

Hydropower in Canada: Approaching a New Century

While the hydroelectric industry in Canada remains strong and active, restructuring is exerting change. Hydro leaders are rallying industry-wide efforts to promote hydropower's status as the country's premier renewable source of energy.

By Paul T.B. Adams and Pierre Fortin

The context in which electricity producers are operating has been profoundly redefined following the opening of markets in North America. The deregulation of energy borders puts hydropower directly in competition with other production operations. As a result, its positioning on the market has become a fundamental issue, not only for ensuring its development where potential still exists, but also for preserving a market for hydroelectric energy producers that will be profitable in the future.

The Kyoto Protocol, signed by 159 nations during the United Nations Framework Convention on Climate Change in December 1997 in Kyoto, Japan, illustrated the need to identify concrete measures to reduce greenhouse gas emissions. Following the convention, Canada made ambitious commitments that vitally affect the energy sector.

Hydropower offers opportunities to effectively contribute to those efforts, especially in Canada and the U.S. However, hydropower is not one of the global solutions currently on the table for discussion. The prolonged absence of any concerted lobbying activities on the part of the hydropower industry in Canada and at the international level has not helped modify the negative perceptions surrounding the hydroelectric option.

The development and implementation

of a climate change policy could be among the most far-reaching environmental initiatives ever embarked upon in Canada and elsewhere. If Canada is to stabilize or reduce its greenhouse gas emissions over the long term, a significant adjustment to the Canadian industry will be required as we move away from fossil fuel-intensive activities.

Hydropower provides Canada with a unique opportunity to significantly reduce the costs associated with stabilizing its greenhouse gas emissions. In addition, the energy storage and dispatchability associated with hydroelectric projects could support development of other low-emitting renewable resources such as wind and solar.

It is vital that hydropower interests work toward ensuring that hydro is an

integral part of Canada's climate change strategy. That is one of the activities of the new Canadian Hydropower Association (CHA), founded in September 1998 by a group of representatives from hydropower producers, manufacturers, industries closely linked with hydro, and other firms active in the hydroelectric sector in Canada.

The principal mandate of the new organization is to promote hydroelectricity nationally and internationally as a source of renewable energy, make hydropower's economic and environmental advantages better known, and publicize the benefits of hydropower in the search for sustainable energy solutions.

CHA: Making a Difference In Canada

The mission of the Canadian Hydropower Association is to provide leadership for the responsible growth and prosperity of the Canadian hydropower industry. As the primary voice for the hydropower industry in Canada, CHA's objectives include:

— Serve as an effective 'forum' for



Hydropower is the predominant source of electrical energy in Canada, accounting for nearly two-thirds of the country's total electricity production. (Photo courtesy Manitoba Hydro)

Paul Adams is the president and Pierre Fortin is the executive director of the Canadian Hydropower Association.

coordinating and promoting the interests of the hydropower industry in Canada;

— Advocate the interests of the Canadian hydropower industry with provincial, federal, and foreign governments;

— Take a proactive role in shaping and influencing strategic thinking and policy development on hydropower;

— Provide a forum for members of the hydropower industry to share experiences in managing and accommodating other interests;

— Promote the environmental advantages and the renewable nature of hydropower;

— Promote greater accountability for ensuring that the planning and implementation of power supply is based on objective treatment of hydropower;

— Promote, in Canada and abroad, the expertise of the Canadian hydropower industry;

— Continually seek to enhance the global competitiveness of the Canadian hydropower industry;

— Collaborate with international organizations to establish clear environmental and social guidelines for the development and use of hydropower; and

— Collaborate with the various national and global organizations, including especially the Canadian Electricity Association, the National Hydropower Association in the U.S., and the International Hydropower Association, to promote a positive image for hydropower.

On the following pages, CHA members representing six provinces share their ideas about hydro in Canada, focusing on important local issues for the hydro industry, the business climate in this era of restructuring and open market competition, and the many contributions hydroelectric power is making throughout the country.

As the essays illustrate, Canadian hydropower stations provide inexpensive, clean, renewable energy to a vast population. However, the advent of restructuring and concern for social and environmental issues have dictated changes...sometimes significant changes...in the way hydro plants are operated and in plans for expanding hydro capacity in the future. ■

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British Columbia: *Balancing Numerous Demands*



BC Hydro is a provincially-owned Crown corporation and the third largest electric utility in Canada. The utility has 45 generating facilities of varying sizes, which produce between 43,000 and 54,000 gigawatt-hours of electricity annually. Over 90 percent of the energy is derived from hydroelectricity, three-quarters of which is produced at major installations along the Peace and Columbia river systems. The remaining power is from thermal sources or produced by independent power sources.

The electricity is moved along approximately 74,000 kilometers of interconnected transmission and distribution lines that traverse extremely rugged and remote mountain terrain.

Like other utilities, BC Hydro faces several challenges to meet growing customer demands, and then to balance those demands with social, economic, and environmental considerations. BC Hydro has 1.5 million domestic customers, and that number is projected to increase by 1.8 percent each year, meaning about 140,000 new customers in five years.

To manage the demands, BC Hydro has initiated several projects to increase its capacity: upgrade, replace, and expand existing facilities, or find new sources of energy. For example, BC Hydro installed an operational information system at ten of its largest generating stations. The system collects and archives near real-time data about generating units, increases operational efficiencies, and provides the ability to combine customer demand information with operational and maintenance decisions.

BC Hydro also is enhancing its Stave Falls power plant, located east of the fast-growing Greater Vancouver area. The existing five-unit 52.5-MW plant is being replaced with a two-unit 90-MW plant, capable of providing 35,000 homes with electricity. The additional capacity promotes an effective use of water, and the material excavated from the project has been used to build an island to enhance bird habitat. (For details on Stave Falls, see the Special Report between pages 42

and 51 in this issue.)

While improving its current facilities will yield additional energy, new power sources also must be identified to meet projected market demands. For example, in 1998 BC Hydro and partners Fletcher Challenge Energy and Westcoast Power Inc. agreed to build a CDN\$220 million cogeneration plant adjacent to the Elk Falls pulp and paper mill near Campbell River on Vancouver Island.

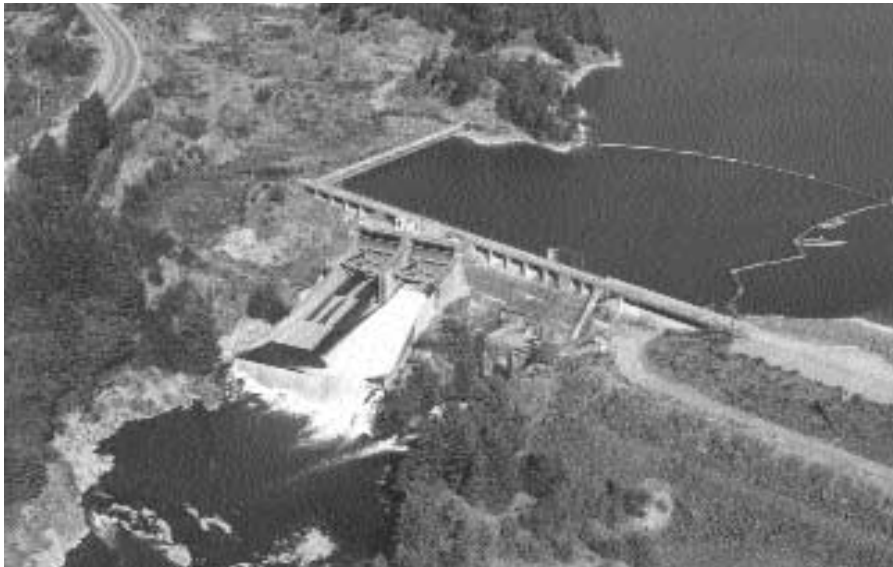
BC Hydro also entered into a partnership with the Alberta-based TransAlta Corporation to build a power plant for the northern town of Fort Nelson. The 45-MW, natural gas-fired plant was completed in 1998 and provides a more reliable source of energy to the community and outlying areas.

To keep pace with economic growth, BC Hydro is planning for the future as well. Among options is the addition of high efficiency combined-cycle gas turbines to the energy mix, something that is driven in part by the availability of inexpensive natural gas in British Columbia.

Additional sources of energy will be obtained through BC Hydro's Energy Futures strategy. The strategy is designed to meet provincial environmental policies and regulations, and will help BC Hydro remain a progressive electricity supplier. The corporation will invest in alternative energy technologies such as small hydro, woodwaste (biomass) energy, fuel cells, and wind, and will advance its energy efficiency and conservation measures.

While alternative energy and other environmental programs such as fish habitat provide a way to balance the effects of hydroelectric generation, operational improvements are also being identified.

BC Hydro, under the direction of the province of British Columbia, is introducing water-use plans for each of its hydro facilities. The plans consider social, economic, and environmental needs in the watersheds that BC Hydro operates. The water use plans will be introduced during the next five years in consultation with stakeholders, including community members, environmental



During the next five years, water use plans will be developed for all of the watersheds managed by BC Hydro, including the Cheakamus River and the Daisy Lake Dam and 157-MW Cheakamus Powerhouse (shown in this photograph), 100 kilometers north of Vancouver.

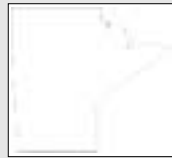
groups, First Nations, and local officials.

The water use planning process is similar to the hydroelectric relicensing process in the U.S., under guidelines of

the Federal Energy Regulatory Commission, where consultation with outside stakeholders is required to gain license renewal.

Manitoba:

Preparing for a Sustainable Future



The province of Manitoba is rich in hydraulic resources, with an undeveloped hydro potential of about 9,000 MW and 50 terawatt-hours (TWh) per year. This undeveloped potential represents about double the present capabilities of the Manitoba Hydro system. Of the undeveloped technical potential, about 4,000 MW, or 25 TWh, are concentrated at nine hydro sites on the Nelson and Burntwood rivers in northern Manitoba. The remaining potential is dispersed among 80 smaller sites throughout the province. The energy costs would be significantly higher for these smaller sites, and not all of these sites will be available due to environmental and social considerations.

Manitoba Hydro is actively preparing for the development of three potential sites, 100-MW Notigi, 200-MW Wuskwatim, and 560-MW Gull. Discussions with local aboriginal and environmental groups have already begun.

These discussions are a part of the process which is under way to help min-

imize the environmental effects associated with the hydro projects, while maximizing the economic benefits to both the local communities and the province as a whole. While there has been no commitment to develop any of these projects, efforts now under way ensure that the design, environmental studies, and community consultations concerning the projects will be well advanced if any commitments materialize.

Manitoba Hydro currently exports up to 46 percent of its generation, most of it under long-term contracts. Unless the export contracts are replaced as they expire, domestic load forecasts suggest that new generation will not be required until 2016. However, new export sales could trigger the earlier development of hydraulic generation. Demand for such sales will be influenced by load growth in neighboring regions, and generation costs for competing resources. The demand for hydroelectric exports also could be influenced by requirements to reduce fossil-fuel emissions, including

Since British Columbians already enjoy some of the lowest electricity rates in North America, there isn't the same urgency to deregulate the electricity industry as exists in other jurisdictions. Having said that, wholesale competition and open access transmission tariffs have been in place since 1996, and BC Hydro continues to develop and offer products and services, including real-time pricing and time-of-use rates.

BC Hydro is a very active trading partner in the Western Systems Coordinating Council. Trading electricity provides an opportunity to grow the business and contributes a reliable and renewable source of power to the power grid in western North America.

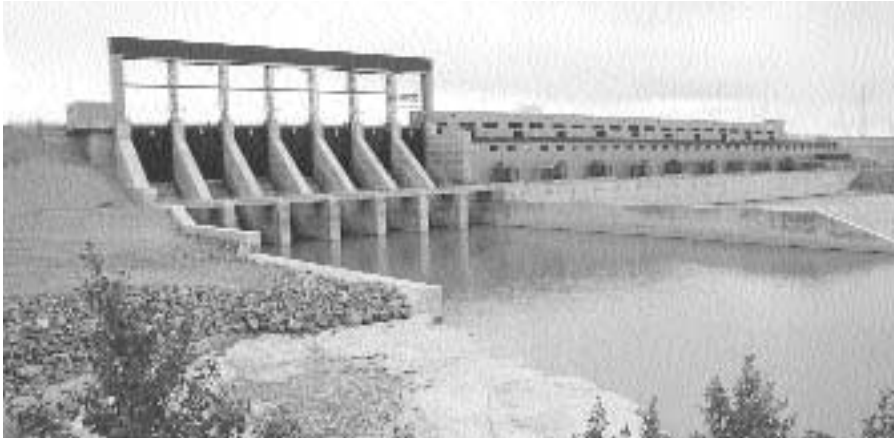
Powerex, BC Hydro's trading arm and wholly-owned subsidiary, will continue to focus on trading power and bundling electricity with new products and other services.

—By Paul T.B. Adams, P.E., manager, Power Supply Operations, and Susan Heming, Corporate Communications, BC Hydro.

greenhouse gases.

Consistent with changes in societal values, Manitoba Hydro's generation development decisions have evolved toward placing a greater priority on minimizing environmental and social effects, even when resulting in lost opportunities and increased unit energy costs. For example, in order to minimize methyl mercury contamination and habitat changes, Manitoba Hydro will minimize flooding associated with future facilities. Also, Manitoba Hydro will not pursue hydroelectric development on special waterways, such as the Seal River, which has been declared a Heritage River in Canada. The protection of some rivers in their natural state, while developing other rivers in an acceptable manner, are important facets of Manitoba Hydro's vision of sustainable development for Manitoba.

Manitoba Hydro's newest hydro plant, the 1,330-MW Limestone Generating Station, began producing electricity in 1990. (See "Developing Hydro the Canadian Way," *Hydro Review*, Volume 9, No. 6, December 1990, pages 12-23.) Despite the large capacity, the plant resulted in only 3.1 square kilometers of flooding. Nearly all of this flooding was over non-organic till and river bed materials in stream valleys, river bed terraces, and the Nelson River Valley walls. There



Manitoba Hydro's 1,330-MW Limestone Generating Station (shown in this photograph) flooded only 3.1 square kilometers, reflecting the utility's commitment to minimize the environmental and social effects of its projects.

was minimal increase in mercury levels in fish in the forebay and no increase in greenhouse gas production.

Two of the three previously mentioned potential sites, Notigi and Wuskwatim, as they are now envisioned, would involve zero or negligible flooding while the third, Gull, would involve moderate flooding. Conawapa, another potential site, is not one of the three sites Manitoba Hydro is actively pursuing. While it is a very attractive site, offering 1,300 MW with zero flooding, for economic reasons it is unlikely to be developed without a significant increase in export transmission capacity, probably in

association with a large export sale. It is also important to note that these projects will not substantially change the seasonal downstream river flow. The three potential sites are on streams that do not contain anadromous fish.

U.S. markets are very important to Manitoba Hydro's development plans. Manitoba Hydro is actively participating in the U.S. energy market, including the offering of open transmission access into its wholesale markets, as well as out of and through Manitoba. In 1998, total sales of CDN\$326 million were to extra-provincial markets, the majority of which went to the midwestern U.S.

Manitoba Hydro is concerned by the trend, particularly in the U.S., to exclude large hydro from definitions of "renewability" and "greenness." Definitions of renewability that exclude large hydro are of particular concern since hydro is, by definition, a renewable, self-replenishing resource. "Green" definitions, which claim to define environmental preferability, but which exclude hydro without a clear environmental justification, need to be challenged. Manitoba Hydro believes the effects of hydro development are so specific to each site and plant design that the environment preference or "greenness" for hydro plants must be determined on the basis of the specific effects of each plant.

There are opportunities to produce very low-impact, emissions-free energy from hydraulic generation at reasonable costs. Furthermore, the energy storage and flexibility associated with hydro generation offers synergies for the development of non-dispatchable renewable resources such as wind and solar generation. It is increasingly important to promote the lowest cost combination of resources as we struggle to achieve society's environmental goals to reduce emissions at an acceptable cost while meeting energy needs.

—By Ed Wojczynski, manager, Resource Planning and Market Analysis, Manitoba Hydro.

Newfoundland and Labrador:

Studying New Development Options



Newfoundland and Labrador Hydro (Hydro) is a Crown corporation that generates and transmits about 95 percent of the electricity produced in the province of Newfoundland and Labrador. The utility also directly serves 35,000 customers in more than 200 rural communities from interconnected and isolated systems.

Hydro is a vertically integrated utility with more than 7,000 MW of installed generating capacity, nearly 90 percent of which is hydroelectric. The majority of the power sold directly to customers and to neighboring utilities is generated from water, and plans to develop additional hydropower resources in Labrador are under way.

On March 9, 1998, the utility announced it would begin negotiations with provincial utility Hydro-Québec to develop about 3,200 MW of additional power on the Lower Churchill River in Labrador. Since the announcement, the Churchill River Power Project has been evolving. It is a complex, multi-party project with three governments, two utilities, and the Innu of the provinces of Newfoundland and Labrador and Québec. With a project of such magnitude, the utilities are taking the time necessary to get it right.

The initial configuration involved expansion of the existing 5,428-MW Churchill Falls project through the partial diversion of two Québec rivers—the

Saint Jean and the Romaine—into the Smallwood Reservoir. A new, 1,000-MW generating station next to the existing powerhouse at Churchill Falls was to be built, along with a 2,200-MW generating station at Gull Island, and associated 735-kV transmission lines connecting the Gull Island facility to the Montagnais station in Québec and to Churchill Falls. The National Energy Board has ranked Gull Island as the lowest cost undeveloped hydroelectric site in North America.

The initial project description also included a commitment to spend up to CDN\$20 million to study the feasibility of developing 800 MW at Muskrat Falls, and Newfoundland and Labrador would undertake discussions with the federal government to finance an 800-MW high-voltage DC transmission line—called the Infeed—to link Gull Island in Labrador to Soldiers Pond on Newfoundland Island. The line, costing CDN\$2.2 billion, would be about 1,100 kilometers long, crossing the Strait of



Newfoundland and Labrador Hydro's proposed 2,200-MW station at Gull Island, shown in this artist's rendering, is one of several options being considered for capacity expansion.

Belle Isle via four submarine cables.

Preliminary engineering studies were released in June 1999, and concluded it is possible to generate almost the same amount of energy at a reduced cost by reconfiguring the project. The utilities have since changed the project description to involve the diversion of only the Romaine River, which provides 88 percent of the diversion water, into the Smallwood Reservoir, and increasing the utilization rate of the 11 turbines at the existing Churchill Falls facility to about 80 percent from 72 percent, instead of building a new powerhouse. The changes will mean increased profits for both utilities, as well as fewer effects on the environment.

Negotiators currently are working on the commercial considerations for a detailed inter-utility memorandum of

understanding (MOU). They also are working on related term sheets for water management, power purchase agreements, transmission, and project management.

The utilities have spent about CDN\$2 million studying the feasibility of Muskrat Falls. The studies have shown favorable results for developing an additional 824 megawatts at this site. But, while the capital costs have decreased from initial estimates, the profitability of this component depends on market factors.

The province of Newfoundland and Labrador is continuing its discussions with the federal government on financing the Infeed to the Island. A decision about the Infeed should be made during the coming months.

The project will be the largest in Can-

ada and one of the largest in the world. The river diversion, Gull Island development, and associated transmission lines will make it a CDN\$6 to CDN\$7 billion project. If the Infeed and Muskrat Falls components proceed, the cost could be as high as CDN\$10 billion. This project will provide significant employment opportunities and other construction-related benefits for the two provinces' people.

The parties have been talking with the Innu of Newfoundland the Labrador and Québec since May 1998, and are working toward a partnership with them on the project. In August 1999, Newfoundland and Labrador Premier Brian Tobin and Québec Premier Lucien Bouchard reaffirmed their commitment to ensuring that the Innu participate meaningfully and effectively in the project.

The project has made considerable progress on the environmental component. Québec passed a bill that enables that province to participate in a single environmental assessment for the project. Newfoundland and Labrador Hydro and Hydro-Québec conducted a full-scale environmental field program in Labrador in 1998, in consultation with the Innu Nation, and conducted a historic resources program in Labrador again in 1999. Some of the work initiated in 1998 continued through the 1999 field season, and additional field work will be conducted in 2000.

—By Kelly Hickman, director of communications, Labrador Hydro Project, Newfoundland and Labrador Hydro.

Ontario:

Preparing for a Competitive Market



Ontario ranks third in hydropower output among the provinces of Canada. In 1997, hydropower resources in Ontario generated 39.7 terawatt-hours, or approximately 27 percent, of the total electricity production in the province. The total installed hydropower capacity in Ontario is 8,100 MW, which represents 25 percent of the total generating capacity in the province. In total there are nearly 200 hydroelectric plants in Ontario, ranging in size from micro hydro units of a few kilowatts capacity to a conventional plant rated at more than 1,300 MW.

Approximately 88 percent of the

provincial hydroelectric capacity is provided by the 69 hydro plants of Ontario Power Generation Inc., whose shares are owned by the province of Ontario. The remainder of the capacity is owned by investor-owned utilities such as Great Lakes Power, and by a few municipal utilities, industries, and independent power producers.

Deregulation is well under way in Ontario, and the industry anticipates the opening of a competitive electricity market late in 2000. The provincial government established a market design committee of members who represented

a broad cross-section of stakeholders in the electricity industry. The committee's recommendations on rules and protocols needed to implement a competitive electricity market in Ontario, submitted in January 1999, set the basis for profound changes to the electricity business in Ontario.

The regulatory role of the Ontario Energy Board has been expanded with regard to market regulation, an Independent Market Operator has been established to manage the Ontario electricity market, and new rules and protocols are being developed for its operation. Hydroelectric producers and other generators will have to secure bilateral power sales contracts or bid for the sale of energy into the spot market. Prior to the emergence of the competitive electricity market, the cost of utility generation in Ontario typically has been incorporated into a monopoly-bundled rate.

The generation business of the former provincial utility, Ontario Hydro, has been incorporated as OPGI. Owing to OPGI's control of about 90 percent of domestic generating capacity, when the market opens in 2000 OPGI's market power will be mitigated through a price cap on 90 percent of OPGI domestic sales, decontrol of OPGI price-setting generation, and regulatory oversight of these targets. The new corporation must gradually decontrol its price-setting generation, in order to effectively reduce its share of the overall market to 35 percent within ten years of market opening. Although up to 1,000 MW of OPGI hydro assets could be decontrolled by 2004, no schedule has been set for this option. OPGI also will be subject to corporate taxation, property taxation, and generally the same business requirements as its competitors.

Since 1982, the government of Ontario has had a policy of encouraging the sustainable development of waterpower resources by the private sector, as part of a larger policy to encourage energy self-sufficiency in the province. Water power resources in Ontario are administered by the Ministry of Natural Resources (MNR), which leases water power sites under long-term contracts to the owners of hydroelectric facilities.

The challenges faced by the water power industry in Ontario have been recognized for several years. As deregulation became imminent, the industry moved to confront these issues. In November 1998, a task force was formed between the provincial government and waterpower industry members who represented more than 95 percent of the waterpower production capacity in Ontario. The process was carried out with MNR, to establish a "new business relationship" for the management of Ontario's water power resources. The



Through upgrades, Great Lakes Power increased its installed hydroelectric capacity by more than 3 percent. In this photograph, workmen are installing a new runner at the 54-MW MacKay Generating Station Unit 2.

new relationship is intended to minimize government intervention and to meet the needs of the environment, the Crown, developers, and other stakeholders.

Five teams were established to deal with specific areas of interest, including water management planning, allocation of new sites, dam safety and emergency preparedness, water power leases, and water power in a competitive electricity market (e.g. deregulation, tax assessments, and "green" energy). The work of the task force was considered a success, and its recommendations have been submitted in draft to the Minister of Natural Resources.

The industry, MNR, the Ministry of Finance, and other Ministries continue their consultations about the municipal tax assessment methodology, which places an onerous tax burden on hydro-

electric plants. This issue has been identified as one of the most serious problems for the hydropower industry as it moves into a competitive market.

The gross undeveloped hydropower potential in Ontario is estimated to be between 9,700 and 12,400 MW, though only about 2,700 MW of this potential would be economically and environmentally practical to develop. Present market conditions, uncertainty about future market prices, and the present municipal tax assessment methodology for hydro plants have discouraged new hydropower developments and redevelopments in Ontario.

OPGI has deferred until 2006 the in-service date for a new tunnel for Sir Adam Beck Generating Station at Niagara Falls. Great Lakes Power has postponed a 45-MW redevelopment of its High Falls Generating Station, and several other small developments have also been deferred or cancelled in Ontario. A 4-MW station is under construction on the Trent Canal, but no other new construction commitments are expected in the near term.

The hydroelectric plants in Ontario have an average age of 55 years, and some stations have been in operation for nearly a century. In the absence of redevelopment, reinvestments are being made to many of these facilities. For example, in 1998 OPGI invested CDN\$138 million to upgrade its hydroelectric plants. Through turbine and generator upgrades, Great Lakes Power increased its installed capacity in Ontario by more than 3 percent to 313 MW. Several owners are moving to automate their stations and prepare for the demands of the competitive market.

—By Colin L. Clark, P.E., vice president, Generation, Great Lakes Power Limited, with acknowledgments to Ontario Power Generation Inc.

Québec:

New Approach to Development Decision-Making



Hydro-Québec is a government corporation whose sole shareholder is the Québec government. The utility's sales totaled CDN\$8.8 billion in 1998. It operates 78 power plants that have an installed capacity of 31,400 MW and

generated 161.4 TWh of electricity in 1998. Hydro-Québec also has access to most of the 5,428 MW of electricity generated at Churchill Falls in Labrador. Above all, the utility produces clean, renewable energy, since over 95 percent

of its sales come from hydroelectric plants.

TransÉnergie, a division of Hydro-Québec, is responsible for electricity transmission, marketing transmission capacity, overseeing energy transmission, and marketing energy transmission products and services. Another subsidiary, Hydro-Québec International, develops international markets, while Société d'Énergie de la Baie James provides engineering and other project-related services. Capitech is a venture capital firm. Noverco is a management

company involved in gas transmission and distribution, and Marketing d'Énergie is a subsidiary that carries out energy transactions in Canada and on the Canada-U.S. border.

Obviously, the restructuring of the electrical industry and keener competition has significantly altered the business climate for Hydro-Québec. Pursuant to a decision handed down by the U.S. Federal Energy Regulatory Commission, and in keeping with the reciprocity agreement that gives Hydro-Québec access to the U.S. market as a wholesale marketer, the wholesale electricity market and electricity transmission in Québec are open to our competitors. However, given our strong competitive position, none of our competitors has offered to sell wholesale energy in Québec.

In 1997 and 1998, sales outside Québec totaled 15.2 TWh and 18.5 TWh, respectively, equivalent to 9.4 percent and 11.5 percent of total sales. This increase in sales is attributable to higher electricity purchases by brokers for resale on open energy markets.

Hydro-Québec intends to play a very active role in the energy market in the northeastern U.S. This strategy is based on the utility's forecast annual increase of roughly 1.5 percent in demand for electricity over the coming decade, deregulation of markets, transmission capacity and interconnections, and its electricity rates, which are among the lowest in North America.

The ice storm that struck southwestern Québec in January 1998 significantly damaged Hydro-Québec's power transmission system. Some 600 kilometers of power lines and 3,300 kilometers of distribution lines were damaged by the combined effect of ice and wind, at a cost of CDN\$725 million.

Forty reconstruction projects were carried out in 1998, and thousands of distribution conductors, poles, transformers, and kilometers of lines have been replaced. Numerous projects are currently under way, with a view to maintaining, optimizing, and restoring facilities and adding new ones.

The most important of these projects is the 882-MW Sainte-Marguerite-3 hydroelectric power plant, now under construction. The project is the subject of an agreement with the aboriginal communities and has led to the establishment of three funds to: support traditional activities, promote economic development, and cover the cost of mitigation measures. The project will be commissioned

in 2001. Various environmental enhancement and regional development measures will cost CDN\$49.8 million.

Hydroelectric power unquestionably affects local communities in different ways, depending on the nature and scope of the projects and the areas where they are carried out. However, the global effects of such projects have become extremely important in recent years, especially from the standpoint of climatic change. Achieving the objectives adopted under the Kyoto Protocol presupposes implementation of a large number of projects that reduce greenhouse gas emissions.

Existing environmental assessment systems have not been designed to manage this broad effect. In practice, they impose stringent requirements on electricity generation options that affect an array of local issues. Furthermore, they do not take into account the project's contribution to global effects or solutions that would make it possible to curtail such effects. Global mitigation must therefore be weighed against the local effects of hydroelectric power, as must the benefits.

Hydro-Québec is keenly aware of the local effects of its projects in Québec, and has taken the initiative by proposing three conditions for the construction of hydroelectric generating stations. First, aboriginal and local communities must be favorably disposed to all such projects. Second, all projects must be acceptable from the environmental standpoint and must foster comprehensive environmental protection while promoting resource development. Third, all new projects must be profitable in light of market conditions.

Residual hydroelectric potential is

considerable. Québec's hydroelectric potential can be further developed by means of diversions and new power generating plants, as well as the Churchill-La-Roumaine project in cooperation with the Newfoundland government. Projects that fail to satisfy all three conditions will not be carried out.

The diversion of the Manouane, Sault-aux-Cochons and Portneuf rivers and the construction of a 440-MW power plant on the Rivière Touloustouc are striking examples of this new approach. The projects were negotiated with the Betsiamites Montagnais community, where 79.5 percent of participants in a referendum approved the partnership agreement proposed by Hydro-Québec. Under the agreement, the aboriginal community will receive 17.5 percent of the energy produced (117.9 GWh), a community fund and three remedial work funds will be set up, and at least 10 percent of the contracts and 12.5 percent of the jobs created by the projects will be guaranteed. The value of the agreement is the equivalent of CDN\$100 million over 50 years.

The management of global effects is also very important. Hydro-Québec relies heavily on renewable energy, since most of the power it generates is hydroelectric. Moreover, the utility purchases renewable energy from small hydroelectric power plants and wind generators. Hydro-Québec buys the entire 100-MW output of the Le Nordais wind farm, the biggest such facility in Canada. Moreover, Hydro-Québec estimates that, between 1991 and 1998, new hydroelectric projects and the purchase of energy from small power plants made it possible to avoid the emission of 78.2 million tons of carbon-dioxide.



The 882-MW Sainte-Marguerite-3 hydro plant (shown in this photograph), now under construction, is the most important of numerous projects Hydro-Québec has under way to maintain, optimize, and restore facilities and add new ones.

Hydro-Québec is also actively promoting the advantages of hydroelectric power. To that end, the utility is participating in Canada-wide initiatives concerning climatic change and in the deliberations of the World Commission on Dams, the International Energy Agency, and the International Hydro-

power Association. Hydro-Québec has also contributed to the establishment of the Canadian Hydropower Association.

Preservation of biodiversity also has become a global issue. Hydro-Québec is closely monitoring the situation and is a member of the Québec government task force on biodiversity. In addition, the

utility has reached agreement with the ministère de l'Environnement du Québec and the Société de la Faune et des Parcs du Québec to establish a biodiversity support program in order to protect biodiversity on its property.

—By Martin Pérusse, senior environmental advisor, Hydro-Québec.

Saskatchewan: *Optimizing Use of Existing Assets*



Power generation in Saskatchewan comprises a mixture of hydroelectric, coal, and natural gas generating facilities. The hydroelectric power component of this mix represents about 25 percent of the province's total installed capacity, and 20 percent of its energy generation capability. The hydroelectric system consists of seven plants containing 26 units with an installed capacity of 850 MW producing, on average, 3,600 gigawatt-hours of energy annually.

Electricity production in Saskatchewan is the responsibility of SaskPower, the provincial government-owned utility.

SaskPower has been looking at its existing fleet of hydroelectric generating units for capacity and efficiency improvements as part of its overall strategy for reducing production costs of electric-

ity. These improvements include the following:

— At the eight-unit, 288-MW E.B. Campbell generating station, engineering investigations are under way to evaluate capacity improvements by improving the hydraulic conveyance of the power canal, as well as increasing the maximum wicket gate settings. Power canal improvements are expected to provide an additional 2 MW of capacity per unit, and increasing the wicket gate settings is expected to provide an additional 1 to 2 MW per unit.

— At the three-unit, 255-MW Nipawin generating station, replacement of undersized servomotors during scheduled major overhauls will improve the output of the units under low-head conditions. The change is expected to

provide additional short-term peaking capabilities of up to 5 MW per unit.

— At the seven-unit, 101-MW Island Falls generating station, recently completed runner and transformer upgrades on three units will provide an additional 6 MW of installed capacity. Upgrading of the remaining four units will be investigated in the future.

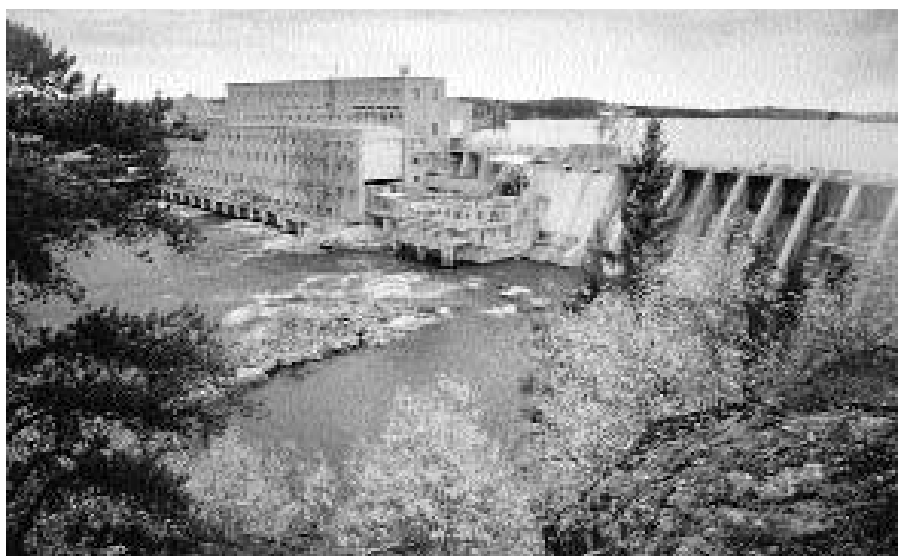
In addition to cost considerations and improvements to SaskPower's existing fleet of hydroelectric generating facilities, water resource management issues continue to have an ever-increasing effect on how hydroelectric power is produced. Mitigation of environmental and First Nations concerns as well as opportunities to optimize the available water resource are changing the way hydroelectric power is produced. Some of these changes include the following:

— Operation of the Saskatchewan River system plants (three plants totaling 729 MW) recently has been modified to allow for increased production during the summer months, resulting in less generation during the winter. Increased summer demand and market sales opportunities are the driving forces behind the change.

— SaskPower continues to work with First Nations and environmental groups to assess the effects of its hydropower operations on the hydraulic regime of the river systems. Alternative modes of operation are being investigated to minimize the effects.

Hydroelectric power generation is an important component of the overall power generation mix within Saskatchewan. However, for the foreseeable future, issues such as reducing greenhouse gas emissions, improving the overall efficiency and cost effectiveness of existing facilities, and optimizing the available water resource within constraints imposed by environmental and First Nations groups will dominate hydroelectric power generation within Saskatchewan.

—By J.M. Peters, Business Performance and Planning, SaskPower.



Saskatchewan provincial utility SaskPower is expanding generating capacity by upgrading existing hydroelectric units. At the 101-MW Island Falls generating station (shown in this photograph), runner and transformer upgrades on three units provided an additional 6 MW of installed capacity. Upgrading of the remaining four units will be investigated in the future.