



Electric Power: A Canadian Specialty

*The Canadian Electric Power Industry
At the Service of the World*

For additional copies of this publication, please contact:

Energy and Marine Branch
Industry Canada
10th Floor, East Tower
235 Queen Street
Ottawa ON K1A 0H5

Tel.: (613) 954-5446

Fax: (613) 941-2463

E-mail: ttc.electric@ic.gc.ca

Internet: www.dfait-maeci.gc.ca/trade/NER

© Her Majesty the Queen in Right of Canada (Industry Canada) 2001

Cat. No. C2-435/2001-3

ISBN 0-662-66010-2



15% recycled
material

Electric Power: A Canadian Specialty

The Canadian Electric Power Industry

At the Service of the World

A Time for Trade

As the World Trade Organization and other international institutions attack trade restrictions around the world, the challenge of providing reliable electric power – long recognized as one of the surest ways of bringing tangible benefits to a country's population and stimulating its economic growth – is increasingly being met in a competitive marketplace. Canada's electric power industry stands ready to meet this challenge.

The purpose of this document is to provide an overview of the Canadian industry's capabilities and highlight some of the Canadian companies that contribute to the development of electric power in international markets.

*New partnerships
for trade and
development in
the electric power
business*

Electric Power in Canada

Electricity has become a cornerstone of the Canadian economy and Canadian life. Canadians are the third highest per capita users of electricity in the world. Plentiful, inexpensive energy is required to provide heat in a northern climate, to transport goods in the second largest country in the world and to run a large industrial economy. High quality electricity supply is essential to provide the medium for Canada's rapidly growing information economy.

Canada's great needs for electricity are met through abundant energy resources: falling water, coal, natural gas and uranium. Installed generating capacity totalled 109.8 GW in 1999 and 557.2 Twh were produced. Sixty-one percent of Canada's electric power is generated from hydro, 26 percent from thermal and 12 percent from nuclear energy sources.

Over the years, Canada's electricity needs have been met by innovative engineering and technology leadership:

- from 1883, when Thomas Alva Edison installed the first electric generator in Canada
- to 1962, when Canada produced its first nuclear-generated electricity
- to 1965, when Hydro-Québec installed the world's first 735 kV transmission line, transporting electricity 1100 kilometres to market from northern Québec
- to today, as the Ballard Fuel Cell powers new, emission-free stationary generators.

*A major force
of progress*

The preponderant portion of Canadian electricity supply is generated by means that minimize adverse environmental effects. The industry has made commitments to finding environmentally beneficial solutions to every aspect of its operations and to contributing to Canada's pursuit of its air pollution control objectives. Canadian thermal, nuclear and hydro technology is state-of-the-art, and Canadians are helping to pioneer some of the emerging alternative technologies.

The Electric Power Industry

The electric power industry in Canada has assets of \$148 billion (1997) and earns \$35 billion in annual revenue. Canadian utilities directly employ approximately 78 000 people, and an additional 25 000 people are employed in electric power production for manufacturing and engineering companies.

In terms of global rank:

- Canada is the fifth largest producer of electric power in the world, generating 4 percent of the world's total.
- Canada is the world's largest producer of hydro power.
- Canada is the world's second largest electricity exporter.

Attaining this level of performance despite extreme terrain, severe climate and long distances has made Canada's electric power industry an international leader. Moreover, the capabilities gained in bringing reliable, low-cost electricity to far-flung communities in Canada can also serve the development needs of other countries.

Significant Achievements

Among Canada's major electric power development projects, the James Bay hydro-electric project in Québec is perhaps the most renowned. Completed in its current configuration in 1984, this electric power complex features a spillway three times higher than Niagara Falls and the largest underground powerhouse in the world. It has five major power stations, with capacities ranging from 1368 MW at LG-1 to 5328 MW at the Robert-Bourassa power station, for a total of 15 000 MW.

In the nuclear field, Atomic Energy of Canada Limited (AECL) developed the CANDU reactor. Major nuclear generating sites are located in Ontario at Pickering, Bruce and Darlington, in Québec at Gentilly and in New Brunswick at Point Lepreau. There are 700 MW class CANDU6 reactors designed by AECL operating in Canada, the Republic of Korea, Argentina and Romania. Three more are under construction, two in China and one in Romania. AECL's larger 900 MW class reactor, CANDU9, is an evolutionary design based on the proven multiunit reactors at the Darlington and Bruce B nuclear generating stations.

In thermal generation, Ontario Power Generation operates one of the world's largest coal-fired generating stations, at Nanticoke on Lake Erie. Its eight power units, built by Babcock & Wilcox, provide a total capacity of 3900 MW. Construction of the site began in 1973. All eight units were completed in 1978.

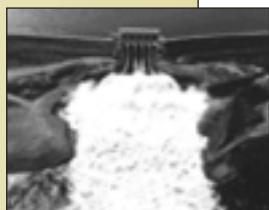


Figure 1 - La Grande at James Bay.



Figure 2 - Darlington Generating Station in Ontario.

The transmission of electricity over long distances constitutes another significant achievement. Canada's many economically attractive hydro sites are often located far from their markets. Canadians have had to pioneer new transmission technologies such as the world's first 735 kV transmission line, which is state-of-the-art in extra high voltage (EHV) alternating current and high voltage direct current (HVDC).

The map (last page) shows the predominantly north-south pattern of high voltage, long-distance transmission lines. Hydro-Québec's system extends more than 1100 kilometres from Churchill Falls in Labrador to Montréal, and from James Bay to southern load centres that include U.S. markets. In Manitoba, pioneering work was done to successfully develop the \pm 500 kV HVDC system bringing hydro-electric power from the Nelson River (Gillam) to customers in the Winnipeg area of southern Manitoba. In Ontario and British Columbia, major EHV systems in the 500 kV class bring electric power from northern generating sites to markets in the south.

Counting all transmission and distribution lines rated 50 kV and higher, Canada's bulk transmission network measures 158 156 kilometres of high voltage power lines.

Canadian Utilities

Electric utilities in Canada are largely under provincial jurisdiction and tend to be highly integrated within each province. Most, but not all, utilities are owned by the provincial or municipal governments.

A striking characteristic of Canada's utilities is their participation in international trade in electricity. In 2000, Canada exported 50.06 Twh (valued at \$4.08 billion) to the United States. This trade has helped customers in a number of provinces enjoy electricity rates that are among the lowest in the world.

The electric power business is going through dramatic changes. Deregulation is well under way in many jurisdictions, opening up this industry to competition and new kinds of electricity companies. Competition is spreading at the wholesale level, and is expected shortly at retail levels in some provinces. The utility functions of generation, transmission, distribution and retail are being unbundled. For example, on April 1, 1999, Ontario Hydro was split into a number of successor organizations, including Ontario Power Generation Inc. and Hydro One. The former manages generation assets, and the latter handles transmission and distribution.

Growing ranks of industrial companies are installing combined heat and power (cogeneration) systems, enabling the efficient consumption of fuel. Independent power producers (IPPs) have emerged across Canada, with companies such as TransAlta and Atco Power playing leading roles. There are new convergences developing among electricity companies, natural gas firms and telecommunications providers.

Cost pressures are increasing relentlessly, and planning horizons are becoming ever shorter. Power quality and system reliability are becoming much more important, calling for specialized engineering techniques. Environmental issues have placed new constraints on the planning and management of all forms of generation.

Canada's experience features major power development projects using hydro, nuclear and thermal energy sources



Figure 3 – Ontario Power Generation's Nanticoke generating station.

Canadian utilities, with a long history of achievement, are adapting vigorously to a new business environment with the help of world-class suppliers



Figure 4 – Suralaya Station, Indonesia, expansion project by Babcock & Wilcox.



Figure 5 – Transformers for Geheyuan Hydropower Station, China, manufactured by ABB Canada.

Globally competitive companies, whose \$6.2 billion in shipments (1997) include \$4.1 billion in exports

Canadian utilities are meeting these challenges vigorously. The Canadian electric power equipment and services industry is providing solutions that offer high-yielding, environmentally sensitive designs and upgrades, turning refurbishments into major capacity gains. These solutions represent solid proposals from builders and operators who have proven track records and who can offer competitive financing.

Equipment Manufacturing

Over the past 10 years, the electric power equipment and services industry has consolidated, restructured and re-created itself. It now puts a much greater emphasis on defining a field or niche in which Canadian operations have the best capabilities and track record, and it competes on a global scale. At the same time, as subsidiaries of multinational corporations based in Europe and the United States, many of the large power equipment manufacturers in Canada have the benefit of their parent companies' contacts, sales forces, technologies and access to capital.

Several Canadian companies have become major players in the international market. For example:

- The GE Hydro plant at Lachine, Québec, has a global product mandate for large hydro turbines and generators.
- The Babcock & Wilcox plant in Cambridge, Ontario, is the world's leading manufacturer of replacement nuclear steam generators.
- ABB Canada maintains Centres of Excellence, with many of its plants specializing in specific types of transformers and other systems for the management and transmission of electricity.

Canada's electric power sector is not known solely for its large companies. Small, highly innovative companies are springing into existence all over the country. Their products and services cover a wide range, from alternative generation to controls, monitoring and testing. They are capable of pursuing market niches on their own or of partnering with larger companies to provide customers with total solutions, particularly if these are aimed at improving efficiencies and environmental performance. Three examples are Trihedral Engineering Limited, with its software for industrial monitoring and control, Thermal Energy International Inc., which can enable power generators to reduce the cost of meeting emission reduction requirements, and Intracoastal System Engineering Corporation, a world leader in automated meter reading systems. These are just a few examples of exciting high technology companies that are transforming the Canadian power sector and penetrating international markets.

Consortia and partnerships often bring together the best Canadian players in various specialties and enable the pooling of skills and resources that are in short supply. For example, two of Canada's largest engineering firms, Acres and SNC-Lavalin, formed Canadian International Water & Energy Consultants to undertake projects in Nepal. In the nuclear power field, strong partnerships are formed between utilities and Canadian nuclear industry participants for servicing and refurbishing nuclear plants.

Partnership is an essential component of research and development (R&D) efforts in the industry. The Canadian Electricity Association plays a valuable role in pooling Canadian R&D resources in joint projects. At the bilateral level, Hydro-Québec and ABB Canada have partnered in the CITEQ (Centre d'innovation sur le transport d'énergie du Québec) R&D Centre to produce a new submersible transformer.

Globalization and rationalization have had a huge impact on the electric power equipment manufacturing industry over the past 10 years. To provide solutions to today's utility needs, Canadian suppliers are emphasizing short lead times, flexible product offerings, more standardized products, performance guarantees and strong support services.

In 1997, Canadian power equipment shipments were valued at \$6.2 billion. That figure includes \$4.1 billion in exports, a 145 percent increase in real terms between 1991 and 1997. Currently, the top export destinations for Canadian electric power equipment are the United States, the United Kingdom, China, Germany, the Republic of Korea and Mexico.

Canada is an open trading nation. Its electricity providers want to be able to look anywhere in the world for solutions from companies with the talent, capabilities and experience to supply their needs. Increasing export and import trade reflects the international specialization of the industry and ensures that domestic manufacturers compete with, and rank among, the world's best.

Power Generation

In power generation, products range from small hydro installations to modular, efficient gas turbines for distributed generation, to the world's largest air-cooled hydro generator, at Guri 2 in Venezuela, built by GE Hydro. Other major manufacturers include Alstom, Siemens, Foster Wheeler and Babcock & Wilcox.

In the nuclear power reactor market, AECL is the third largest global supplier of nuclear energy systems and technology. Major subcontractors include Babcock & Wilcox for nuclear steam generators, Alstom for calandria, and CAE Electronics for operations training simulators. Today's CANDU power reactors represent proven technology and have a long history of evolutionary advancements to reduce capital costs, enhance safety and exploit this design's exceptional fuel cycle flexibility.

Other generation technologies that possess considerable environmental advantages are emerging in Canada. Examples include wind power, photovoltaics and fuel cells. Some of these emerging technologies are also well suited to fill growing requirements for distributed generation and customized energy services. This is very much the case for Ballard Generation System's 250 kW natural gas-powered Fuel Cell Power Plant for stationary power applications. There is a growing fuel cell industry including such companies as Global Thermoelectric, a leader in solid oxide fuel cell technology, and Hydrogenics Corporation, a developer of fuel cell power generators and test equipment.



Figure 6 – Guri 2, Venezuela. The world's largest air-cooled hydro generator, built in Canada by GE Hydro.



Figure 7 – The Wolsong nuclear generating station in the Republic of Korea, with four AECL-designed CANDU6 units, was completed in 1999.



Figure 8 – Ballard Generation System's 250 kW natural gas-powered Fuel Cell Power Plant.

State-of-the-art transmission, distribution and management for deregulated networks, from pioneers of high voltage transmission



Figure 9 - Manitoba Hydro's Radisson Converter Station in northern Manitoba, with Kettle Generating Station in the background. Radisson is one of two stations converting electricity produced at Manitoba Hydro's three Nelson River Generating Stations from AC to DC, transmitting by HVDC up to 3850 MW of power to Winnipeg at +/- 500 kV, where it is converted back to AC for distribution to the 230 kV distribution system.

More than 200 consulting engineer and engineering contractor firms, plus the expert services of Canadian utilities

Transmission and Distribution

Canada's electric power industry has experienced and highly competent suppliers of equipment and services in transmission and distribution, in particular, advanced transformers, switchgear, and wire and cable.

In high voltage transmission systems, major projects by Manitoba Hydro, Hydro-Québec, BC Hydro and Hydro One showcase a capability that Canada has defined. Pauwels Canada specializes in HVDC converter transformers, and ABB Canada has recently developed a system of low-voltage transmission to link the main grid with distant loads such as Aboriginal communities. Such a system could be an economical solution to the enormous cost of diesel fuel currently being consumed to serve these loads.

To manage the challenges of transmission and distribution in open, deregulated markets, the latest generations of supervisory control and data acquisition (SCADA) and other network management systems are being integrated into Canadian power systems. SNC-Lavalin Energy Control Systems Division (formerly CAE Electronics ECS) is active in this field in Canada and worldwide, notably in the supply of a high voltage transmission SCADA system to EDESUR (Empresa Distribuidora Sur) in Argentina.

Services

There are more than 200 firms of consulting engineers and engineering contractors in Canada's electric power industry. Several Canadian utilities also provide expert services to international customers.

This sector is composed almost entirely of Canadian-owned companies that have a long international track record in power projects. The largest companies are able to take on the role of an engineer-procure-construct (EPC) contractor. They provide services such as taking full responsibility for a plant's construction and start-up, generally on a fixed-price, turnkey basis, including design and procurement of subcontracted equipment and services, together with the construction and start-up risks. Some go further to provide total project solutions, including full financial structuring, occasionally taking their own investment positions. The following companies are among the Canadian service providers active in international power development:

- AMEC, with 7000 employees and offices in 40 countries, has completed projects in more than 100 countries. A world leader in hydro-electric and thermal generation projects, it also brings environmental and financing capabilities in order to provide a global approach.
- SNC-Lavalin is one of the leading engineering and construction firms in the world, with over 8000 employees in offices in some 30 countries. SNC-Lavalin is involved in services, turnkey packages and ownership of power facilities. Its financing arm, SNC-Lavalin Capital, has helped put together packages worth over \$5 billion in recent years.

- Acres International, a leader in hydro-electric developments, is an employee-owned firm with a staff of 700. Acres currently has projects under way in more than 25 countries and has completed assignments in 110 countries. Associate firms with more than 200 employees are active in Africa, Latin America and Asia.
- Dessau-Soprin, with nearly 1,000 employees, specializes in hydro-electric production, transmission and distribution, and environmental services.
- Canatom NPM, with 250 highly specialized employees, provides engineering, procurement and project management services to the nuclear sector.
- Teshmont, with 35 employees, is a good example of a number of distinguished and specialized smaller firms in the sector that are active internationally. Teshmont has provided services in 18 countries, in projects representing more than half of the world's installed capacity of HVDC transmission systems.

Several utilities sell their expert services internationally. TransAlta and Canadian Utilities are notable as active investors and operators of IPPs. Hydro-Québec International is active in IPP, build-own-operate (BOO), build-own-transfer (BOT) and build-own-operate-transfer (BOOT) projects. Canadian utilities, such as Hydro-Québec and New Brunswick Power Corporation, have been involved in training nuclear plant operators from other countries. Manitoba Hydro has signalled its intention to take a larger role in selling its expert technical and management consulting services internationally through the formation of Manitoba Hydro International, which continues the parent company's work in delivering training and technology transfer programs to utilities around the world.

Repair, Modernize, Upgrade

For aging plants, choosing refurbishment and/or repowering rather than building new generating capacity can lead to substantial improvements in capacity, efficiency and environmental performance. Canadian utilities have turned increasingly to the repair, modernize and upgrade (RMU) option as plants reach the end of their life cycle, and have developed state-of-the-art techniques and equipment for this purpose. Among numerous RMU projects under way across Canada, Ontario Power Generation is currently performing a major overhaul and upgrade of the Sir Adam Beck Generating Station Number Two at Niagara Falls, which will increase capacity by about 150 MW when completed.

New Brunswick Power Corporation has partnered with Westcoast Energy to redevelop an oil-fired unit at Courtenay Bay into a 280 MW natural gas-fired combined cycle unit. Several utilities have completed refurbishments of existing conventional steam electric power plant units to enable these units to operate in a more efficient and environmentally friendly manner.

Canadian consulting engineers and contractors, as well as companies such as Hydro-Québec International, are active internationally in providing a full range of consulting services for power station rehabilitation. Canadian advanced products in this area range from robotic repair and maintenance units, to diagnostic and control systems, generation scheduling and river management software.



Figure 10 – In Bosnia-Herzegovina, Acres serves as engineer in the reconstruction of war-damaged generation, transmission and distribution facilities.

Getting the most from existing plants and using refurbishment to increase capacity, efficiency and environmental performance

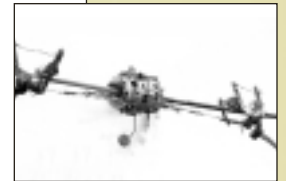


Figure 11 – Performance-improving technology for 220 kV transmission lines in Peru. Dessau-Soprin worked with the National Research Council of Canada to analyze corrosion and contaminant problems in the 1600-kilometre, 220 kV coastal transmission network of ETECEN (Empresa de Transmisión Eléctrica Centro Norte). Then, a lightweight and durable conductor-cleaning device was designed in collaboration with the Institut de recherche électrique du Québec. Its use offsets the expense of replacing conductors, while saving an estimated US\$1.5 million in energy losses on a 200-kilometre section. In 1998, this project won awards from the Canadian Consulting Engineering Association and Canadian Manufacturers & Exporters.

Canada's Export Development Corporation provided nearly \$1 billion in financing support to the Canadian electric power industry in 2000

Financing

No matter how good the team of project managers, consultants, contractors and manufacturers may be, financing often makes or breaks a deal. That is where Export Development Corporation (EDC), Canada's export credit agency, comes in. For more than 50 years, EDC has supported Canadian exporters and Canadian investors in international projects, with a world-class range of finance and insurance management services.

Services include project financing, insurance to cover a range of political risks, support for contract bonds, as well as accounts receivable insurance and financing. These services are provided through a specialized team of financing and insurance experts dedicated to helping the Canadian power industry export and operate abroad.

In 2000, EDC provided over \$45 billion of insurance and financing support to Canadian businesses, with close to \$1 billion specifically for the Canadian power industry.

EDC has accumulated considerable experience in arranging, structuring, preparing and negotiating the financing security and political risk insurance arrangements for projects. It is prepared to consider transactions at the forefront of sector and market developments. EDC strongly believes in combining its expertise with that of other financial institutions, key project players and exporters. With its financial partners, EDC has been very active in IPPs and merchant power projects across the world.

Choosing Canada

In summary, Canada's electric power industry has the capabilities needed to develop electric power throughout the world, with:

- skilled, experienced specialists
- proven international capability and competitiveness
- attractive financing.

Annex: Selected Projects

Canadian electric power firms have a long-standing international presence. The following selected projects illustrate the four major capability areas of the industry.

Power Generation

- Teeside 1875 MW combined cycle (United Kingdom): AMEC provided EPC services.
- Suralaya 4 x 400 MW thermal (Indonesia): Boiler island supplied by Babcock & Wilcox, with EDC support.
- Three Gorges 18 200 MW hydro (China): GE Hydro is supplying turbine generators.
- Wolsong Nuclear Generating Station (Republic of Korea): AECL was project manager for Unit 1 and prime contractor for plant design and engineering for all four units. Canatom NPM was subcontractor for architect engineering scope for all units. GE Canada provided initial fuel loads for Units 1, 3 and 4. Zircatec provided the initial fuel load for Unit 2.
- Chamera II 300 MW hydro (India): SNC-Lavalin is supplying electromechanical equipment, design and financing.

Transmission and Distribution

- 161 kV transmission system reinforcement for Volta River Authority (Ghana): Acres conducted expansion, new construction and modernization of transmission facilities.
- 220 kV, 660-kilometre BOOT transmission line (Peru): Hydro-Québec International carried out this project on a build-own-operate-transfer basis.

Services

- Tambak Lorok 2 x 530 MW combined cycle station blocks (Indonesia): SNC-Lavalin provided design audit, project and construction management, commissioning supervision and technical assistance.
- Akosombo 912 MW hydro generating station retrofit (Ghana): Acres is providing engineering, procurement and construction management services.

Repair, Modernize, Upgrade

- SCADA high voltage transmission system for Buenos Aires (Argentina): SNC-Lavalin Energy Control Systems Division (formerly CAE Electronics ECS) supplied the RMU services.



Figure 12 – Akosombo hydro station, Ghana, site of a major retrofit.

For your electric power needs, consider Canada!



High voltage, long distance transmission lines in Canada

Lignes de transmission de haute tension et à longue distance au Canada.

Líneas de transmisión de larga distancia y alto voltaje en Canadá.

加拿大的长 距离高压输电线路 图

カナダの 長距離高压送電線