against making money, but I see the electricity deregulation course being promoted by those who stand to earn money, not those whom it is going to cost. I see merchant bankers and consultants and developers and equipment suppliers and natural gas producers and electricity retailers. It is this group now that is blaming government and its perceived inaction for high electricity prices and the dire consequences of not planning ahead and, in the meantime, running short of supply.

Ironically, the Ontario deregulation community is now faced with government delays (and the inherent costs thereof) in the same way that the government repeatedly delayed the commissioning of nuclear units at Pickering and Darlington in the 1980s. Those delays cost Ontario Hydro and the people of Ontario billions of dollars in additional financing charges. And the rate freeze over the past 7 years has only served to drive up the stranded debt by hundreds of millions of dollars. It is exactly that kind of politically-motivated tinkering that makes power planning and execution more difficult. I would even go so far as to suggest that had the Ontario government never meddled in Ontario Hydro affairs and imposed programs on the utility that had little to do with generation, transmission and distribution, and kept out of the scheduling and commissioning of plants, the whole system would be healthier today and in a lot less debt.

In both these Canadian provinces, Alberta and Ontario governments are being blamed for the shortcomings of electricity. So long as government has its hand on the throttle, it will not easily relinquish control when it knows that it will be expected to answer with rebates for the failings, if and when they occur.

There will never be one single independent power producer who will take the heat for higher prices and offer rebates to cushion the blow. Success has a thousand fathers and failure is an orphan. And this orphan is a ward of the state.

In Alberta, even after two auctions, there are really only two retailers and neither is signing up customers with long term, price fixed, contracts — and prices there are the highest in North America outside of California. In Ontario, the government is not about to relinquish control and open the market when there is no guarantee that the government (and the public) will get what it was promised.

Randy Hurst
Publisher/Executive Editor
rwh@istar.ca

Ontario Power Generation Notifies Customers of 2001 Rate Change

Ontario Power Generation (OPG) today announced that effective June 1, 2001 all energy charges to its wholesale customers will increase by 0.7 cents per kWh.

OPG President and CEO Ron Osborne noted that revenues associated with this rate change will go to the Ontario Electricity Financial Corporation (OEFC). "This is the first increase in wholesale electricity rates in the last eight years, given that there has been a rate freeze since 1993," Osborne stated. While this freeze helped protect consumers and businesses over this period, it did not provide a sufficient revenue stream to address the old Ontario Hydro debt.

Overall inflation increased by about 15 per cent since the price freeze was first announced. This means that the real cost of power for the consumer is now 15 per cent less than it was in 1993. In the meantime, environmental and fuel costs have been rising.

Since 1990, OPG and the former Ontario Hydro have spent about $2 billion to improve environmental performance. "Environmental-related costs are expected to increase in the years ahead and represent a significant cost pressure within the North American electricity sector," Osborne added. OPG anticipates that its environmental expenditures alone could be as high as $1 billion over the next few years.

The rate increase would represent an average increase in electricity rates of about eight per cent for residential customers. It will ensure that funds are available to pay down the debt and liabilities of the old Ontario Hydro. The OEFC is responsible for managing and paying down this debt. In the year ending March 31, 2000, the OEFC debt increased by $852 million to over $31.3 billion for the fiscal year 1999-2000. This rate change is being put into effect by government regulation.

Board of Trade Warns of Job Loss if Electricity Market Opening is Delayed

If the provincial government fails to proceed with opening Ontario's electricity market by November 1, 2001, many investors and their jobs will move to Ontario's economic competitors," says Elyse Allan, President and CEO of the Toronto Board of Trade. "Although the Premier and Energy Minister have both indicated that market opening will proceed, to date we have not been provided the necessary commitment to succeed," continued Allan. "A firm opening date is essential for businesses to plan. Without a firm date, current pricing and supply arrangements could be jeopardized and new, innovative and environmentally-desirable electricity supply will go elsewhere."

Ontario has a comfortable 18 per cent generating reserve, greater power supply flexibility, and the potential for new generation - assuming an immediate government commitment to a firm November 1, 2001 market opening date. To further delay market opening would be to risk this advantageous supply/demand balance. It would perpetuate a monopoly that has left Ontarians with $20 billion in stranded debt. Both the Independent Market Operator (IMO) and the Ontario Energy Board (OEB) have indicated they will be ready for an October/November 2001 opening.

The Toronto Board of Trade supports a world-class made-in-Ontario open market model. They encourage the government to:

- Set November 1, 2001 as the open market date;
- Accelerate decontrol of Ontario Power Generation's assets;
- Streamline approvals and recognize the value of environmentally-desirable projects; and,
- Foster a customer-friendly retail market.

"A November first market opening brings greater consumer choice, reliable electrical supply, environmentally-desirable options, competitive pricing, jobs and investment," said Allan, "That's much preferred to the current uncertainty consumers, investors and businesses now face as they plan for the future. To provide certainty in the marketplace, the provincial government must proceed with opening Ontario's electricity market by November 1, 2001."

The Municipal Electric Association Follows Up With the Ontario Energy Board as OPG Announces Wholesale Rate Increases

The MEA has been in contact with the Ontario Energy Board (OEB) recently to clarify issues regarding Ontario Power Generation's announcement that it is raising all energy charges to its wholesale customers.

The government has passed a regulation to allow OPG to increase charges to customers by 0.7 cents per kWh effective June 1, 2001. OPG President and CEO, Ron Osborne, says that revenues associated with this rate change will go to the Ontario Electricity Financial Corporation.

The MEA is following up with the OEB about how Ontario's distribution utilities will pass this increase to customers. ET

ONTARIO ELECTRICITY REPORT

Ontario Government Launches Tough Actions to Improve Air Quality

The Ontario government will impose strict emissions limits on the electricity sector and require Ontario Power Generation's Lakeview Generating Station in Mississauga to cease burning coal. The announcement came as a part of the Ontario Ministry of Environment's long-awaited guidelines on thermal generating station emissions standards.

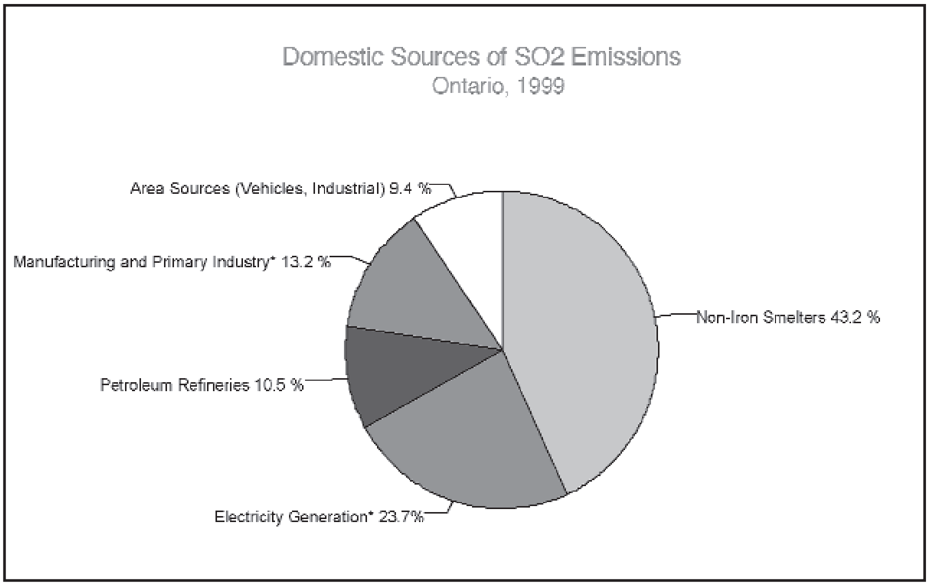
"The government is keeping its promise to ensure the environmental integrity of the future electricity market in Ontario," Ontario Environment Minister Elizabeth Witmer said. "Our review of coal-fired plants is now complete, and while this framework of actions comes with a price, the benefits will be priceless — cleaner air and healthier communities across Ontario," she added.

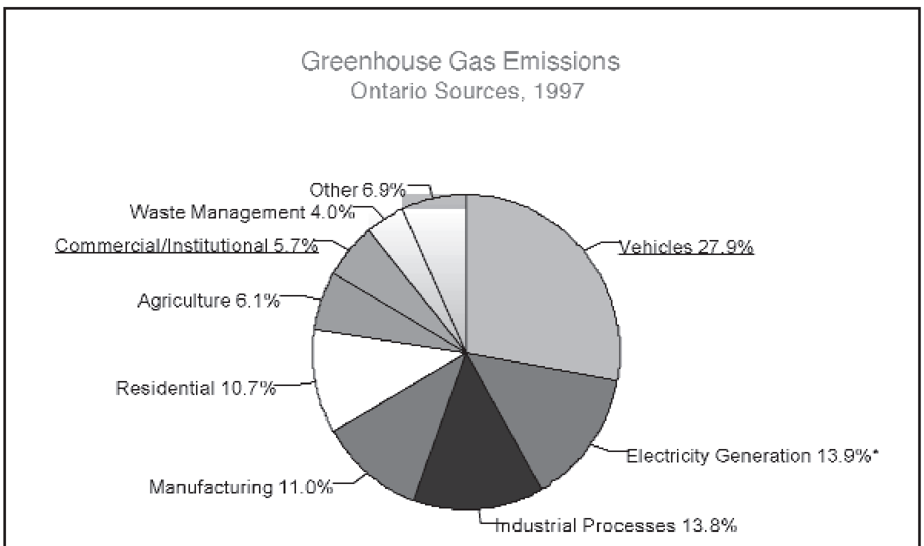
The proposed caps would drastically reduce current limits on six fossil-fuel plants currently owned by Ontario Power Generation; the limits on smog-causing nitrogen oxides would be reduced by 53 per cent, while the cap on acid rain-causing sulphur dioxide would be cut by 25 per cent. The government also proposed that the Lakeview Generating Station cease burning coal by April, 2005. These measures would ensure the government keeps its promise to match or exceed the tough smog requirements of the U.S. Environmental Protection Agency.

Following a consultation period, through the Environmental Bill of Rights registry, the government would be in a position to lift the moratorium on the sale of coal-fired electricity plants imposed in 2000 and begin implementation of the air quality actions.

"It's important to understand that the electricity sector is just one piece of our overall air quality strategy," Witmer said. "With these measures in place, the government will now take aim at other sources of air pollution, such as further reductions from transportation and other industry sectors. Ontario is determined to continue setting the pace as a North American leader in air quality."

The government has also released a discussion paper on a proposed emission reduction trading program. Once in place, this system would provide industry with incentives to reduce emissions above and beyond regulated requirements.





*does not include independent power producers. OPG fossil fuel stations only.

Improving Ontario's Air Quality

According to Ontario's Air Quality Index, the people of Ontario enjoy "good" to "very good" air quality more than 90 per cent of the time. Air pollution, however, continues to be a considerable challenge.

Significant air quality challenges are posed by emissions of nitrogen oxides (NOx), sulphur dioxide (SO2), carbon dioxide (CO2) and mercury. While causing smog, acid rain, toxic deposition and contributing to the threat of climate change, these key pollutants also affect human health. Air pollution affects Ontario over the short term — during air pollution episodes — and the long term, when air pollutants fall to the ground and accumulate in our lakes, soils, plants and wildlife.

Greenhouse gases are responsible for climate change, potentially leading to higher average global temperatures and the accompanying extreme weather events, climate zone shifts, agricultural damage, etc. Ontario's millions of vehicles contributed 27.9 per cent to Ontario's greenhouse gas emissions, while Ontario Power Generation's fossil fuel power plants were responsible for 13.9 per cent.

Fossil fuels such as oil, coal and natural gas are the very engines that drive Ontario's economy and way of life. Ontario's transportation sector (on-road: cars, trucks, buses; off-road: construction equipment), for example, is responsible for approximately 60 per cent of smog-causing NOx emissions made in Ontario.

Officially introducing emissions reduction trading will make Ontario one of North America's leaders in the field of market-based environmental protection. In the years ahead, Ontario intends to share this expertise with the world.

Transboundary and Domestic Air Pollution

Ontario is part of a regional airshed that stretches from the U.S. midwest into Quebec and the northeastern U.S.

Domestic contributions to air pollution are far outweighed by pollutants entering Ontario from U.S. sources. Prevailing wind patterns make U.S. pollution sources the largest contributors to air pollution in Ontario. This is especially true for smog — on average more than 50 per cent of Ontario's smog is due to pollution from south of the border. The province's successful court interventions supporting the U.S. Environmental Protection Agency's smog requirement will see significant benefits for our air quality at home.

To combat air pollution, the Ontario government is employing an air quality strategy that is integrated, comprehensive and balanced. Ontario's strategy targets a variety of sectors simultaneously - including transportation, industry, power and residential - while continually growing in scope to ensure broader contributions across the province. All individuals and sectors must continue to do their fair share toward eliminating or reducing the emissions that lead to air pollution.

Environmental Protection Framework for Ontario's Electricity Sector

In placing a moratorium on the sale of all coal-fired electricity plants last May, the government undertook a review to ensure effective environmental protection measures are in place prior to the start of a competitive electricity market. The review, now complete, yielded a proposed framework of air quality actions that will put the government in a position to lift the moratorium.

Tough Emissions Limits Mean Cleaner Air

The government is proposing tough new emission limits (caps) on air pollutants from the electricity sector that cause smog and acid rain. The proposed caps would be ratcheted down over time and be expanded to cover other major industrial emitters in the future.

1. In January, 2000, the government proposed net limits for 2001 that would cap net NOx emissions at 36 kilotonnes and net SO2 emissions at 157.5 kilotonnes.
2. When the limit is fully implemented in 2007, net NOx emissions would be capped at 18 kilotonnes and net SO2 emissions at 131 kilotonnes.
3. These proposed caps would reduce current limits on Ontario Power Generation's six coal and/or oil-fired plants as follows:
   a) smog-causing NOx by 53 per cent; and
   b) acid rain-causing SO2 by 25 per cent.

Lakeview Generating Station to Cease Burning Coal

The high demand for electricity in the Greater Toronto Area (GTA) has meant the Lakeview Generating Station is needed for system reliability and "peak period" power demand. Active since 1962, Lakeview is the oldest station in Ontario Power Generation's fossil fleet, with emissions rates for NOx, SO2, CO2 and mercury above average for coal-fired stations in Ontario.

Located in Mississauga, on the shore of Lake Ontario, the plant's four smokestacks make it a very visible part of the GTA western waterfront. A comparison using recent GTA inventories for NOx and SO2 emissions indicates that Lakeview accounts for 26 per cent of the region's SO2 emissions and 8 per cent of NOx emissions. As well, the plant is currently the second-largest mercury emitter in the GTA.

Because of Lakeview's age and unique location in a heavily-populated urban area, the government is proposing the Lakeview Generating Station cease burning coal by April 30, 2005. In the interim, the Ontario government is also proposing a strict 3.9-kilotonne NOx cap to help protect the GTA's air quality.

This interim cap is significantly lower than the plant's NOx emissions in 2000. Once implemented, this proposed regulation would remove thousands of tonnes of smog and acid-rain-causing pollutants from our air, while also drastically reducing emissions of mercury and the greenhouse gas CO2. ET

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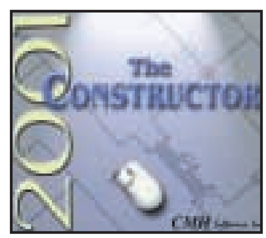

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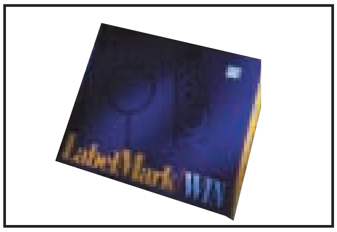

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Ontario's Electricity Sector and Fossil Fuel Generation

In 1999, 143.1 TWh of electricity was fed into the provincial power grid by Ontario-based generators. This includes 131.5 TWh of production from Ontario Power Generation (OPG) and 11.6 TWh from Independent Power Producers. In 1999, Ontario imported about 7.7 TWh of electricity and exported approximately 5.9 TWh, primarily to Michigan, yielding net imports of 1.8 Th. OPG's mix of generating assets currently in operation includes nuclear, coal, oil/gas-fueled and hydroelectric generation with a total capacity of 25,800 MW. In addition, OPG has capacity which is currently not operating. This includes nuclear capacities of 2,060 MW at Pickering and 3,076 at Bruce-A.

OPG Fossil Fuel Station Emission Rates and Total Emissions (1999)

Station	Net Energy TWh	Emission Rates				Emissions							
		NOX kg/MWh	SO2 kg/MWh	CO2 kg/MWh	Hg g/MWh	NOX kt	%	SO2 kt	%	CO2 kt	%	Hg kg	%
Lambton	9.0	1.42	3.03	870	0.015	12.78	25.2	27.3	19.4	7,830	24.7	135.0	21.4
Nanticoke	18.9	1.28	4.3	890	0.014	24.19	47.8	81.3	57.7	16,821	53.0	264.6	42.0
Lakeview	3.2	2.6	5.5	910	0.026	8.32	16.4	17.6	12.5	2,912	9.2	83.2	13.2
Lennox	2.3	0.89	0.7	660	n.a.	2.05	4.0	1.61	1.1	1,518	4.8	n.a.	n.a.
Thunder Bay	1.6	1.27	4.7	950	0.050	2.03	4.0	7.52	5.3	1,520	4.8	67.1	12.7
Atikokan	1.1	1.18	4.98	1,010	0.061	1.30	2.6	5.48	3.9	1,111	3.5	63.0	10.7
Total	36.1	1.41	3.9	880	0.017	50.7	100	140.7	100	31,712	100	629.9	100

% is percentage of emissions from all six OPG fossil fuel stations. NOx is reported as NO.

Due to recent reductions in nuclear power generation in the province, OPG's fossil fuel plants have increased power production to meet electricity demand. Independent Power Producers (IPPs) are generators that have contracts with the Ontario Electricity Financial Corporation (OEFC) to deliver defined amounts of capacity and energy. IPP generation includes hydroelectric as well as waste-fueled and natural gas-fueled thermal generation. IPP installations range in size from about 1MW to 165 MW with a total capacity of 1,766 MW.

In addition to OPG and IPPs, there are other electricity generators in the province that operate to supply electricity for their own internal use. These supplies are generally referred to as self-generation or internal-generation and are not made available to the provincial grid. The installed self-generation capacity in Ontario is approximately 1,500 MW. Self generation capacity includes about 986 MW in the industrial sector, of which only 517 MW is actually operated due to costs, 400 MW with other utilities, and 120 MW with municipal electric utilities and the commercial sector.

- Base load capacity operates to satisfy relatively constant demand;
- Peaking capacity operates intermittently to provide power during periods of maximum demand;
- Intermediate capacity operates fewer hours than base load capacity, but more than peaking capacity.

Fossil fuel electricity generation

Ontario Power Generation's fossil fuel generating stations are used to provide intermediate and peaking capacity to match fluctuations in electricity demand. While their short run marginal costs are high, these stations offer greater operational flexibility to take advantage of market opportunities compared with nuclear generating stations which are base load facilities that provide little or no operational flexibility. Fossil fuel generation has typically represented the smallest part of OPG's generation mix, operating primarily to satisfy peak demands. As a result of recent reductions in nuclear generation, OPG's fossil fuel generation has increased to support intermediate and base load needs.

Ontario Power Generation owns and operates six fossil fuel stations. A total of 23 generating units are currently in service with a combined power capacity of approximately 9,700 MW, representing approximately 38 per cent of its total in-service capacity. Coal-powered generating units at Nanticoke, Lambton, Lakeview, Thunder Bay and Atikokan account for approximately 7,600 MW of in-service capacity. Dual-fueled (oil/natural gas) generating units at Lennox account for approximately 2,100 MW of in-service capacity.

The location of each station is as follows:

- Lakeview is located in Mississauga, on the shore of Lake Ontario;
- Nanticoke is on the north shore of Lake Erie;
- Lambton is south of Sarnia on the St. Clair River;
- Lennox is near Kingston;
- Thunder Bay is on Lake Superior; and
- Atikokan is in northwestern Ontario between Lake Superior and the Manitoba border.

Ontario Power Generation's major fossil fuel plants were constructed during a period of high electricity demand when their output capacity was expected to be fully utilized. However, lower than expected growth in demand led to an oversupply of capacity and thus, OPG's coal plants were primarily used to meet demand during peak periods.

To meet demand in the face of declining nuclear generation with the shutdown of the Bruce A and Pickering A stations, fossil fuel generation increased between 1995 and 1999. To provide the majority of additional fossil fuel generation, the scrubber-equipped units at Lambton and the eight units at Nanticoke have operated essentially as base load units since 1995 and 1998, respectively.

Continued on page 14

Continued from page 13

In 1998, OPG commenced an asset enhancement program at these stations, designed to improve mechanical reliability, safety and environmental performance.

Air Pollution and Fossil Fuel Generation

Air pollution from Ontario's power sector is generated almost exclusively in coal or oil/natural gas-fired stations. Domestically, OPG's six fossil fuel stations account for the following proportion of total domestic provincial emissions:

- 14.7 per cent of nitrogen oxides (NOx)
- 23.7 per cent of sulphur dioxide (SO_2)
- 13.9 per cent of greenhouse gases (CO_2 equivalents)
- 22.6 per cent of mercury (Hg)

As part of its efforts to reduce air emissions, OPG has already undertaken a number of initiatives including:

- increasing its use of low-sulphur coal;
- upgrading the low-NOx burners on all eight units at Nanticoke;
- converting all four units at Lennox to dual-fueling so that natural gas or oil can be used. Natural gas has no SO_2 emissions and lower NOx emissions than oil;
- installing scrubbers in two units at Lambton to reduce flue gas SO_2 content, completing combustion process modifications for two units and installing enhanced boiler controls in two units to reduce NOx emissions; and
- committing to the installation of four NOx removal technologies (SCRs) on two units at Lambton and two units at Nanticoke, and to the installation of low-NOx burners at the Lakeview station.

Ontario Power Generation has reduced the average NOx emission rate from its fossil fuel stations by 36 per cent

Summary of Fossil Fuel Generating Facilities

Station	No. of In-Service Units	Net In-Service Capacity (MW)	% of Fossil Capacity	Net Energy TWh (1999)	% of Fossil Net Energy (1999)	Net Capacity Factor (%) (1999)	Capacity Factor Since In-Service	Original Unit In-Service Date(s)(1)
Nanticoke	8	3920	40.4	18.9	52.4	55	42	1973-1978
Lambton	4	1975	20.4	9	24.9	52	47	1969-1970
Lakeview	4	1140	11.7	3.2	8.9	32	28	1962-1969
Lennox	4	2140	22.1	2.3	6.4	12	6	1976-1977
Thunder Bay	2	310	3.2	1.6	4.4	59	47	1981-1982
Atikokan	1	215	2.2	1.1	3	59	43	1985
TOTAL	23	9700	100	36.1	100			

Notes:

- All units are coal-fired except at Lennox. Lennox has four dual-fueled (oil/natural gas) units capable of burning natural gas and oil.
- All units at Lambton are coal-fired. Extensive rehabilitation has been completed on Units 3 and 4.

OPG Fossil Fuel Station Emission Rates and Total Emissions (1999)

Station	Net Energy TWh	Emission Rates				Emissions							
		NOX kg/MWh	SO_2 kg/MWh	CO_2 kg/MWh	Hg g/MWh	NOX kt	%	SO_2 kt	%	CO_2 kt	%	Hg kg	%
Lambton	9.0	1.42	3.03	870	0.015	12.78	25.2	27.3	19.4	7,830	24.7	135.0	21.4
Nanticoke	18.9	1.28	4.3	890	0.014	24.19	47.8	81.3	57.7	16,821	53.0	264.6	42.0
Lakeview	3.2	2.6	5.5	910	0.026	8.32	16.4	17.6	12.5	2,912	9.2	83.2	13.2
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% is percentage of emissions from all six OPG fossil fuel stations. NOx is reported as NO.

Lakeview Generating Station (shown above) is located in Mississauga, Ontario on the shore of Lake Ontario.

since 1983 and 22 per cent since 1990 (as of 1999). Sulphur dioxide emission rates have been reduced by 68 per cent since 1983.

About The Lakeview Generating Station

Lakeview is located in Mississauga, Ontario on the shore of Lake Ontario. The oldest station in OPG's fossil fuel fleet, the plant's units entered into service during the period from 1962 to 1969. Lakeview's book retirement date is 2006. In practice, however, the station's lifespan can be extended indefinitely with overhauls and replacement of components. Current capacity is 1,138 MW from four coal-fired units (Units 1, 2, 5 and 6). Each unit consists of a coal-fired boiler, a steam turbine and a generator. Four generating units at Lakeview representing approximately 1,100 MW of power capacity were taken out of service in 1992 as surplus capacity. Significant expenditures would be required to reactivate and operate these units.

Lakeview provides two basic functions to support system reliability. It provides capacity to meet overall system loads and reactive support to maintain local voltages. The high demand for electricity in the Toronto area has meant that Lakeview is needed during peak periods to meet system demand. The Independent Electricity Market Operator (IMO) reports that, if some of the Darlington and Pickering units were not available during summer peak period, Lakeview would be necessary to maintain system reliability in the Greater Toronto Area.

Current plans are for Lakeview to continue its role to provide power during peak periods and as required for system reliability. Lakeview's in-service units were given extensive overhauls in the early 1990s. These units have an estimated remaining life of five to 10 years.

In 1999, Lakeview produced 3.2 terawatt-hours (TWh) of electricity, operating at 32 per cent of in-service capacity. The heat rate (a measure of efficiency) of Lakeview was 10,800 kilojoules (kJ) per kWh.

Pollution control technologies currently in place for Lakeview Units 1 and 2 include:

- boiler tuning and optimization using artificial intelligence to advise operators on how to minimize NOx formation;
- electrostatic precipitators controlling particulate emissions; and
- low-NOx burners currently scheduled for installation in 2001 at a cost of $4.4 million

Units 5 and 6 have the following:

- artificial intelligence system which directly controls the boiler to minimize NOx formation.
- Estimated reduction of 10 per cent at full load, and higher reductions at partial loads; and
- low-NOx burners installed and currently being commissioned. The expected emission rate for these low-NOx units is 1.3 kilograms of NOx per MWh (up to a 50 per cent reduction).

Lakeview is part of the Greater Toronto Area (GTA), which is home to about five million people. This heavily urbanized area requires substantial infrastructure to support business and industry, and a viable transportation network. All of this requires power — and with the fossil-fueled generation of power comes air pollution. A comparison using recent GTA emissions inventories for NOx and SO_2 emissions indicates Lakeview accounts for 26 per cent of the GTA's SO_2 emissions and 8 per cent of NOx emissions.

The Lakeview station is a major source of local mercury emissions. Lakeview emitted 83 kg/yr in 1999 and is currently the second-largest emitter in the GTA. The largest is the KMS Peel incinerator in Brampton, Ontario at 140 kg/yr. The Peel incinerator is upgrading and soon its emissions will be reduced to 25 kg/yr, leaving Lakeview as the largest mercury polluter in the area.

Another facility, the Ashbridges Bay sewage sludge incinerator, emits about 68 kg/yr, but is slated to close in 2001. Operating as it presently does, by December 2001, Lakeview would clearly be the single largest mercury source in the GTA, emitting triple the amount of the next biggest source. The coal presently burned (characterized by 1,450 ppm chloride, 0.08 ppm mercury) produces a high proportion of ionic mercury - about 65 per cent of the total emitted. Ionic mercury tends to be deposited locally (i.e., within 48 km of its point of origin). ET

ONTARIO ELECTRICITY REPORT

Robert K. Green, President, UtiliCorp United:

Ontario Should Push On With Deregulation Despite California Rate Disaster

"There is no doubt about it, California has given deregulation a bad name," said Robert Green, President and Chief Operating Officer, UtiliCorp United and Chairman, Aquila Energy, to a recent Toronto Board of Trade luncheon.

"According to one opinion poll, 90 per cent of Californians believe that deregulation contributed to the energy fiasco there. But what failed in California was not deregulation. What failed were price controls on retail electric rates and an overly restricted wholesale market. A perfect storm!" he remarked.

He told delegates that there are other "paths to deregulation" that have worked elsewhere and can work in Ontario, and suggested that Ontario proceed with electric deregulation simply because it is in Ontario's self interest.

The crisis in California, he said, was a long time coming. California in the mid 1990s, was paying on average 50 per cent more for electricity than the rest of the country. There were estimates at the time that the regulatory regime was costing residential customers on average $265 a year, commercial users about $1400, industrial users more than $23,000.

"Yes, it's true that my company would benefit from deregulation. We would benefit insofar as we'd have a freer hand to stabilize our operations, as well as a greater opportunity to meet customer needs and grow market share. However, we'd also face much greater risks. To correct the situation in California, the state decided, in the words of one of their utility executives, to "use the English model as our guide." That is, California wanted to follow the model established by England in the deregulation of its electricity market. Unfortunately, California's model resembles the English one the way Austin Powers resembles James Bond," he joked.

"To correct the situation in California, the state decided, in the words of one of their utility executives, to "use the English model as our guide." That is, California wanted to follow the model established by England in the deregulation of its electricity market. Unfortunately, California's model resembles the English one the way Austin Powers resembles James Bond."

Robert Green, President and Chief Operating Officer, UtiliCorp United and Chairman, Aquila Energy

Perhaps the most important difference was England's emphasis on creating excess supply capacity. The country began its deregulation program in 1990 with a legacy of overbuilt facilities. Nevertheless, the English program included an incentive in its pricing mechanism to encourage the development of long-term reserve capacity. Additional supply has grown so plentiful that this incentive is going to be discontinued.

By contrast, California's capacity was in decline when it began to deregulate in 1996. From 1988 to 1998, generating capacity decreased 5 per cent. No new plants have gone on-line since 1990. And under current regulations, it's very difficult to build new facilities. Another difference, the English model allowed retail prices to fluctuate. The English did include price caps in the beginning, but these were discontinued as the market matured and the public had more retail choices," he said.

"California, on the other hand, reduced consumer rates by 10 per cent and then froze those rates for 6 years. Therefore, Californians had no incentive to conserve, and they didn't. And potential new power suppliers had much less assurance that they could recoup their investments if costs increased significantly," he added.

California also made a number of other miscalculations, he said. One of the most serious was not to allow utilities to enter into long-term contracts. By relying solely on the volatile spot market, the utilities could not hedge against price spikes.

In December, wholesale electricity prices soared to more than $600 (U.S.) per megawatt hour. This compares to $120 per megawatt hour in June and $22 at the time deregulation went into effect in March of 1998. As a result, the utilities have paid up to 8 times as much as the $65 per megawatt hour that they can charge consumers, he said.

"So, it's not surprising that Pacific Gas & Electric, the largest California utility, bought out-of-state power in December for $1.7 billion and sold it to its customers for $70 million. The utilities have been threatened with bankruptcy and have ceased paying suppliers. The federal government has invoked emergency orders to force suppliers to keep the electricity flowing. Alternative suppliers, which had provided 23 percent of the total, have threatened to go off-line. And rolling blackouts have afflicted much of the state," he said.

The effects go far beyond the utility industry. Just for the week of January

Continued on page 18

Continued from page 16

14th, California's economy suffered an estimated loss of $1.7 billion due to the electricity crisis. In terms of electricity prices, the shockwaves have already extended beyond California. Rates have skyrocketed in Idaho, Montana, Utah and other states that compete for the same power sources. Several factories have closed rather than run up catastrophic power bills, and hundreds of workers have been laid off.

"Of course, not all of the circumstances that led to this predicament were California's fault. Their utility executives claim, with some justification, that a number of factors could not have been foreseen to occur, at least not simultaneously," he offered.

In 1996, few people anticipated the dramatic surge in natural gas prices. Natural gas is the predominant fuel on the margin for electric generation in California. Recently, it has sold for four times as much as it did the year before. In late December, the fuel broke the $10 per million Btu mark. And an earlier explosion at one of the major pipelines feeding the state hasn't helped. The extended economic boom also surprised many. California's economy grew by 32 per cent in the past five years, led by the energy-intensive demands of Silicon Valley, which resulted in a 24 percent increase in the consumption of electricity. Weather also played a part. An unusually dry winter in the Pacific Northwest has decreased its ability to export power to California. And severe storms in Central and Southern California have also hurt. Two of the state's nuclear generators had to limit operations recently to avoid ocean kelp from being driven into their cooling systems. A convergence of events not unlike the perfect storm.

"I believe that Ontario should deregulate its energy supply because it is in your own self-interest. And let's be clear, deregulation is just another word for free markets. I suspect that most, if not all, of you here today operate your businesses every day under the risks inherent in free markets, and you wouldn't have it any other way. And I doubt that I need to emphasize that the alternative to free markets poses even greater risks," he said.

"Some may say, "But electricity is different, it is too vital to our economy to be left to an uncontrolled market." My response to that is, what about gasoline? Does anyone think that gasoline or diesel fuel isn't vital to our economy? That market is fully deregulated in California and in Canada. Clearly, the free market can deliver energy reliably and efficiently. As everyone here knows, trade barriers are falling around the world," he said.

Technology and information are replacing the old pillars of wealth creation — land, labor and capital. Nowadays you can run almost any kind of business virtually anywhere in the world, or even throughout the world. This new kind of global marketplace puts a great premium on infrastructure. Infrastructure, of course, has always been important. The privately financed railroads of the 19th-century helped to build the United States into a world power. Cheap and available electricity helped jumpstart Central Canada's growth in the early part of last century, he said.

"We have seen this distortion in Canada's electricity prices, which rose more than 30 per cent from 1992 to 1997. And we all know the legacy of Ontario Hydro. Now, in talking about Ontario we have to consider another example closer to home — namely, Alberta. When Alberta became the first province to deregulate five years ago, it had some of the cheapest electricity rates in North America. Today, only California and Hawaii have higher rates. However, I would submit to you that the price spike is not due to deregulation. Part of the problem has to do with bad timing, but much of it also stems from bad public policy. In terms of timing, skyrocketing natural gas prices had a significant effect on the province. Alberta gets about 30 per cent of its generation from gas. Nevertheless, if Alberta had moved with more determination toward deregulation, and if it had been clearer about its rules, it would have attracted more new suppliers. As it is, good economic times created a rise in electricity demand of 5 percent last year that was not matched by additional supplies," he said.

Fortunately, Alberta is better off than California, he said. Several new generation projects have been announced. And the same boom in oil and gas prices that helped create its high electricity bills has enabled the government to rebate some of the higher power costs back to consumers. So, if Alberta and California are examples for Ontario, they are examples of opportunities missed.

Hopefully, California will learn the right lessons from this crisis. A number of experts have suggested both short-term and long-term solutions. Most of these have to do with creating a true market-based system and allowing appropriate price hedges, such as long-term contracts, into the program.

"In the face of all these misplaced accusations against deregulation, I would respectfully urge Ontario not to miss its own opportunity. To echo the sentiments of at least one Canadian journalist, the timing is good now to move decisively to free up your electricity market over the next several months. The elements are in place, and the important players are ready, or soon will be," he said.

Unlike California, Ontario has a comfortable 18 percent generating reserve, according to a recent IMO forecast. The province has the flexibility of using hydro or coal as well as natural gas. Grid interconnections and enhancements with Quebec and Michigan, as well as the anticipated reopening of the Pickering nuclear station, will all reduce price volatility.

"In fact, Ontario has thought out the deregulation process so well that it has the chance to shine as a leading-edge example of what deregulation can do," he suggested.

"However, at this point, any wavering on the part of officials might scare off a sufficient number of suppliers to make this an optimally contested market. If the examples of Texas, England and Pennsylvania teach us anything, it's that suppliers will turn out in strong numbers if a clear and healthy deregulatory environment is in place. Of course, moving away from regulatory franchises also exposes firms and consumers to a complex set of risks. I don't want to give you the fairy-dust version of deregulation. You do have to stare down the dangers of the real world, but you as business leaders are used to doing that every day," he added. "As our economies become ever more dependent on reliable energy supplies, and as these supplies become more contested, the regions of the world that encourage open energy markets will have a tremendous competitive edge. Competitive markets are the best at allocating resources and attracting investment — especially the huge investments needed for energy projects. And open markets provide the most socially acceptable method of spreading risk. Besides, we've seen what wonders open markets have done to create prosperity around the world in the past few years. Imagine what an open energy market can do here to build a brighter future for Ontario, as well as for Canada. We believe that Ontario should proceed to deregulate its energy supply on the same free market principles that have worked so well in countless other markets," he said. ET

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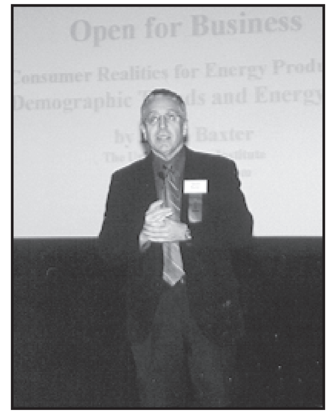
ALBERTA ELECTRICITY REPORT

David Baxter, Executive Director, Urban Futures Institute:

Power for the People

Over the past fifty years, the production of goods has accounted for an ever-diminishing share of the North American economy, with the shares of transportation, trade and services increasing. This does not mean that North Americans are any less materialistic, but rather that our goods are increasingly manufactured outside of North America. Making things generally takes a lot of energy, relative to the production of services: as a result, the amount of energy (in BTU5) required to produce a billion dollars of North American GDP (in constant dollars) has fallen by almost 50 per cent since the end of the second world war.

More than ever, the future of electricity generation will be in the business of providing warm showers, cold beer, and entertainment. With an increasing share of demand driven directly by households, and indirectly by the industries that provide goods and services to consumers, electricity producers will be increasingly aware that population matters.



David Baxter,
Executive Director
Urban Futures Institute

While GDP is less energy intensive, consumption is not: per capita consumption (BTUs per capita) of energy in North America increased by more than 60 per cent over the same period. Residential and commercial energy consumption now essentially equals industrial consumption, while fifty years ago residential and commercial uses consumed only two thirds of what industry did. Air conditioners, fridges, VCRs, microwaves, camcorders and computers not only revolutionized living, they also increased, and are increasing, energy demand significantly.

Appropriately, given the digital and appliance revolution, the greatest increase in energy consumption was of electricity. While per capita energy consumption increased by 60 per cent, per capita electricity consumption increased by 350 per cent. In terms of consumption, coal was the big loser of market share, going from 30 per cent of total consumption to 3 per cent, while electricity was the big winner, going from 15 per cent to almost 40 per cent. (The drop in coal's share on the production side is not nearly as significant, as much electricity is made from coal: in the 1950s, over a third of all energy was produced using coal, compared to slightly less than a quarter now.)

The structural shift in North America's economy has changed the drivers in the demand for energy in general, and electricity in particular, with population growth, rather than industrial locations, being the focus of demand (and hence the California electricity crisis). The future pattern of increasing power demand will be the pattern of population growth in North America.

While per capita consumption of electricity is not likely to grow as much in the future as it has in the past (as most households now have a pretty full complement of electrical consumer products), the total demand for electrical energy will.

The population of the United States is projected to increase by 60 million people in the next twenty-five years, and that of Canada by 6 million, for a 22 per cent increase in the population in the North American energy market, with any increases in per capita consumption adding to this increase in demand.

This growth will be concentrated in a few regions. Three states in the United States will account for half of the growth: California is projected to grow by 16.8 million, Texas by 7.1 million, and Florida by 5.5 million. Add (in order of additional population) Georgia, Washington, New York, Arizona, North Carolina, Virginia, and Illinois, and ten states will account for more than two thirds of the United States population growth in the next twenty-five years. The ten most rapidly growing states, all either on the west coast or across the southern half of the country, will account for 60 per cent of the nation's growth. In Canada, almost 60 per cent of the 6 million person population growth over the next twenty five years will be in Ontario, with BC, Alberta, and Quebec accounting for almost all of the rest.

This does not necessarily mean a stable future in electrical energy markets. Part of the variance will result from the spatial gap between generation and demand. Traditionally, electric power was produced where the energy resources were and transmitted to where the consumers were. This is not a particularly efficient system, when approximately 9 per cent of electricity generated is lost in transmission and distribution. As well, the capacity of many long distance transmission lines is not adequate to handle current peak demand, and certainly not future increased demand.

This has lead to an increasing emphasis on reducing the distance between generation and consumption, by producing the electricity closer to the consumer using natural gas fired generators.

Natural gas now exceeds hydro as a source of power generation in the United States: the future problem in this regard lies with the fact that natural gas transmission lines into the high growth states are also facing capacity limits.

Much of the variance will come from the changing structure of the power industry. The recent California electricity crisis was a windfall for Canadian electricity exporters: it should be treated as such. Canada is NAFTA's net electricity exporter, exporting over 6 per cent of our production, with both United States and Mexico being net importers. But our exports account for only 1 per cent of the United States consumption, a margin that can disappear quickly and permanently. An effective energy conservation program in the United States or a strong increase in US production capacity can eliminate export demand. So can deregulation.

In both Canada and the United States, generation by independent power producers, small producers and co-generators is anticipated to increase much faster than that by major utilities. It is true that increasing consumer prices will lead to increased generation of electricity, but it is also true that they will lead to reductions in consumption, and for electricity imports.

More than ever, the future of electricity generation will be in the business of providing warm showers, cold beer, and entertainment. With an increasing share of demand driven directly by households, and indirectly by the industries that provide goods and services to consumers, electricity producers will be increasingly aware that population matters.

David Baxter is Executive Director, Urban Futures Institute. He made this presentation to the recent annual meeting of the Independent Power Producers Society of Alberta (IPPSA). ET

ALBERTA ELECTRICITY REPORT

Seabron Adamson, President, Frontier Economics Inc.:

Making Dollars and Sense of Alberta's Electricity Prices

Alberta now finds itself nearly three months into the operation of an electricity market where prices are determined through market forces rather than regulation. While the Power Pool of Alberta has been in operation since 1996, prices for the majority of electricity volumes were determined by regulated contracts. As of 2001, however, this is no longer the case. Recent high Power Pool prices have some observers wondering if the expected benefits of deregulation will materialize.

We submit that the underlying realities of Alberta's electric power sector made higher prices inevitable, even if it had preserved its system of regulation. Comparisons with neighboring regulated jurisdictions are misplaced, as are comparisons with the regulated rates of old. The hard reality is that Alberta needs to develop significant new generating resources in order to meet its growing needs. Such new investment will always be expensive, no matter if it is financed through regulated rates or through market prices.

Perhaps more importantly, recent prices must not distract policymakers from the need to continue to develop the Alberta marketplace. The focus must be firmly on attracting private investment in new capacity through market means. Most importantly, the government cannot appear to undermine the free market process, as few things alienate investors quite as effectively as the specter of regulatory intervention.

In the coming months, several issues will require responsible guidance from policymakers, including the development of forwards markets and a market for ancillary services. Sound market design, of the kind that has characterized reforms to date, will do the most to create an attractive place for investors to do business, and for the benefits of deregulation to materialize.

From the point of view of consumers, the new deregulated environment means that they are no longer the captive guarantors of new investments. A firm making a poor decision will no longer have recourse to consumers' pocketbooks to recover their costs. While this protects consumers from bearing the costs of poor decisions, they also benefit from the competitive pressure created as multiple firms pursue good investments.

Seabron Adamson, President
Frontier Economics Inc.

Hardships Stemming From Current Market Prices

This is not to say that we should not be concerned with the hardships stemming from current market prices. Some customers will be better able to avail themselves of opportunities created by deregulation than others, and it is the proper role of government to assist the most vulnerable consumers. This can be achieved through programs such as rebates and the use of deferral accounts to offset current high prices against future expected lower prices. Carefully designed programs can provide protection to eligible consumers without distorting the underlying market.

The real benefits from deregulation will be realized when new plants are necessary to meet the needs of a growing system. This is precisely the case in Alberta, where the need for new generating capacity has been widely acknowledged for several years. A new plant that is built in the province no longer has any assurances that it will realize a return on its investment. It is therefore incumbent upon the private investor to carefully analyze the need for new generation, as due diligence will be its only assurance of a good investment.

From the point of view of consumers, the new deregulated environment means that they are no longer the captive guarantors of new investments. A firm making a poor decision will no longer have recourse to consumers' pocketbooks to recover their costs. While this protects consumers from bearing the costs of poor decisions, they also benefit from the competitive pressure created as multiple firms pursue good investments. Firms will try to develop the most cost-effective projects possible, as this maximizes their profits. In the course of doing so, the combined effect is to reduce prices overall.

The key benefits to deregulation arise not because it fundamentally lowers the cost of doing what has been done for decades, but because it alters the nature of new investment.

Comparing Apples and Oranges

Two common refrains in newly deregulated markets are to compare electricity prices to those in neighboring markets, and to compare them to what they used to be. Both such comparisons are potentially misleading. It is wrong to compare Alberta's energy prices to those in British Columbia, for example, because the prices reflect fundamentally different situations, not only in terms of regulation but also in terms of historic investment, system needs, and available resources.

B.C. is fundamentally different from Alberta. Its extensive endowment and development of hydro resources is the mirror opposite of the thermal system in Alberta. More importantly, B.C. does not currently face a capacity shortage, so its rates will be driven by an asset base of depreciated investments. Alberta cannot hope to see the rates faced by B.C. consumers because Alberta is not B.C.

The appropriate comparison for gauging whether deregulation offers benefits to consumers, then, is to ask how Alberta would have met its current challenges under the old system of regulation. Given the realities of the Alberta electric system, the real question should not be to lament its situation — as comparisons to other jurisdiction or to the past do — but to ask how these challenges can be best met.

Rise in Prices Reflect Changing Market Conditions

An obvious first question is to ask whether recent market prices make sense. These prices must be viewed in the context of various factors that influence electricity prices:

- Prices of natural gas rose dramatically during 2000, from an average of $2.8/GJ in January to nearly $12/GJ in December.
- Hydro generation was nearly 20 per cent below 'average' levels during 2000, increasing the reliance on thermal generation in the province, just as this thermal generation was getting more expensive.
- Imports fell over 35 per cent while exports tripled, reducing net imports by 70 per cent compared to 1999. This was due primarily to the surge in prices in the Pacific Northwest, in turn influenced by rising California prices. This increased competition for importing sources while also increasing the demand for exported power.
- System load grew by approximately 5 per cent in 2000.

Every one of these factors indicates a tightening in the supply/demand balance, from a system that had been generally regarded as being in need of new capacity for several years. While we have not undertaken a complete study to determine if these factors explain the higher Power Pool prices during 2000, we would have been very surprised if prices in 2000 had not been significantly higher than in previous years.

We stated previously that the real benefits from deregulation stem from the shift of risk and responsibility for new investment away from regulated utilities and into the hands of private investors. One seemingly obvious test, then, would be some sort of measure of private-sector interest in investing in new capacity. We would argue that this is the ultimate test; no other benefits of competition are as valuable as getting government out of the business of building new power plants. If Alberta's electricity policy fails to get new capacity built by private investors, the entire effort will have been for naught.

At first glance, it would appear that Alberta is successful in this regard. The initial market reforms have led to nearly 1,000 MW of new independent power capacity to enter service. With over 4,000 of planned and announced new generation, there is at least an indication of strong interest, even if such announcements are not exactly commitments. Another positive sign in the $1.1 billion of revenues raised by the PPA auction; this is revenue in addition to shouldering the obligation of making fixed and variable payments to the plant owners for up to 20 years.

These promising signals aside, it is probably too soon to tell how much private capital Alberta's market will ultimately attract.

Room for Improvement

Nevertheless, there are aspects of the Alberta market that raise some concern:

- The Power Pool rules were amended to prevent imports from setting the Power Pool price. This is pure price discrimination, and weakens the price signals within the Province.
- The Balancing Pool has become an active market participant, directly controlling one of the key plants in the system. There is a legitimate concern about a market where a dominant participant has poorly defined operating incentives. The offer strategy adopted by the Balancing Pool - in which Clover Bar was offered below its properly defined marginal cost during peak hours — was regarded by many as a deliberate attempt to manipulate Power Pool prices.
- The precise interaction between ancillary services and the Power Pool price is not clear. In particular, how is energy dispatched from a unit providing reserves priced? If these reserves are tapped to prevent rationing, prices should reflect the compromised nature of reserves. As far as we are aware, however, reserves do not affect Pool prices, even when called to deliver energy.

The rule changes and actions of the Balancing Pool do not inspire complete confidence in this market. Imports continue to be an important source of power for Alberta, yet the Power Pool no longer reflects this. In January and February, there were 38 and 35 hours, respectively, in which imports were procured even though they were more expensive than the Power Pool price.

If the true price of electricity is not reflected in the Power Pool price, consumers will have insufficient incentive to conserve, and generators will have insufficient incentive to increase production through improved operations or through new investment.

The offer strategy adopted by the Balancing Pool is more disturbing. By improperly calculating the price paid for gas for Clover Bar, the Balancing Pool offered output from the plant below its economic marginal cost. On January 5, for example, Clover Bar set the Power Pool price in 16 hours at approximately $97/MWh. Its actual marginal cost was closer to $130/MWh, implying a distortion to market prices of 25 per cent in each hour it was setting the Pool price. The message to private investors, unfortunately, is that the Balancing Pool has the ability and demonstrated willingness to distort market prices.

Consumer Protection

If the government is concerned about high electricity prices, it has several options at its disposal that do not distort the market. The Regulated Rate Option is one such alternative, in which deferral accounts are established to smooth out the transition to deregulated prices for certain customers. It rightly provides price protection for the most vulnerable customers while not preventing those with the skills, desire and incentive to actively participate in the market from doing so.

Other options also exist; including fixed monthly rebates to customers. This reduces the cost of electricity while not distorting the marginal incentives for consumption. Consumer protection does not need to come at the expense of market transparency and credibility.

Conclusions and Recommendations

We have now experienced three months under the new market rules, where the price of all electricity is set by market forces rather than by regulation. It is tempting to look at Power Pool prices during this time and pronounce deregulation as an expensive proposition.

However, this would have been a

Continued on page 24

Continued from page 23

period of rate increases even under regulation. If higher prices were inevitable — as they necessarily will be in any system with a shortage of generating capacity — then we must turn our attention to whether new supply is best developed under regulation, or under competition. The key concern must be to look forward, to ensure new supply is attracted by creating and fostering a credible marketplace where companies will want to invest.

Several developments will need responsible guidance in order to fortify the Alberta electricity market. Some issues in particular will need attention:

- Control of the PPAs held by the Balancing Pool must be transferred to private entities with commercial incentives. Despite its best intentions, having a quasi-public entity control a large fraction of generating capacity will always be viewed with suspicion. Competition on a level playing field was a central tenet of the Electric Utilities Act; active participation of the Balancing Pool in the market offends this principle.
- Emerging forwards markets will play a key role in providing price signals over different time frames. Both over-the-counter and exchange -based trading is developing, and at least two Binding Day-Ahead Markets are expected. It will be critical that the choice of markets not be distorted by such issues as allocation of uplift costs.
- A market for ancillary services is being developed to replace the RFP process currently being used. Considerable effort will be required to design the rules that govern this market, as well as how it will integrate with the real-time energy market.
- Much of how the Alberta market currently functions depends on the ability of the transmission grid to operate as a single provincial system. If this ability is eroded, significant issues will arise, such as the need for location-based prices and the allocation and use of transmission rights. Experience in the American markets shows it is difficult to ‘fake’ a one-zone system. Either a commitment must be made to maintaining an uncongested transmission system, or work must begin on considering designing a market that reflects the limitations of the grid.
- Large industrial load could well make Alberta the first electric market to truly involve load in the price-formation process. The resulting ‘Alberta model’ may become the leading example of a complete electricity market.

In general, Alberta has developed a very attractive market. The fundamental design is transparent, the relevant institutions are well established, and there is a large volume of information available about how the market functions. A renewed commitment to ‘letting the market work’, while pursuing minimally distortionary consumer protection programs, should encourage the private investment the sector so obviously needs.

Seabron Adamson is President of Frontier Economic Inc. and directs the firms North American energy practice. Mr. Adamson made this presentation to last month’s annual meeting of the Independent Power Producers Society of Alberta. ET

ALBERTA ELECTRICITY REPORT

Deregulation Costs Consumers

Power prices in Alberta will continue to sting in 2001 — and for years to come, according to a recent report written by Optimum Energy Management. In addition, the report claims that deregulation of the Alberta electricity industry has cost consumers $3 billion more than if the provincial industry had remained regulated. The report predicts electricity will cost between 7.5 cents to 13.2 cents per kWh in 2001. That compares to an average spot price in 2000 of 13.3 cents (or $133.22 per mWh), 4.3 cents in 1999 and 1.4 cents in 1996.

"This is forecasting," noted Optimum vice-president Duane Reid-Carlson in a recent interview. "It's an art, not a science."

But the result is grim, added Dale Hildebrand, another Optimum executive: "It is no longer clear that the prices consumers will pay are going to be lower as a result of deregulation."

It didn't have to be like this, the report suggests. The slow move to deregulation began in 1996. If the industry had remained regulated, there would have been a steady rise in demand and price, and probably a couple of new regulated, coal-fired generators to meet the need.

But the province's deregulation process created uncertainty and stopped any significant new developments for five years.

"It is anticipated that consumers have lost as much as $3 billion of value from Alberta's previously regulated generation as a result of electricity industry restructuring," the company said in a statement.

Current high spot prices have prompted companies to announce new projects totalling over 4,200 megawatts by 2006, including Epcor's plan to build a 400 MW plant at Lake Wabamun.

TransAlta has plans to build a 900 MW plant in the same area.

But the province's needs in that time frame will amount to 2,000 to 3,000 new MW, not 4,200. "It is not likely that all projects will be built as announced," Reid-Carlson said.

In fact, less than one-third of the badly needed power plants proposed for Alberta have a realistic chance of being built, he said. About 4,250 megawatts of new generation — roughly half of the province's existing capacity — have been proposed for construction by the end of 2006.

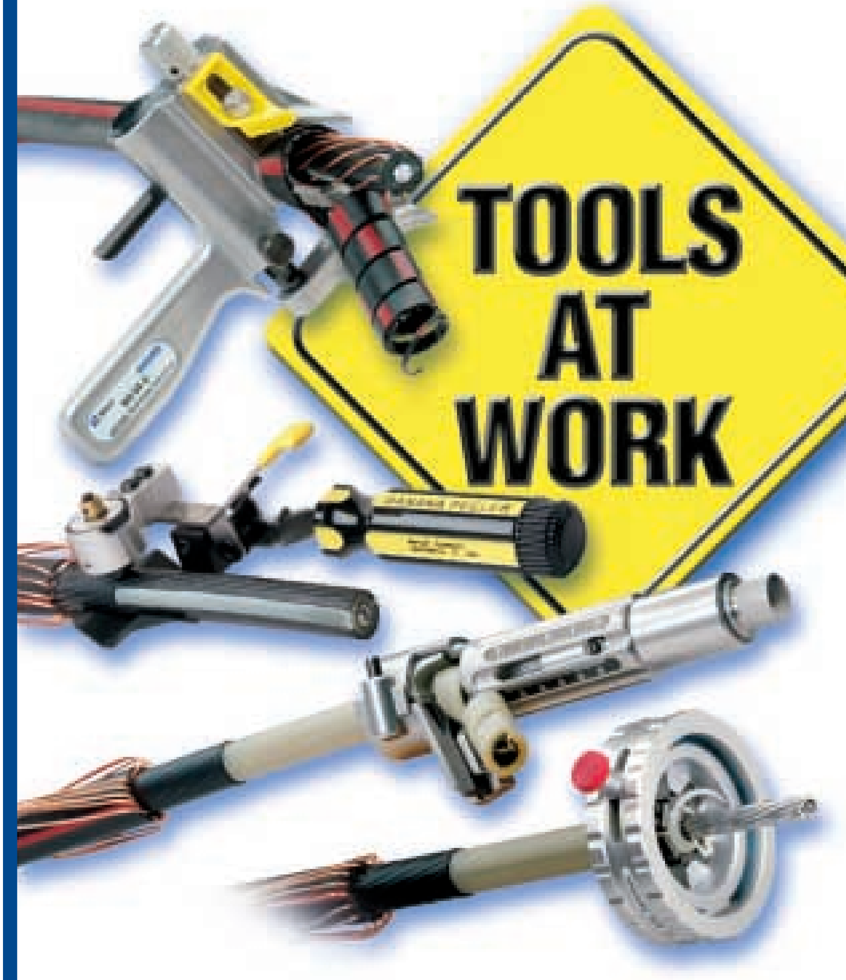
But it is unlikely many of those will ever become a reality, according to the Optimum Energy Management report.

The Calgary-based consulting firm gives just 1,300 MW worth of new power plants a better than 80-per-cent chance of being built. The plans that are most likely to be abandoned before construction begins are proposals for natural gas plants, said Reid-Carlson.

"As the price of natural gas climbs, coal becomes more attractive," he said. "But it's first-come, first-serve. Whoever gets their plant built first will have an effect on what other plants get built."

The new plants are needed to ease Alberta's power supply crunch, which has been worsened by rapidly growing demand for electricity. But high natural gas prices threaten to turn gas-fired plants into inefficient money burners, compared to coal-burning generators. Gas prices are expected to remain high for the next five years, say analysts.

Continued on page 43



INDUSTRIAL ENERGY EFFICIENCY

Benchmarking Energy Consumption to Identify Opportunities for Conservation

By D.M Bruce

Today and even more so in the future, the pressure to reduce energy consumption will come from the twin drivers of improving cost competitiveness and ensuring market acceptance of pulp and paper products from an environmental viewpoint. Awareness of the energy issue has risen significantly since Canada signed the Kyoto accord in December 1997, in which the Canadian government committed to a 6 per cent reduction of greenhouse gas emissions (GHGs), relative to 1990 levels, by 2010 to 2012. Governments and industry in North America and Europe are looking for strategies and types of policies and measures that ought to be adopted to address these emissions. A large part of the answer must lie in fuel substitution by biomass and in the industry making better use of the fossil fuel and electricity it does consume.

In our industry a number of initiatives are already in place. Eco-labelling in Europe has been developed in order to address issues such as the efficient use of resources, including energy and the minimization of greenhouse gas emissions. At home, the Canadian Industry Voluntary Challenge and Registry (VCR) and the Canadian Industry Program for Energy Conservation (CIPEC) aim at reduced greenhouse gas emissions through voluntary action undertaken by individual companies.

Such well publicized initiatives complement the perhaps less visible activities of the Canadian Pulp and Paper Association (CPPA) and the Pulp and Paper Technical Association of Canada (PAPTAC) in encouraging energy efficiency among their member companies. Many of these activities are long-standing, dating from the oil crisis of the

Continued on page 28

TABLE I. Some preliminary data on departmental-specific steam consumptions in GJ/adt.

	Softwood						Hardwood	
	Typical 1980s	S. America 1990s	N. America 1990s	European 1990s	S. America 1990s	Model Mill	N. America 1990s	Europe 1990s
Woodroom	0.30	0.00	0.00	0.20	0.00	0.00	0.38	0.40
Digesting, washing and screening	4.10	2.34	3.33	3.20	2.00	1.79	1.94	2.20
O_2 delignification	0.00	1.32	0.18	0.20	0.50	0.40	0.31	0.00
Bleaching	3.50	2.84	0.58	0.40	0.40	0.00	3.38	0.68
Pulp drying	4.40	2.69	4.49	3.10	2.70	2.37	4.13	2.98
Chemical preparation	0.30	0.31	0.37	0.30	0.40	0.11	0.17	0.30
Recausticizing and kiln	0.50	0.40	0.00	0.00	0.30	0.00	0.00	0.30
Evaporation and stripping	4.10	3.90	5.40	4.20	4.70	3.34	3.77	3.04
Steam and chemical recovery	4.90	3.28	2.61	1.60	1.70	1.22	1.05	0.92
Total of process departments	**22.10**	17.09	16.96	13.20	12.20	**9.18**	15.12	10.77
Relative magnitude, %	181	140	139	108	100	75	140	100

TABLE II. Some preliminary data on departmental-specific power consumptions in kWh/adt.

	Softwood					Hardwood	
	N. America 1990s	S. America 1990s	European 1990s	N. America mid-1980s	Model Mill	N. America 1990s	Europe 1990s
Woodroom	24	37	20	43	56	68	28
Digesting, washing and screening	168	150	205	181	125	156	156
Bleaching	124	132	110	33	55	92	94
Pulp drying	155	143	140	150	165	114	172
Chemical preparation and oxygen	59	8	60	0	5	7	5
Recausticizing and kiln	30	23	25	61	60	14	19
Evaporation and stripping	125	98	30	75	35	125	28
Chemical recovery and steam	191	124	110	18	90	91	150
Water and effluent treatment	66	56	40	108	40	85	45
Total of process departments	**944**	801	**740**	**669**	630	**752**	**647**
Relative magnitude, %	141	120	111	100	94	116	100

Continued from page 26

1970s, and include: the issue of quarterly energy consumption questionnaires and compilation of the annual Energy Monitoring Report; the activities of the Energy Committee, which include organizing the Energy Conservation Opportunity awards; and the co-ordination of the Environmental Profile Data Sheets for products of CPPA member companies, which provide audited information on resource consumption including energy.

The convergence of several issues now emerging will shape how mills view and manage energy costs:

- The move toward gas and electric utility deregulation, combined with the possibility of long-term energy prices rising increase uncertainty;
- The advantage of a low energy bill in an increasingly competitive marketplace;
- Control of greenhouse gas emissions whether in the form of regulations, taxes or voluntary action.

For these reasons there seems to be a growing recognition that proactive management of energy costs, minimizing fossil fuel use, and energy efficiency must be part of company strategy over the long term.

This article draws upon the Guide to Energy Savings Opportunities in the Kraft Pulp Industry [1], which PAPTAC published in December 1999 and distributed to mills across Canada. The PAPTAC Energy Committee supported the development of this energy conservation guide limited to kraft pulping, and a contract was awarded in August 1997, with funding provided by Natural Resources Canada.

The Guide is designed to give the mill engineer a practical, step-by-step approach to improving the energy efficiency of kraft pulp mills. The key elements of the recommended approach comprise in-depth energy audits, benchmarking against existing and new mills, gathering energy savings ideas, assessing the degree of thermal integration of the process, evaluating impacts on mill systems, and projecting energy cost savings. A more comprehensive document has recently been completed covering all types of pulp and paper manufacturing processes and mill types.

Recommending A Systematic Approach

Over the years, many energy conservation measures have been carried out in mills without comparing them to other possible opportunities. If the measure can be clearly seen to save purchased fuel or purchased power, and to meet the company's investment hurdle rate, there would seem to be no apparent reason to delay. However, the shortcomings of this piecemeal approach are that better opportunities may be missed, or even foiled, by sub-optimal investments. Taking a comprehensive review of all possible opportunities takes time, personnel with appropriate skills, and management backing, all of which have been in short supply in recent years given the relatively low priority given to energy.

TABLE III. Energy conservation projects in the chemical recovery department.

Description	ECO#	Type
Reclaimed blow down hot water for recovery area wash down	SP 26	HI
Use mechanical seals on black liquor pumps	KP 29	HI
Conversion of #6 oil tank to heavy black liquor storage saves gas firing	SP 69	PC
Recover heat before diluting with fresh water	KP 55	HI
Increased combustion air temperature increases liquor throughput	SP 59	PC
Optimized washing of cascade evaporator	KP 29	PC
Optimized sootblowing frequency saves unnecessary blowing	SP 70*, 94	PC
Replace salt cake by sulphur and caustic	KP 59	PC
Reduce steam coil air heating by raising firing solids	KP 29	PC
Optimization of combustion air and liquor firing	SP 1	PC
Teller scrubber hot water displaces cold water makeup in bleach plant	KP 41*, SP 40	HI
Improved liquor firing reduces oil firing and sootblowing	SP 48	PC
Oil usage reduced by improved operator motivation and communication	SP 49	PC
Improved steam generation efficiency by conversion to low odour	KP 64	PC
More efficient electric variable speed ID fan drive saves power	SP 56	PC
Installation of automatic primary air port cleaners improves efficiency	SP 74	PC

Therefore, the detailed energy audit is an essential first step in any comprehensive and systematic approach to improving energy efficiency. It includes the setting up of computerized heat and mass balances, which are a necessity to efficiently reconcile all the "hard" sources of data, while also considering the less accurate or "soft" information, so that the most reliable baseline of the current mill operation is established. Audits are also an excellent opportunity to get to know the details of the mill and enlist the cooperation and assistance of the operating staff and access their knowledge.

The balance of this article focuses on benchmarking and identification of energy efficiency projects, while information on other important aspects such as evaluating impacts on mill systems and projecting energy cost savings, may be found in the literature.

Benchmarking Energy Consumption

Whether for energy, production costs, or uptime, benchmarking mill operating statistics is conducted with mills of a similar type producing essentially identical products and is fundamental to competitiveness analysis. Regular audit-based benchmarking exercises allow a mill to track progress and establish the gap between it and mills of newer, more modern design or between mills of similar age.

Energy benchmarking data is presented for some newer mills, a group of older mills more typical of the current age of many of North American bleached kraft pulp mills, and a model mill. The newer mills are representative of designs since about 1990. The sources of the information are published data, mill audits conducted by H.A. Simons (now AMEC) or are data received directly from the mills themselves. Typically, these mills use extended cooking, oxygen delignification, ECF bleaching, high solids firing (72 to 76 per cent), and have a total mill water consumption in the 50 to 70m^3 adt range.

The data for the group of older mills, taken from an energy consumption survey published in 1981 for 17 Canadian and seven Nordic mills, is labelled Typical 1980s. This data is very similar to that presented for a 1980s-era mill in the United States.

Data on a hypothetical mill published first in Svenska Papperstidning, and subsequently in English, was prepared by AFIPK of Sweden. The mill included no direct fresh steam heating of warm or hot water, three stage flashing of black liquor at the digester, press-based washing, condensate heating with evaporator flash vapour and no steam use in the causticizing or kiln area.

Additional specific steam consumption data for Swedish mills not presented here is found in recent literature.

Steam Energy Consumption

Definitions:

The specific steam consumption of a department or a steam load is defined as the heat absorbed from the steam and condensate system per unit mill production, and is expressed as GJ/adt in metric units. The definition credits the heat in the condensate returned, while the heat lost in the condensate not returned becomes a charge against that department, which is determined by the temperature of the makeup water, e.g., river temperature. This definition has the advantage of allowing direct comparison with the Nordic countries.

Results:

Specific steam consumption data for eight bleached kraft market pulp mills is presented in Table I. This shows that for softwood, the spread among the 1990s-era mills is 100 to 140 per cent of the best mill, while that for the Model Mill is 25% lower. The corresponding value for the 1980s typical North American mill approaches twice that of the best 1990s mill. The spread in the two hardwood data is also large.

An underlying reason for the differences in consumption is mill design and process technology adopted. This is shaped by the economic environment, such as the cost of fuel, power, labour, construction, requirements for return on capital and owner philosophy. Also, the basis for some data was not a detailed audit due to lack of resources.

Most importantly, some audits were conducted before a sustained production plateau had been reached. Accordingly, the results should be treated as preliminary.

Electric power consumption

Some preliminary specific power consumption data for seven mills is presented in Table II. All of the mills were built in the early-1990s, with one exception, a mill built in the mid1980s. Here the spread for softwood mills is 100 to 141 per cent of the best mill, while that for the Model Mill is 6 per cent lower. Hardwood values are somewhat less. Data for 1980-vintage mills are not presented, but would be similar to that for the 1990s mills. Further specific power consumption data for Swedish mills not presented here is found in recent literature.

Identifying Energy Conservation Projects

Types

Energy cost reductions can be achieved by a broad range of measures, from adopting a new procurement policy, or changing the excess air setpoint on a boiler control in the steam plant, to a project requiring significant capital.

In organizing an approach, it is useful to distinguish between four types of improvement measures:

- Energy procurement strategies and policies;
- Operating practices and maintenance initiatives;
- Energy conversion efficiency and fuel substitution projects: fuels and electricity into heat and shaft power and fuel or falling water into shaft power and electricity;
- Increasing the efficiency of the energy used to meet the needs of the process by 1) better thermal integra-

Continued on page 30

Continued from page 29

tion for the reuse of secondary heat, and 2) minimizing heat rejected or lost to the surroundings

The list can be thought of as a chain of dependency, with measures towards the top being generally independent of the measures lower down. For instance, lowering an excessive furnace 02 set-point on a boiler control in the steam plant — an operating measure — is an action that will result in immediate benefits, and is essentially independent of steam use and, therefore, on whether a steam energy efficiency project proceeds or not.

The last category, the efficiency of energy use, is linked to, and therefore generally depends on, the categories that precede it, because they determine the cost of energy saved. Thus, to justify spending capital to reduce energy consumption somewhere in the process depends on the price of fuel or power, those operating and maintenance practices which affect energy conversion efficiency, and the boiler or motor efficiency.

Although this dependency is generally true, it is not a hard and fast rule, particularly when the amount of energy saved is large, such as one that may result in the shutting down of a boiler. The interdependence of energy efficiency projects can be counter-intuitive because of linkages that may exist among the foregoing categories of measures. This makes the role of validated computer models of the mill an essential tool in preventing unintended consequences.

Sources of ideas

Almost inevitably the first projects identified are those found during the detailed energy audit process itself. The projects are generally operational in nature, and though small, many have the merit of not involving any capital investment at all. Often, the idea has its origins with alert operating staff. Savings on such initiatives can justify the cost of the audit itself.

A second source is through the review of technical literature including anthologies and compilations of energy savings projects by CPPA, PAPTAC and TAPPI.

The Guide [1] facilitates the accessibility of kraft pulping-related energy conservation opportunity (ECO) projects from 1982 to 1995 by presenting them departmentally. Project distribution is as follows:

- 65 in the kraft pulping fibreline;
- 98 in the evaporator, recovery and power boiler, steam plant, and power generation areas;
- 11 in the condensate system mill-wide.

An example for the recovery area is shown in Table III, where HI indicates heat integration and PC process change.

Most of the ECOs are applicable to older mills. While some are mill specific with limited broad application, even these are useful in documenting mill ingenuity in surmounting difficult, long-standing inefficiencies. It is obvious, as well, that some energy savings concepts are most easily justified when applied to new mill designs, and are not economical in retrofit situations unless implemented for other process reasons. Examples include increasing steam generation pressure, use of low pressure instead of medium pressure steam at the pulp dryer or adding evaporator effects to increase steam economy.

A new route to identifying potential projects is through evaluation of the degree of process thermal integration using Pinch Analysis — a procedure that allows determination of the theoretical minimum or "target" energy consumption required for a defined process. This allows the gap with the existing consumption to be quantified, and is a great motivator for improvement. Pinch analysis is not effectively summarized in a few words without introducing examples, but some very good literature is available.

A study that assessed the potential of pinch analysis to reduce greenhouse gas emissions, if it were applied to the whole of the market kraft pulp sector of the Canadian pulp and paper industry, conservatively estimated that the total process thermal energy would be reduced by 6.8 per cent.

This was based on a sampling of mills to determine actual projects completed and put into operation some time after pinch studies were completed. In general, pinch studies initially show much greater reductions.

TABLE IV: Results of analysis of 12 projects from two separate kraft pulp mills

Number of projects	Capital cost, $	Payback range, months
6	10 000 - 80 000	2 - 3.2
5	50 000 - 180 000	4 -15
1	250 000	30

Small is often best: A surprising aspect of implementing energy savings projects in existing mills is that small projects tend to outperform large ones. As we have seen, a number are operating and maintenance measures which involve no capital expenditure at all. Table IV shows results of the analysis of 11 projects from two separate kraft pulp mill studies. This means that the focus should be on small projects, because chances are that they will be the easiest to justify — particularly during times of low fossil-fuel prices. A similar trend in energy-savings projects was reported in the literature.

Conclusions

Proactive energy management is consistent with ensuring environmental acceptability of products in an increasingly competitive marketplace, deregulation of energy markets combined with the possibility of long-term energy prices rising, and the need to reduce the emissions of greenhouse gases.

Recent published guides recommend a comprehensive~ systematic and ongoing approach. which includes in-depth energy audits, benchmarking against existing and new mills, assessing the degree of thermal integration, gathering energy savings ideas, evaluating impacts on mill systems, and projecting energy cost savings.

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D. M Bruce is with AMEC (formerly AGRA Simons Ltd.) based in Vancouver, B.C. This article is based on a paper presented at the 84th Annual Meeting of the Pulp and Paper Technical Association of Canada. ET

Harmonic Study Analysis Guidelines For Industrial Power Systems

By Ali Mihirig, Ph.D., P.Eng.

Harmonic study analysis becomes an important and necessary task for consultants and engineers in almost every industrial project, primarily because of the fact that thyristor controlled equipment is widely and heavily used in most industrial plants.

This article provides step-by-step guidelines for engineers to conduct a proper harmonic study analysis for typical industrial power distribution systems in light of standards and good engineering practices. The task starts at the planning and design stage by laying down all the different options available concerning power factor correction capacitors — sizing and location, advantages and disadvantages of each option and effects on the system performance.

This article introduces a practical method for system modelling. The method concludes that modelling of certain elements in the system have negligible or minimum effects on the study results.

Introduction

Harmonic producing equipment represents a significant portion of the total connected load of modern industrial systems. The effect of harmonics can be noticeable in many ways such as voltage and current distortion, low voltage notching, communication systems interference and high voltages and currents in case of resonance.

Harmonics may cause relay misoperations, PLC interference, equipment failures, capacitor fuse interruptions and high overall system losses.

Harmonic study analysis must be conducted in the engineering design stage of all industrial systems that include harmonic producing equipment, alongside load flow and short circuit studies. The interaction between load flow and harmonic study should lead to the best system configuration design, optimal operat-

Main Sources of Harmonics

No.	Power System Equipment	Major Harmonic Characteristics	Magnitudes (% of 60 Hz)
1	Transformer - Saturation - Energization	Current Harmonics 3rd, 6th, 7th 2nd, 4th	1 - 8 %
2.	Arc Furnace and Arc Welders	Voltage Harmonics 5th, 7th	2.5 - 8 %
3.1	Power Converters: - Line Commutated eg. Rectifyers	Current Harmonics h = np ± 1	$1_h = \frac{100}{h}$
	- Self Commutated eg. Inverter using fuel cell or battery as energy source	Voltage Harmonics h = np ± 1	52 - 78 % (1)
3.2	Cycloconverter eg. large drive in mills for direct AC to DC conversion	Current Harmonics h = np ± 1	5 - 9 %
3.3	Static Var Controller (used in conjunction with arc furnace or inductive furnace)	Current Harmonics h = np ± 1	2 - 4 %
4.	Saturable Reactor (Normally in parallel with capacitors for VAR compensation in arc furnace)	Current Harmonics 3rd, 5th, 7th	1 - 8 %

Legend: h=harmonic orders p=number of phases n=1,2...α
(1) This assumes that no corrective measures have been undertaken. However, equipment normally incorporates harmonic cancellation magnetics which will reduce the lower harmonics to a negligible level, but the 17th harmonic is still some 20% of the fundamental.

Continued on page 32

Continued from page 31

ing conditions and proper size and location of power factor correction capacitors.

When medium voltage capacitor banks are considered, it is also important to conduct transient analysis study to assess the possibility of switching problems.

Power Factor Correction Capacitors

Installation of power factor correction capacitors in industrial systems is one of the most effective ways to reduce energy consumption and utility bills. It also allows the usage of transformers and feeders full capacity. Although capacitors are easy to install and cheap to maintain, they can be the most troublesome element in the whole plant when installed in the presence of harmonics in the system.

Capacitors can be distributed all over the system at load locations or centralised in one location at the medium voltage level to correct power factor.

Distributed Capacitors

Usually medium and low voltage capacitors are distributed alongside loads at the 2.4kv and 600 volts or less. This method has the following advantages and disadvantages;

Advantages:

- Power factor is corrected at load location where transformers and feeders can be utilised to full capacity.
- Low possibility of harmonic resonance problems if proper size is selected.
- Low possibility of switching transient problems.
- Easier and less expensive to maintain.

Disadvantages:

- Larger space is required and more expensive per Kvar compared to the centralised medium voltage banks.
- Need to be tuned with reactors when connected in parallel with large harmonic producing loads.

Centralised Capacitors

Medium voltage capacitor banks at the 13.8kv or 6.6kv voltage levels are used to compensate the overall plant reactive power. Some advantages and disadvantages are;

Advantages:

- Less space is required and less expensive per kvar compared to distributed capacitors.
- Can be installed outdoors.

Disadvantages:

- Series reactors are likely required to prevent harmonic and/or switching problems.
- Loss of the bank for any reason subjects the plant to power factor penalties.

When tuning reactors are used with medium voltage capacitor banks, high magnetic fields are generated. They must be blocked by non-magnetic materials to prevent interaction with nearby sensitive equipment such as display systems and computers.

Power System Modelling

Power system modelling for harmonic studies still requires more improvements to achieve better accuracy and less complicated models. Improved models are specifically needed for transformers, loads, harmonic sources and utility equivalents.

Typical Unimproved Power Factor Values

By Industry	Percent power factor
Auto parts	75-80
Brewery	76-80
Cement	80-85
Chemical	65-75
Coal mine	65-80
Clothing	35-60
Electroplating	65-70
Foundry	75-80
Forge	70-80
Hospital	75-80
Machine manufacturing	60-65
Metalworking	65-70
Office Building	80-90
Oil-field pumping	40-60
Paint Manufacturing	55-65
Plastic	75-80
Stamping	60-70
Steelworks	65-80
Textile	65-75
Tool, die, jig	60-65

By operation	Percent power factor
Air compressor:	
External motors	75-80
Hermatic motors	50-80
Metal working:	
Arc welding	35-60
Arc welding with standard capacitors	70-80
Resistance welding	40-60
Machining	40-65
Melting:	
Arc furnace	75-90
Inductance furnace 60 Hz	100
Stamping:	
Standard speed	60-70
High speed	45-60
Spraying	60-65
Weaving:	
Individual drive	60
Multiple drive	70
Brind	70-75

Source: IEEE Std 141-1993

In the real world, harmonic study must be conducted and accommodated within the electrical system study budget and time constraints. Therefore, system modelling should be as simple as practical that would provide reasonably accurate results for design purposes.

System flexibility is needed, however, for harmonic suppression after proper measurements are conducted to verify study results.

The resistance element of the following models must be frequency dependent to encounter for the skin effect and provide realistic harmonic damping in the system.

Harmonic Sources

Harmonic producing equipment such as variable speed and D.C. drives, arc furnaces and welders and any other non-linear loads are harmonic sources. Typically, harmonic sources are modelled as current source with magnitude and phase angle for each harmonic frequency. This model provides reasonable results for power systems with no resonance at or near generated harmonic frequencies.

When system impedance contains both inductive and capacitive elements, which is usually the case for industrial systems, the simple current source model produces unrealistically high estimates of harmonic voltages, current and distortion factor in case parallel or series resonance at or near one of the generated frequencies.

Simulating harmonic sources as current sources with an infinite shunt impedance means that harmonic parameters can reach any value without limitations. In fact every harmonic source is limited by its internal circuit. Therefore harmonic sources must be modelled by their Norton's or Thevinin's equivalents in order to limit harmonic voltage and current rises in case of resonance.

For power converter drive systems, the ratio of locked rotor current to rated current can be used to derive Norton or Thevinin equivalent impedance (ratio of 3 has been suggested [1]).

The harmonic producing equipment supplier must provide harmonic currents (magnitude and angle) to be used in simulation studies.

In most cases, measured harmonic currents are different from theoretical values given in text books or standards.

Loads

Passive loads are modelled by their

Contnued on page 34

Contnued from page 33

equivalent impedance based on MW, Mvar and rated voltage. Motor loads are represented by their subtransient and locked rotor impedance for synchronous and asynchronous motors respectively.

Several detailed motor models are proposed for harmonic studies. In practice, when detailed models are used in a typical industrial system of several hundred motors, the task of harmonic study analysis become unbearable due to budget and time constraints. Furthermore, the effect of low voltage loads on the system impedance-frequency response is only marginal and falls within 10-15 per cent. e.g. Typical 3 MVA transformer with 5.75 per cent impedance supplying full load and 750 Kvar capacitor bank at 600v, the resultant parallel resonance at the 600v bus is largely dominated by the transformer and capacitor reactance regardless of the load models being used. Therefore, loads can be generally neglected at low voltage levels (<600v). Only in special cases when filters are considered at low voltages, should loads be included to size filter elements.

When medium voltage capacitors (2.4kv-13.8kv) are considered, load modelling becomes more significant and may be included. Here again, the simple model of sub-transient and locked rotor impedance models are acceptable for motors.

Transformers, Transmission Lines and Cables

For low frequency harmonics up to 1.5KH, transformers, transmission lines and cables can be safely represented by their equivalent short circuit impedance. For higher harmonic calculations such as I.T. product, these models become inaccurate and may produce misleading results.

Detailed models were proposed but again with so many transformers in industrial systems it becomes impractical to use detailed models unless studying the performance of a few or a single transformer in the system. This situation arises when calculating the telephone influence I.T product at the point of service with utility. It is important in this case to model tie transformers and associated cables in more detail including their internal capacitance which becomes effective with higher harmonic frequencies.

Using simple short circuit impedance model for utility tie transformers, lines and cables to calculate the I.T product at the point of service with utility would generally produce higher results than the measured ones.

Utility Equivalent

The utility equivalent short circuit impedance is usually used to represent the utility system at the point of service. This model can be used with a good degree of accuracy in the following cases:

- No series or shunt capacitors are connected to the transmission line or nearby substation serving the system under study.
- Calculation of low frequency harmonics up to 1.5KH.
- No other customers closeby producing harmonics and sharing the same line with the studied system.

In most cases, the above conditions are not satisfied because of the fact that most North American utilities are now in the process of implementing the IEEE standard 519 which recommends specific limits for harmonic distortion and telephone interference.

For the telephone interference calculation, higher harmonics must be included because of their large weighting factor in the I.T product. It is important in this case to model the utility by its frequency dependent equivalent up to the 49th harmonic. Closeby capacitor banks and other harmonic producing customers must also be included in the model.

It is important that both utilities and their customers share responsibilities and join efforts to meet the specific limits of the standard. In some cases, the customer operates very well below the standard voltage distortion and telephone interference levels but as soon as the utility switches on their capacitor bank in the nearby substation, the harmonic distortion or interference rises above the standard limits. This case requires joint effort by both parties to satisfy the standard. In another case, two industrial customers share the same transmission line, one of them is injecting harmonics into the line such that the distortion factor is already up to the limit (e.g. 1.5 per cent at 220Kv). Later the new customer will face a zero tolerance situation where any additional harmonic injections will push the harmonic distortion higher and therefore exceed the standard limit. In this case the three parties should share the cost of reducing the harmonic distortion.

Impedance Calculation

After system modelling is completed, the first step in the harmonic study is to explore resonance points through impedance versus frequency calculations. These calculations can be simplified in the case where only one capacitor bank exists in the system. Impedance versus frequency can be calculated for a quick scan of the system to determine resonance frequencies. A typical industrial system with distributed capacitors and various harmonic sources requires computer calculations.

Generally, if the system exhibits resonance at or near any of the system potential harmonics, mainly at the 5th, 7,11 or 13th harmonic, in the presence of harmonics and medium voltage capacitor banks (2.4Kv-13.8Kv), then the safest thing to do is to tune the capacitor banks to the 5th harmonic to eliminate any possibility of resonance above the 5th harmonic. The tuned capacitor bank size is usually capable of absorbing all 5th harmonic currents as it is sized for power factor correction purposes not as a harmonic filter.

In case of distributed capacitors at load locations (480v-2.4kv), impedance versus frequency calculations should be performed at each capacitor location. The size of these capacitors must be selected such that it does not resonate with its area transformer impedance.

Where the load is a harmonic source, the capacitor bank can be de-tuned at a much lower frequency (2nd-3rd harmonics) to reduce reactive losses and force harmonics to flow upstream. This can be done as far as the harmonic distortion at the higher voltage level is kept within acceptable limits.

Impedance-frequency plots are very helpful to visualise potential resonance for different system configuration and corrective measures. Frequency steps should be small enough to detect sharp resonance (.1 to .5 pu).

Harmonic Parameters Calculation

Harmonic parameters usually calculated in typical harmonic study are:

- Harmonic Voltages at buses of concern.
- Harmonic Currents at branches of concern.
- Total harmonic distortion factors (THD for voltage and current)
- Telephone interference factor and I.T product.
- Residual telephone interference and I.T product.

Harmonic analysis computer programs are needed to calculate the above parameters for mid-size and large industrial systems. Results of computer programs must be taken with caution for the obvious modelling limitation reasons mentioned in section 4 above. Field measurements are necessary to verify the theoretical computer simulation results.

Various system equipment ratings must be checked for possible overload and/or over stress due to excessive harmonic currents and voltages. Power factor correction capacitors are particularly vulnerable to high harmonic voltages and currents due to system resonance. Capacitor total rms voltages and currents, including harmonics, must be checked against standard maximum rated parameters [4].

The total voltage harmonic distortion factor THD% is a very significant measure to ensure proper overall performance of system equipment. Acceptable limits for harmonic distortion are given in the IEEE standard 519-1992 for different voltage levels [5].

Total harmonic distortion factor is defined by:

THD% = SQRT(Vh2 / V12) % [1]

Where

Vh is harmonic voltage for h = 5, 7, 11, 13……..etc.

V1 is the fundamental voltage, h=1

Also the maximum THD% for a known drive characteristic is given by:

THD% =

100 x SQRT((4.24 x 10-6 x An x F1)/(V1)) [2]

Where

An = Notch area in volt-microseconds.

F1 = Fundamental frequency

• = Ratio of the total inductance to the common system inductance

Although equation 2 is derived from equation 1, two different results have been reported [6] when using an oscilloscope to measure the notching for equation 2 and spectrum analyser which uses equation 1. It is recommended, therefore, to use an oscilloscope to measure notching and equation 2 to calculate the harmonic distortion at the harmonic source supply bus.

The I.T. product calculation can be estimated by calculating all harmonic currents injected into the utility system at the point of service, then multiplying each by its TIF weighting values. The utility system, in this case, must be represented as a frequency dependent equivalent impedance in order to get reasonable results.

Harmonic Measurements

Simulation results could be far from reality and therefore must be verified by field measurements to ensure proper system performance. Measurements of harmonic voltages and currents through typical system voltage and current transformers are subject to limitations and can only be trusted up to 1.5-2 KHz. This may be enough to identify potential harmonic problems due to system resonance in the range of 5th to 13th harmonics. For the purpose of telephone interference measurements which highly depend on the higher harmonic frequencies, special measurement devices are required.

Voltage harmonic distortion measurements using spectrum analyser may be misleading in the presence of deep short notching in the system, especially at the harmonic source bus.

Measurements can be confirmed by careful analysis of the notching spikes as mentioned in section 3 above and reference [6].

It is important that harmonic currents injected into the system from all harmonic sources be measured and compared with theoretical values used in the simulation. Harmonic filters and capacitor banks should also be targeted for harmonic current measurements to ensure proper performance.

The basic equipment required for harmonic measurements is spectrum analyser and/or oscilloscope with data recorder. This equipment is enough for industrial plant harmonic measurement purposes. High frequency harmonic filters are required for telephone interference and I.T. product measurements.

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Ali Mihirig is President of AM Power Systems Inc. He can be reached at amps@ telus.net ET

OVERHEAD TRANSMISSION & DISTRIBUTION

Steel Poles Stand Up to Severe Weather

Severe weather conditions can pose a serious threat to an electric utility's ability to deliver electrical power to its customers. With this in mind, taking steps to protect a utility's physical infrastructure, and most notably its electrical distribution system, from the hazards of ice, wind and water is a task of major importance for both rural and urban utility companies.

Weather damage can take many forms. Most managers readily point to downed or broken wood distribution poles and live lines as a major hazard. But storm damage can also create crew shortages and serious safety issues for customers and linemen.

A number of forward-thinking utilities are now taking proactive steps to protect their systems against the elements. This is in sharp contrast to the "don't fix it if it's not broken" approach that was often used in the past.

Today's utility managers are planning for infrastructure improvements by examining the impact that new materials and methods can have on the entire utility enterprise, rather than as a single part of the distribution system.

The use of steel distribution poles is one concept that is growing in its acceptance. As proof of this, the American Iron and Steel Institute reported a 62 percent increase in steel distribution pole purchases in 2000 as tonnage shipments to this market doubled.

This 'new' choice has proven especially beneficial in areas that are prone to catastrophic weather conditions, as well as remote locations where installation and line repair is difficult.

The use of steel distribution poles is one concept that is growing in its acceptance. This 'new' choice has proven especially beneficial in areas that are prone to catastrophic weather conditions, as well as remote locations where installation and line repair are difficult.

Steel Poles Stand Tall Against the Elements — and the Competition

Snow, ice, wind and rain — all types of weather can impact an electrical distribution line. Snow and ice add weight to lines, causing lines and poles to break. Winds can toss trees and limbs onto lines and, if strong enough, can down complete sections. Rain saturates soil, flooding roadways and causing damage to highways. These conditions impair the ability of work crews to access affected areas.

Steel distribution poles offer a cost-effective answer to the havoc that the elements can wreak.

"Because of extensive storm and ice damage to our wood distribution poles, we switched to steel poles for their strength and durability," says Bryan Zapf, electrical engineering supervisor at Sheffield Utilities in Alabama.

Zapf, and other utility industry managers who implemented the use of steel, have not been disappointed with the staying power and strength of steel.

Arizona Public Service Saved Labor Time And Money With Steel

Arizona Public Service's search for an alternative to wood got serious after an extremely damaging summer season, when strong winds damaged the company's distribution-pole system. The repairs required were costly, both in expense and lost labor time.

"We began to look for ways to increase the longevity and reliability of our distribution structures," Duane Oliver, construction supervisor for the Northwest Division, remembers. "More than that, we had to stop the damage caused to the system when we lost one structure. Often, one pole would go down, and would cause a domino effect with other poles. We saw this in all seasons, with high winds in the summer, or with snow and ice in the winter. This was not acceptable."

When APS switched to steel, they found that a damaged steel pole often did not require immediate repair. This helped eliminate off-hours work, which resulted in costly overtime and could become a safety issue to tired crews.

Research showcases the strength of steel in bad weather

Dr. Habib Dagher is professor of structural engineering and director of the Advanced Wood Composites Center from the University of Maine. Over the

Duane Oliver, (above) construction supervisor for the Northwest Division, Arizona Public Service believes steel poles have helped increase the longevity and reliability of his utility's distribution infrastructure.

past five years, Dr. Dagher has conducted extensive research to determine the reliability of steel distribution poles in hurricane-force winds in a variety of locales.

After hurricane George hit Puerto Rico in 1998, the Puerto Rico Electric Power Utility reported 8,450 wood distribution poles damaged or failed, but none of the utility's 1,000 steel distribution poles failed.

In July 1997, a storm with sustained winds of up to 120 m.p.h. hit Monticello and Big Lake, Minn. Anoka Electric had both steel and wood poles in the area, but only the wood lines sustained severe damage.

In short order, a turn of the weather can inflict serious damage on a utility company or cooperative's ability to deliver the power its customers need for basic living and business.

As utility managers look to the future, they are choosing cost-effective options like steel that offer a myriad of benefits. In the case of steel distribution poles, the advantages can appear in several ways: as cost savings due to the longer life of steel; and fewer labor hours required for installation, with its light weight, or for repairs due to steel's reliability. Steel is also a benefit because, as a manufactured product, it is specifically designed to stand up to a range of extreme conditions.

To be precise, steel stands up in the face of sever weather — and the competition.

About the American Iron and Steel Institute (AISI)

The mission of the American Iron and Steel Institute centers around these common goals and vision for the future:

- to provide high-quality, value-added products to a wide array of customers;
- to lead the world in innovation and technology in the production of steel;
- to produce steel in a safe and environmentally friendly manner;
- and to increase the market for North American steel, both in traditional and innovative applications.

AISI is comprised of producer member companies, including integrated, electric furnace, and reconstituted mills; associate member companies, which are suppliers to or customers of the industry; and affiliate member organizations, which are downstream steel producers of products such as cold-rolled strip, pipe and tube, and coated sheet. Member companies account for more than three-quarters of the raw steel produced in the United States, Canada, and Mexico. ET

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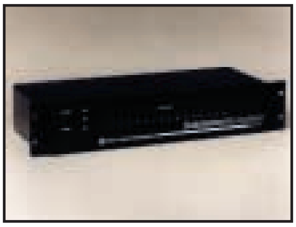

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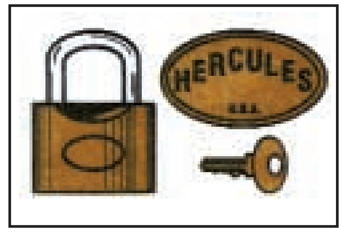

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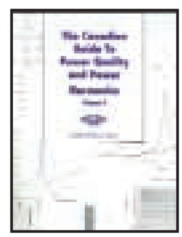

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SCADA

SCADA Network Cloud Enhances Power Distribution Services and Reduces Communication Costs for Utility Group

The tumultuous changes in power production and distributed systems demand that Utilities Plus, a municipally-owned energy services company, find new and better ways to capture real-time information from its members. To do that, and to help its 14 member utilities provide uninterrupted services at competitive rates, requires improving services through shared resources. That is the fundamental purpose of this not-for-profit organization.

This four-year-old entity buys and sells a broad range of services for its municipal and public power utilities. Utilities Plus and its 14 area members needed to capture real-time meter and system status information so that operating decisions could be made quickly and cost-effectively. They decided that it was time for a load aggregation system. The vendors vying for this new system were quoting in the $250,000 to $300,000 price range, a cost that was considered expensive.

"That's when we decided that our new, existing SCADA system could be used to aggregate the load," says Paul Leland, Manager, Blue Earth Light and Water, Blue Earth, Minnesota. One of the Utilities Plus members, Blue Earth Light and Water recently replaced its original Landis & Gyr network with a QEI 2000 Frame Relay SCADA (Supervisory Control and Data Acquisition) system. The new QEI system uses a distributed 64-bit RISC workstation architecture to provide the maximum performance, flexibility, and scalability to meet Blue Earth Light and Water's needs. The system was supplemented with a Data Comm for Business (DCB) Broadcast Polling FRAD (Frame Relay Access Device.)

"We decided to throw our hat into the ring and demonstrate to the other members of Utilities Plus that we could effectively use our new SCADA system to create a network cloud and aggregate the load," Leland explains.

"Over the past 6 months we had been working on pieces of the system, including the communications side. We needed to develop some kind of wide-area communications scheme to meet our load aggregation requirements. We needed a low cost, easily maintainable, highly reliable communications product, and that's where the DCB Broadcast Polling FRAD devices came in."

QEI recommended the use of DCB Broadcast Polling FRADS, which work well with any SCADA system. Essentially, the DCB product is an async FRAD that allows multi-point polling over Frame Relay networks via RS-232 interface. Each master FRAD supports up to 160 remote terminal units (RTUs), and is more cost effective than multi-point polling modem networks.

At a cost of just hundreds of dollars for each master polling FRAD, the DCB units helped to ensure that the communications cloud could be completed at a cost well below what vendors had been proposing earlier.

Cost-effectiveness was very attractive to Blue Earth Light and Water as well as the Utilities Plus organization. They had considered an Internet-based communications alternative because it would have been practically cost-free.

"We talked with several vendors who said they were already working on Internet-ready RTUs and Internet-ready meters, and so forth," Leland explains. "But I don't think we could rely confidently on an Internet-based system yet." Leland says he was especially concerned with technological trade-offs involved in integrating Internet-based communications with SCADA systems that are continuously polling and relatively time-sensitive.

"If we move to the point where we're monitoring load and coordinating the control of our generation assets as one logical entity, I just don't think we can use the Internet at that point. There are big issues with reliability and other timing issues with existing SCADA systems. Are we going to rely on the Internet for that kind of control? What if an Internet communications delay or failure jeopardized a power generation system at a critical point in time? The cost could be enormous in today's energy market. I'm sure there will be a place for the Internet communications for this type of application at some time in the future, but it's probably going to be a few years from now."

Another factor influencing the situation: a large investor owned utility, which sets the engineering benchmarks for power companies in the local region, provides standards on new generation equipment.

"They have all sorts of engineering specs," Leland says. "And one of the current components is a communications tie between the new generation equipment and the IOU's control center. We have four or five cities that have fallen under these new engineering standards, and they are meeting the communications requirement via costly leased lines. Our new system will be able to eliminate those costs. Plus, once we aggregate all this data over our Frame Relay network back in Blue Earth, we will probably include the IOU in our frame cloud and just pass on all of the aggregated data to them from here in Blue Earth."

Interestingly, while the Internet did not offer a viable solution to Blue Earth Light and Water's network communications requirements at this time, it aroused some other interest. Because some member cities in the Utilities Plus group have no access to DSL or ISDN Internet connections at this time, it may be feasible to offer a substitute high-speed/high-bandwidth service to these cities via the SCADA communications cloud.

So far Blue Earth has installed 6 Broadcast Polling FRADS and will be ordering another 6 to 8 units as the other cities in the Utilities Plus organization get connected. Leland says the goal is to have that done by May 1, 2001.

The DCB product was recommended by QEI, who told Leland that even though they have their own hardware, DCB seems to be genuinely technically qualified.

"They're not just there to sell hardware," Leland explains. "I got a good feeling from DCB. Now I would tend to use their service for any type of communication question in general. They seem to be quite innovative and yet personalized." ET

POWER QUALTIY Q&A

Our Expert Offers Answers to Frequently Asked Questions About Power Quality

By David Windley, P.Eng., C.I.M.

Question:

What is meant by an 'isolated ground' receptacle and how does it work?

Answer:

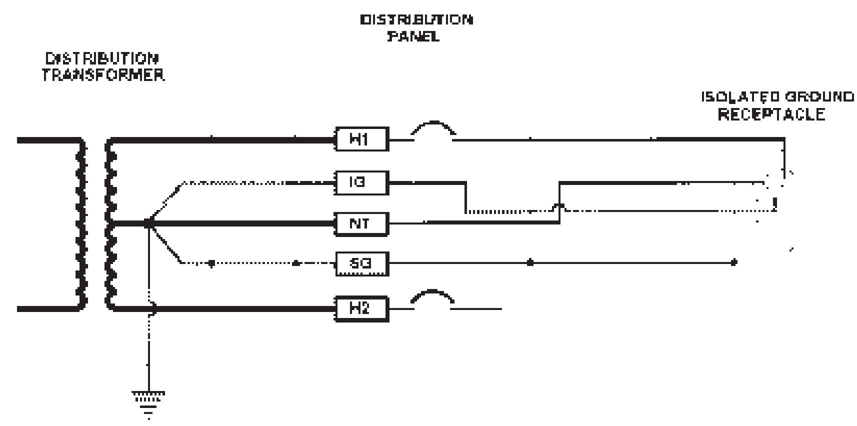
An isolated ground receptacle is a receptacle with standard configuration that has an orange face instead of the usual brown or ivory. This colour standard indicates that the ground pin on the receptacle has no intentional connection to the outlet box or the mounting bracket and hence is isolated from the enclosure. This type of receptacle is generally specified to supply a sensitive electronic device such as a computer.

However, to gain the desired result, the receptacle must be installed and wired a certain way. Please refer to the illustration.

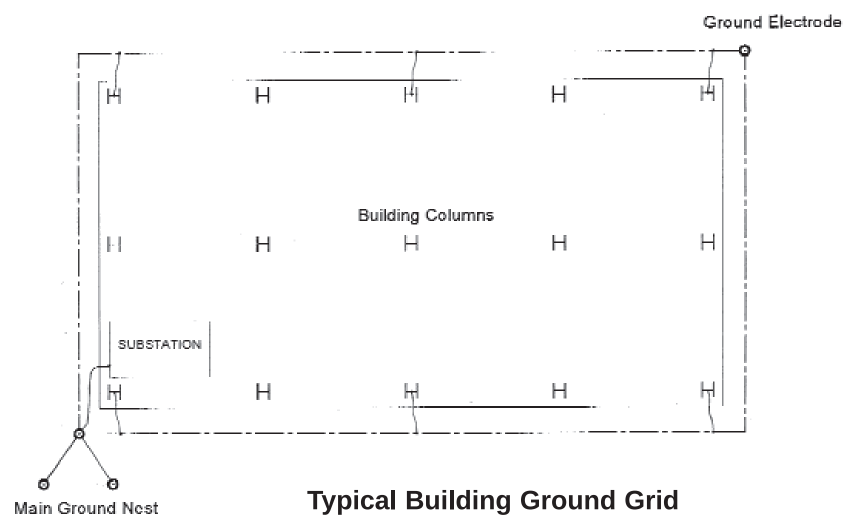
The connections to the receptacle are basically the same as a standard receptacle except that the connection to the ground pin is made with a separate, insulated green conductor that runs back to the distribution point ground. The distribution panel is fitted with a ground bus that is isolated from the enclosure or safety ground (SG). Ideally, the distribution transformer will be an isolation transformer with an electrostatic shield.

The theory behind this practice is that the isolated ground (IG) is open ended and therefore no current path for noise-producing ground loops exists.

When connecting the sensitive equipment to the receptacle, one must ensure that the equipment casing or other exposed metal is insulated from building steel or other conventionally grounded equipment. Otherwise, a ground loop is set up and electrical noise will occur.



Typical Isolated Ground Circuit



Typical Building Ground Grid

Question:

Sometimes we experience nuisance electrical trips and malfunctions when there is storm activity in the area. What causes this and what can be done to prevent this?

Answer:

One of the leading causes of this symptom is improper building grounding. Traditionally, the steel columns in an industrial or commercial building were bonded to a ground loop buried around the foundation of the building. This ground loop is connected to the main system ground nest.

This practice ensures that building steel is adequately grounded for safety and power quality and that no significant difference in ground potential exists within the building. It can also serve as a screen to deflect unwanted electrical disturbances.

We have noticed that many new buildings are neglecting to install this ground grid resulting in a floating structure and potential noise and safety issues. For this reason, we specifically incorporate this into our designs. An example of a typical grid is shown above.

Sometimes external transients can come in through the utility connection. The best way to minimise these effects is to ensure that the main service ground connection is less than one ohm and that properly sized lightning arresters have been installed.

David is the President of Wintek Engineering. You can forward your questions or comments to him at wintek@wintek-eng.com. Some of these questions will be addressed in future issues.of Electricity Today ET

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CLASSIFIEDS

Correction Notice:
On the cover of Issue 2, 2001 the name Wescast Industries was spelled incorrectly.

Continued from page 25

The proposals for new plants include about 1,700 MW of coal-fired electricity and 2,230 MW of gas-fired power.

Despite skepticism from industry watchers, the provincial government is confident most of those generators will be built.

Proponents of natural-gas fired plants, such as Virginia-based AES Corp., which is building a gas-fired plant near Calgary, have touted the fuel as a cleaner way of generating electricity compared to coal. The plants are also cheaper to build.

But Epcor, one of the province's largest natural gas and electricity retailers said it is also putting its faith in coal. Plans are under way for a massive 400 MW expansion of Epcor's coal-fired Genesee station.

"One should not be surprised if a lot of those (gas-fired) plants are not built," Epcor president Don Lowry recently told industrial consumers in Calgary.

"It's a very turbulent time for natural gas . . . and many of those plants aren't going to be able to compete with the price of coal, he said. ET

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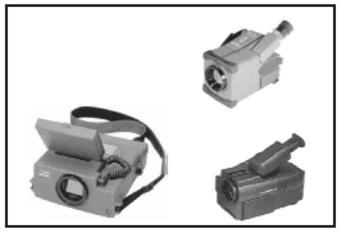

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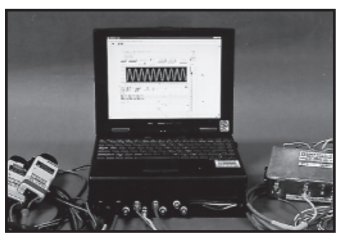

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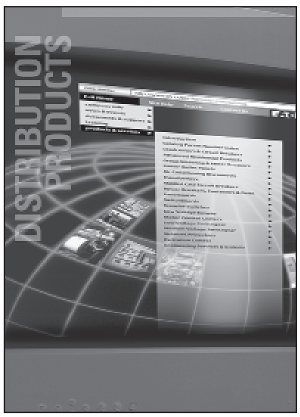

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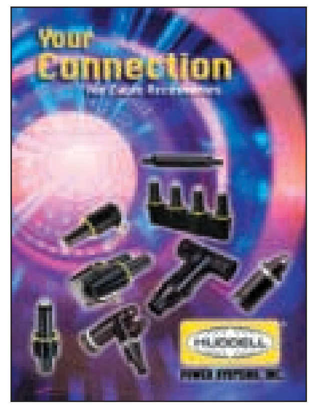

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Please email literature requests to: InfoHPS@HubbellOnline.com

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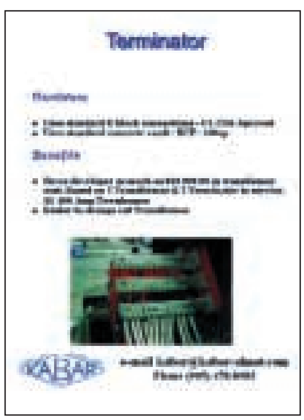

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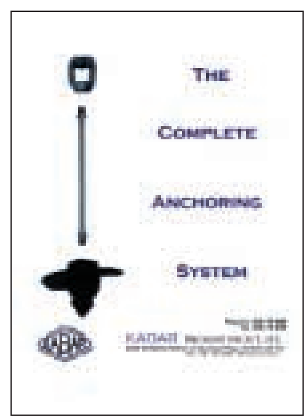

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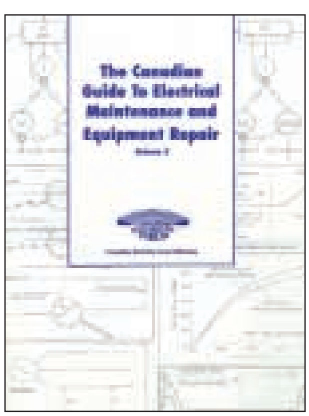
CANADIAN ELECTRICITY FORUM
The Canadian Guide to Electrical Maintenance and Equipment Repair Vol. 2



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