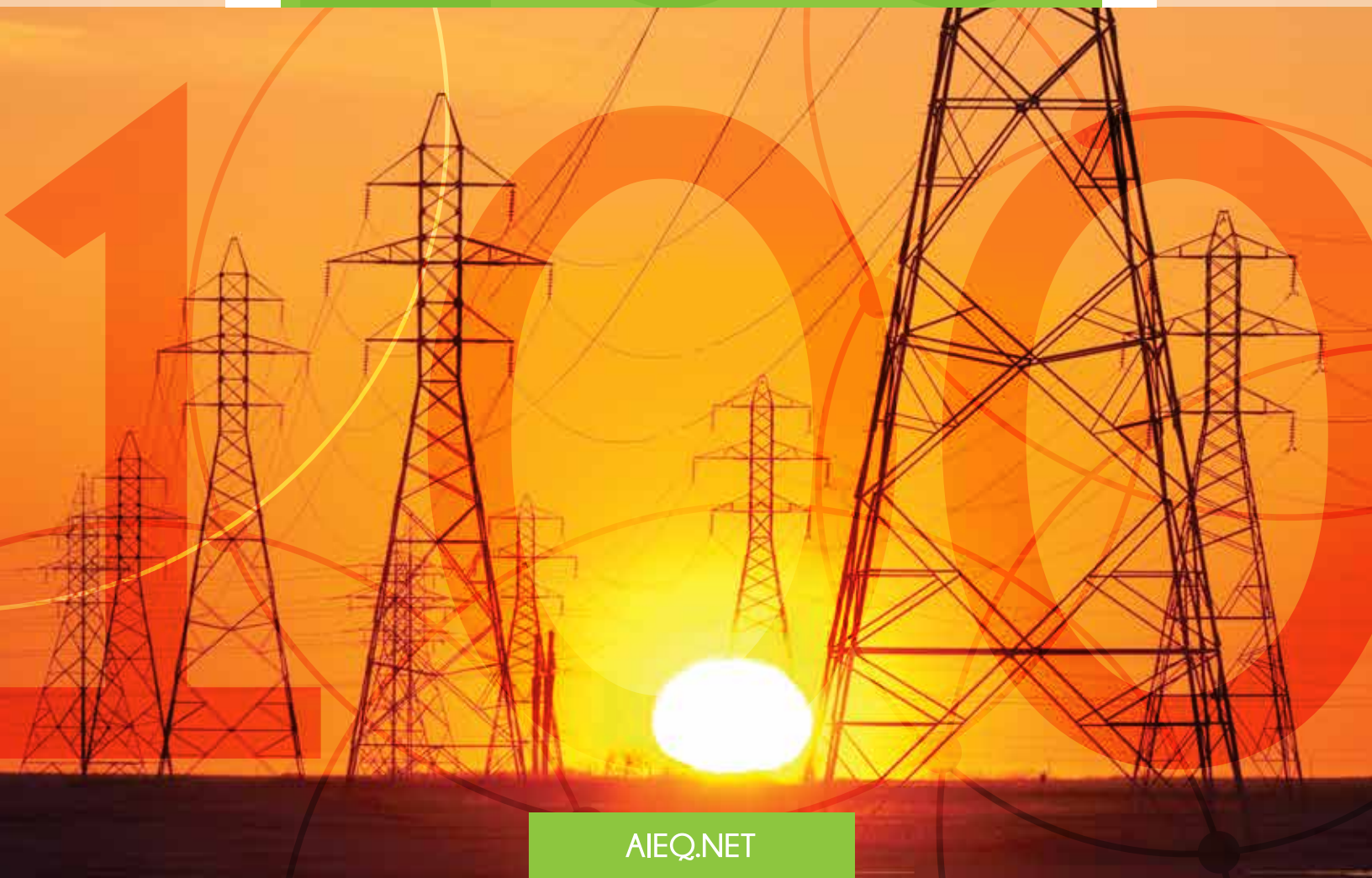
ASSOCIATION DE L'INDUSTRIE ÉLECTRIQUE DU QUÉBEC

HIGHLIGHTING 100 YEARS OF EXPERTISE

2016 EDITION



AIEQ.NET

epiQ

ELECTRIC POWER
INDUSTRY OF QUEBEC

An initiative supported by Hydro-Québec

COME SEE US AT HYDROVISION!
BOOTH 1125!

We look forward to attending HydroVision as it proves to be a valuable experience when interacting with the largest gathering of hydro professionals worldwide.

EPIQ at HydroVision is:

This year at HydroVision, four companies of the Electric Power Industry of Quebec are participating:

- Hydro-Québec Research Institute (IREQ)
- EBC
- BBA
- Dassault System

They are all offering products and services that are ideal hydropower electric installation plans and specifications, construction and simulations.

In addition, EPIQ is pleased to announce that Jocelyn Gaudet, Chief of Technology at IREQ, will be in the EPIQ booth after his conference of Wednesday, July 27 at 11:45 AM.

CONFERENCE:
PUTTING A S.T.A.M.P. ON YOUR FLEET

WEDNESDAY, JULY 27, 2016
FROM 9:30 AM TO 11:30 AM - ROOM 205C

Come by Booth 1125 and meet with Jocelyn to discuss safety, testing, analysis, models and predictions to improve your fleet management, installation safety and operational efficiency, as well as decrease your operating costs.

Visit us at booth 1125 and meet four innovative companies with strong hydroelectric know-how.

[1] EPIQ stands for Electric Power Industry of Quebec

PRIME MINISTER · PREMIER MINISTRE

Dear Friends:

I am pleased to extend warm greetings to everyone marking the 100th anniversary of the Association de l'industrie électrique du Québec (AIEQ).

This event is a wonderful occasion to celebrate the many achievements of the AIEQ. For 100 years, it has been promoting best practices and quality within a burgeoning sector, and advocating for its members' interests. You can be very proud to represent one of Quebec's economic powerhouses and to belong to an organization that encourages excellence and professionalism.

At a time when the whole planet is facing urgent climate challenges, it is more important than ever to move toward new models and adopt more innovative products so as to reduce our dependency on fossil fuels. I am sure that electrical industry stakeholders will rise to those challenges, through strategies geared to growth and to sustainable and responsible development.

On behalf of the Government of Canada, I offer my congratulations and best wishes for future success.

Yours sincerely,

The Rt. Hon. Justin P.J. Trudeau, P.C., M.P.
Prime Minister of Canada

As premier, I would like to congratulate the Association de l'industrie électrique du Québec, which is celebrating its 100th anniversary. This is an accomplishment worthy of pride!

Over the past 100 years, this organization has brought together the industry's various stakeholders, such as General Electric Canada, Shawinigan Water and Power, and Westinghouse, around major common goals. Today, the Association is considered to be the voice of Québec's electricity industry.

In an environmental context in which global warming is a threat to the planet's future, the Association is stressing the importance of continuing to research and develop renewable energies that lead to a reduction in greenhouse gas emissions. This mission corresponds perfectly with the Government's desire, which is stronger than ever, to be recognized as a leader in fighting climate change. I am very pleased to see this.

The contributions and expertise of the Association de l'industrie électrique du Québec's members make them key economic players in Québec, and front-line partners for our government.

Bravo and happy centenary!

Philippe Couillard
Premier of Québec

ENSEMBLE on fait avancer le Québec

Québec

I would like to congratulate the *Association de l'industrie électrique du Québec* on its 100th anniversary and for successfully bringing together key players of the electrical industry around common goals.

The end of the 19th century marked the establishment of the electrical industry in Montréal. Our city has played a leadership role in the field of energy for a long time and contributed substantially to the growth of this industry.

Today, Montréal demonstrates the same level of leadership that is part of the DNA of Montrealers. The city provides favourable conditions to develop the industry, by supporting a strategy for transportation electrification, and to achieve its environmental objectives.

This strategy involves three axes: the electrification of *Société de transport de Montréal* buses, conversion of the municipal fleet of combustion vehicles to electric vehicles, and introduction of a network of on-street charging stations for electric vehicles.

The initiatives to fight against climate change are part of the leadership role that Montréal has been playing since the end of the 19th century. Montréal has successfully translated its energy ambitions through local private enterprises and partners. The *Club d'électricité de Montréal*, which is now called the *Association de l'industrie électrique du Québec*, has been one of the city's key partners since 1916. Montréal can also count on the noteworthy contribution of several partners, most of them headquartered in Montréal.

City initiatives to enhance transportation electrification serve as levers to develop a new industrial pole of attraction, or electrical sector, and create quality jobs. Montréal will become a laboratory and help businesses test their new electric mobility technologies. The city also plans to encourage synergies between the enterprises involved in that field and promote a new pole of excellence.

I invite the electricity industry to join Montréal and rise to this 21st-century challenge.

Denis Coderre
Mayor of Montréal

Montréal

Fostering sustainability worldwide

By Denis Tremblay
President and CEO of epiQ

The 2015 Paris Climate Conference (COP 21) ended with an international agreement, applicable to all 195 participating countries and validated by all participants, with the objective of limiting global warming to between 1.5°C and 2°C by 2100, compared to the pre-industrial era (we're already at +8.8o C) and the understanding that efforts must be deployed to remain under 1.5°C.

While we do not yet know the agreement's terms of implementation, it is clear that the future holds a new "decarbonized" economy. The whole world is looking for ways to lower GHG emissions and the business community is no exception. The shift is happening at full speed. Industrial managers are aware that their business environment is undergoing a fundamental change and that, to remain competitive, they must invest heavily in the research and development of solutions with low GHG emissions. The automotive sector is finalizing the electric car; the aerospace industry is developing the environmentally-friendly aircraft; the commercial and residential construction industries are expanding their expertise in green buildings and energy efficiency, to name a few examples. Every industry is looking for ways to reduce their CO2 emissions.

Countries that quickly transition towards a low GHG emissions economy will gain a distinct competitive edge. Quebec has a considerable advantage in this race. More than four decades of work have enabled Quebec to emerge as a world power in the production of renewable energies. It has also fostered the development of "green" technologies, including the only environmental expertise of its kind in the world.

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At the John Hart generating station, our experts teamed up with BC Hydro to design, build, finance, and maintain the new 132 MW facility for 15 years, continuing to provide environmentally friendly energy in British Columbia, Canada.

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Over the past 40 years, Quebec has built a complete ecosystem of manufacturers, engineering firms, building contractors and service providers. This Quebec electrical industry accounts for more than 15,000 highly skilled jobs and over 400 companies[1].

The Quebec electrical industry is also very active in the Canadian market. By 2035, the Conference Board estimates that close to CAD $350 billion will have been invested in the production, transportation and distribution of electricity in Canada[2]. This is very good news for our domestic companies. As a matter of fact, the new North-American energy context offers numerous opportunities for the Quebec electrical industry:

- The growing need for electricity and transmission lines in Canada and in USA.
- Refurbishing electric power infrastructures, including modernization and upgrades (the electric power infrastructures are between 40 and 60 years old).
- Integrating wind energy into the electricity distribution networks.
- Optimizing power plants.
- Electrification of transport.
- The widespread deployment of the Smart Grid.

Quebec's expertise could also be well-received on other continents, provided its strategy is effective.

For example, Africa has undertaken a serious electrification initiative that relies primarily on hydroelectricity. It has created a multi-billion dollar investment program headed by the African Development Bank and supported by several Western countries. By 2040, Africa will invest several billion US dollars in electric power infrastructures (the PIDA program). It is currently anticipating its first major success with the "Renaissance" hydroelectric project. Located in Ethiopia, this project has been under construction since 2013. It represents an investment of $3.2 billion[3].

Many more projects will be completed on the African continent in the coming years and, by participating, Quebec could achieve several goals, including maintaining its high electrical industry expertise and involve its financiers, including the Caisse de dépôt et placement du Quebec, in funding electric power infrastructure in Africa. In addition to participating in the development of an African economy with low GHG emissions, Quebec could strengthen its ties with member countries of la Francophonie.

Of course, Africa and Canada are only examples; there are other opportunities to consider, such as upgrading the aging infrastructures in the United States. Our neighbours to the south wish to increase their hydroelectric generation. There is also Latin America, where Mexico is currently undertaking a major electrification project.

THE DEMAND FOR INVESTMENTS WORLDWIDE

Before COP 21, the International Energy Agency (EIA) estimated that the total annual investments in electric power worldwide would account for a huge market of $16.4 billion by 2035[4].

Investments just for the OECD countries will be $6.2 billion during this period, mainly to replace outdated infrastructure and to meet GHG reduction targets[5]. Total investment needs in electric power infrastructure in India will reach $1.6 billion by 2035[6]. Although the public sector is very active in the industry, India will require greater contributions from the private sector.

In the struggle to reduce GHG emissions while meeting growing energy needs, Quebec has a distinct competitive advantage. For example, Quebec's electric power industry has accumulated more than 40 years of experience in environmental impact assessment (including best solutions for project impact on wildlife, flora and impacted citizens, considered mitigation measures, emergency measures and surveillance and monitoring programs). Such experience is very rare. Regarding innovation, Quebec companies have also developed state-of-the-art expertise and technologies in an effort to adapt to changing realities in the industry (Ex.: the 735 kV line, integrating renewable energies into the distribution network, creating charging infrastructures for the electric vehicle, lithium-ion batteries for electric vehicles, etc.).

Over the years, Quebec's electrical industry has not only acquired solid experience by working on major hydroelectric projects, it has also developed a comprehensive understanding of all the factors affecting the production, transportation and distribution of electricity and now offers a highly competitive aggregate supply (Price-Service-Quality-Innovation).

The first countries to rise to the challenge of a major reduction of their GHG emissions and an increase of their electricity production from renewable source will position themselves as leaders, and ensure their economic future. The Quebec electrical industry possesses the expertise and the technologies to help these countries reach their goals. ■

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[1] The number of jobs and companies noted herein does not take into consideration the sectors of electricity production, transport and distribution.

[2] Conference Board, "*Shedding Light on the Economic Impact of Investing in Electricity Infrastructure*", 2012

[3] See Amadou Zakou "*Les perspectives de croissance de la production et du transport d'électricité en Afrique*", AIEQ 2015 Symposium: http://aieq.net/wp-content/uploads/2011/09/Pr%C3%A9sentation_Montreal_26-mars.pdf?3c98dd[4] See International Energy Agency, "World Energy Investment Outlook 2014", p.102

[5] Ibid, page 103

[6] Ibid, page 29

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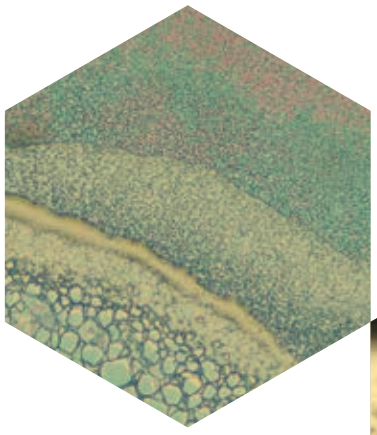

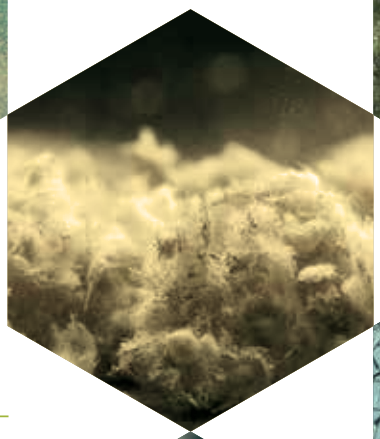





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The epiQ Solution

THE CHALLENGE OF DIVERSIFYING MARKETS IN CANADA AND AROUND THE WORLD. THE EPIQ SOLUTION

This year, the epiQ launched the epiQ (electric power industry of Quebec) initiative, a project intended to help members of the epiQ diversify their markets by organizing turnkey events outside of Québec.

epiQ's first mandate is to present the electric power industry of Québec as a strong brand ("branding" as they say in marketing). epiQ capitalizes on the reputation of Québec's expertise to leverage the interest of international work providers. This famous branding revolves around some of the competitive advantages of the industry in Québec, including its solid background working on major hydroelectric projects with Hydro-Québec, its specialized and well-trained workforce, the fact that it meets the criteria set by Hydro-Québec, which are recognized as some of the most demanding in the world, etc.

The electric power industry of Québec also has the great advantage of being composed of several hundred companies representing a complete value chain with a highly competitive aggregate supply, expressed as a price-service-quality-innovation ratio.

epiQ is also a year-round promotional campaign. The organization even has its own website: www.theepiqgroup.com. epiQ relies on a network of 8,000 people in North America. As a result, it employs several different communication strategies to disseminate its messages (online campaigns, email campaigns, promotional videos, Lumière magazine, etc.).

epiQ
ELECTRIC POWER
INDUSTRY OF QUEBEC
An initiative supported by Hydro-Québec

epiQ also has boots on the ground. Meeting with people who have a real impact on the purchasing process of its products or services is not an easy task. The decision makers and influencers of the electric power industry meet only a few times a year at major events such as Distributech, Hydrovision, CIGRE, IEEE and TD World. There are few events at which a company can actually significantly increase its business contacts. You therefore cannot afford to miss the mark.

These immense trade shows provide access to the whole world in a single location and for a short period of time. The problem lies in how to stand out from the crowd. For example, at Distributech, there are nearly 500 exhibitors. Yet only one hundred or so booths attract most of the attention. Why is that?

First of all, it is clear that the major brands draw attention by their notoriety. But even these big names know that is not enough. You need visibility! There are three ways to achieve visibility. First, you need a big eye-catching booth. A small, isolated space is nowhere near enough. Second, you should be located in a high-traffic area. Third, you need to advertise your presence. epiQ offers these three things to member companies of the epiQ.

epiQ's first activity was to organize Québec's presence at Distributech. The booth occupied an area of 600 square feet and was located next to the biggest names in the industry. On the floor at Distributech, fewer than 50 booths had an area equal to or greater than that of epiQ. Therefore, epiQ did not go unnoticed.

The companies that participated in Distributech in connection with epiQ found the cost-benefit ratio to be highly favourable. First of all, the cost to attend such an event was very affordable with epiQ as the organisation taking care of all logistics. But more than that, the possibility of doing real business was very high. For example, 91% of exhibitors at Distributech said that the business meetings met or exceeded their expectations. Regarding the number of leads developed at Distributech, 14% of exhibitors estimated it was between 1 and 3, 29% between 4 and 10, and 40% at 11 or more.

Distributech was epiQ's first event. But its success led to other ambitions. In July, we plan to attend Hydrovision. Our three-year business plan prioritizes trade show organization. Strictly speaking, we have no limit, but we have clearly paid particular attention to Distributech, Hydrovision, CIGRE, IEEE and TD World. The epiQ has great hopes for epiQ. For the Association, epiQ is a way to help its member companies with business development. It is a concrete project that will focus its activities on business meetings between work providers and the suppliers of products and services in the electric power industry of Québec. ■

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La Romaine-2
Source: Hydro-Québec

La Romaine hydroelectric complex

Québec, Canada

La Romaine is considered the biggest hydroelectric construction project underway in Canada and will have an estimated total installed capacity of 1,550 MW.

AECOM provided preliminary and detailed engineering services to Hydro-Quebec for Romaine-2. For La Romaine-1, -3 and -4, AECOM provides detailed engineering.

Construction started in 2009 and will be completed in 2020.

New Post Creek
Powerhouse site

New Post Creek hydroelectric development

Ontario, Canada

The project consists in the construction of a 28 MW powerhouse with an embankment dam.

AECOM's service include the preparation of an optimal design for all project components during the front-end engineering phase, as well as detailed design and technical support during construction phase.

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Industry Snapshot

By François Toussaint
Analyst at epiQ

The electric industry in Quebec is a world leader in the construction of large hydropower plants, transmission lines, often over long distances, and efficient and reliable power stations. With an installed capacity in Quebec of over 40,000 MW of hydropower (Hydro-Québec, Rio Tinto Alcan, Brookfield Renewable Energy, etc.), nearly 3,500 MW of wind energy, 34,000 km of transmission line and 530 substations[1], Quebec's electric industry has built a solid reputation.

The electric industry in Quebec represents:

- **500 companies**
- **8000 suppliers**
- **37000 jobs in Quebec**
- **Exports of nearly 3 billion Canadian dollars**
- **A major participation in electricity projects realized throughout Canada**

[1] Hydro-Québec, 2014 Annual Report, p. 2

The Quebec electric industry represents a real value chain consisting of 7 principal links (electricity producers, transporters and distributers, electricity consumers, product and service suppliers, and research and training institutions).

It is the massive development of production, transport and distribution of electricity infrastructure that helped this important economic sector grow in Quebec. As a matter of fact, the vast majority of Quebec electricity companies participated in the realization of these infrastructures.

With 36,643 MW of hydropower capacity installed in 2014[2], Hydro-Québec, by itself, is one of the largest producers of electricity worldwide.

Since the early 2000s, the company has significantly increased its hydropower capacity and several plants were built (Ste-Marguerite, Rapide-des-Cœur, Peribonka, Eastmain, Eastmain 1-A-Sarcelle- Rupert and the La Romaine complex). This is over 4,000 MW of new hydro capacity that was added to the Hydro-Québec production facilities[3]. These new installations enabled the electric industry to sustain its leadership in the renewable energy sector.

Added to this are nearly 3,500 MW of wind power in the same period.[4]

The electric industry products and services of Quebec companies are of interest for many other work providers - American, European, international. Since 2010, export sales of the manufacturing sector experienced a sharp increase from just over $2 billion Canadian dollars in 2010 to almost $3 billion in 2014. [5]

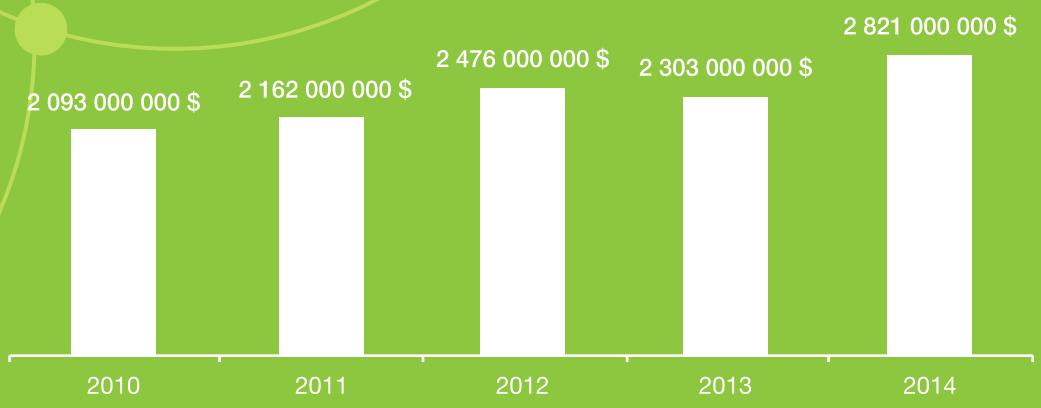
[2] Ibid.

[3] Hydro-Québec, 2009-2013 Strategic Plan, p. 19

[4] Ibid.

[5] All statistics concerning exports in this article come from Industry Canada. They come from the Trade Data Online software: http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/home.

Exports of the manufacturing sector of the Québec electric industry
Total and Total % for the major countries (NAICS 3336, 3353 et 3359 grouped
During the last 5 years - in current Canadian Dollars



Source : Industrie Canada

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EBC is a construction company that has the advantage of being both diversified and specialized. EBC's project teams works to achieve our ultimate goal of ensuring our worker's safety and our client's satisfaction.

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You can count on EBC and its subsidiary, GLR, for the construction of aerial power transmission lines or any electrical installation work.

For construction and reconstruction of roads, bridges, overpasses, tunnels and municipal services (water and sewage), EBC is your ideal partner.

For wind farm projects, EBC executes all types of works from construction of concrete foundations, access roads, substations and underground collector networks, to the assembly and installation of wind turbines.

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Exports of the manufacturing sector of the Québec electric industry
Total and Total % for the major countries (NAICS 3336, 3353 et 3359 grouped
During the last 5 years - in current Canadian Dollars

	2010	2011	2012	2013	2014	%
United States	$124,709,000	$1,263,688,000	$1,340,653000	$1,275,003,000	$1,530,063,000	54%
France	$92,179,000	$122,660,000	$195,245,000	$211,352,000	$219,749,000	8%
Germany	$95,638,000	$127,950,000	$135,801,000	$96,073,000	$135,591,000	5%
China	$60,461,000	$102,843,000	$86,347,000	$115,085,000	$126,024,000	4%
Italy	$64,067,000	$84,423,000	$99,729,000	$88,201,000	$90,440,000	3%
Brazil	$23,837,000	$48,170,000	$59,889,000	$48,394,000	$68,638,000	2%
Singapore	$29,970,000	$36,210,000	$48,117,000	$5,865,000	$62,974,000	2%
Spain	$23,611,000	$12,141,000	$31,549,000	$40,648,000	$53,855,000	2%
Qatar	$1,651,000	$2,952,000	$3,041,000	$3,553,000	$49,638,000	2%
United Kingdom	$127,197,000	$99,740,000	$73,882,000	$34,646,000	$40,820,000	1%
Sub-Total	$1,765,704,000	$1,900,778,000	$2,074,254,000	$1,971,598,000	$2,377,794,000	84%
Others	$328,076,000	$261,254,000	$402,654,000	$331,826,000	$444,050,000	16%
Total (All countries)	$2,093,780,000	$2,162,032,000	$2,476,908,000	$2,303,424,000	$2,821,844,000	100%

Source : Industry Canada, Trade Data, research by industry – NAICS 3336, 3553 and 3359,
Total per country – 10 major countries

The main electrical products sold for export by Quebec companies are the following:

Total exports of the manufacturing sector of the Quebec electric industry (by individual product) - for 2014 - Canadian dollars	
	2014
Towers and lattice masts, in cast iron, iron or steel	$7 840 995
Structures and parts of structures of towers and lattice masts (or prefabricated) in aluminum	$73 588 854
Turbines and francis runners	$1 300 000 000
Gas turbines and parts of gas turbines with power below and above 500 kilowatts but not more than 5000 kilowatts, NDA	$898 697 783
Electrical transformers, static electric converter	$119 911 942
Electrical capacitors	$7 541 574
Wires, cables and other insulated electric conductors	$130 000 000
Electrical apparatus for disconnecting electrical circuits	$88 000 000
Monitoring stations for electrical command and distribution	$167 725 058
Total	**$2 793 308 220**

Source : Industrie Canada , Données sur le commerce direct, recherche par produit pour l'année 2014

EACH OF THE QUEBEC ELECTRIC INDUSTRY COMPANIES PROVIDES CUSTOMERS WITH A HIGHLY COMPETITIVE SOLUTION WITH A PROVEN LONG-TERM COMMITMENT FOR SUCCESS.

THE STRENGTHS OF QUEBEC'S ELECTRIC INDUSTRY:

1

ONE OF THE WORLD'S GREATEST HYDROELECTRIC, VERY LONG DISTANCE, AND HIGH VOLTAGE ELECTRICAL ENERGY TRANSMISSION INDUSTRIES

Quebec is one of the largest power generators in North America.

Hydro-Québec alone has an installed capacity of 36,500 MW. These hydroelectric facilities include 62 power plants and 27 large reservoirs with a storage capacity of 176 TWh.

Hydro-Québec also operates a network of more than 34,000 km of transmission lines, 530 substations and 15 interconnections.

2

AN ALMOST UNIQUE CONCENTRATION OF CAPABILITIES

- 500 companies
- 8,000 suppliers

Every sub-sector of the electrical industry is represented in Quebec and a wide variety of products and services is created all along the value chain.

3

A PRESENCE IN MORE THAN 180 COUNTRIES

The main markets are Canada, the United States (Texas, Pennsylvania, Florida, West Virginia, New York, New England) and Europe (France, the United Kingdom and Italy).

4

A HIGHLY SKILLED WORKFORCE

The Quebec electrical industry has 37,000 highly skilled workers in more than 500 companies.

Most of these professionals are engineers, technologists, electricians and biologists who are trained in Quebec universities and colleges.

5

A VERY COMPETITIVE AGGREGATE SUPPLY (PRICE-SERVICE-QUALITY-INNOVATION)

Hydro-Québec's standards for selecting and monitoring suppliers are some of the most stringent in the world. These requirements refer to price, quality and service. The electric industry also has a global understanding of all factors affecting the production, transmission and distribution of electricity.

6

A STRONG CAPACITY FOR INNOVATION

The expertise and innovation of the Quebec electrical industry center on five major niche markets:

- major hydropower plants (design and refurbishment);
- high-performance equipment built to withstand extreme climatic conditions;
- the integration of renewable energy into the transmission network;
- demand restraint;
- the automation of the transmission network and power stations (network simulation software, SCADA, etc.).

7

A FOREIGN SECTOR PRESENCE THAT CONTRIBUTES TO INTERNATIONAL EXPERTISE AND INFLUENCE

The subsidiaries of foreign electricity companies contribute significantly to economic development. In addition to investments made in Quebec, companies such as ABB, Alstom, Voith, Schneider Electric and Siemens are developing other markets from inside Quebec. The presence of major equipment suppliers also helps forge partnerships with Quebec companies.

8

RESEARCH INSTITUTIONS THAT FOSTER INNOVATION

Quebec has 24 energy institutes and research centres, 11 universities and 40 colleges. The Institut de recherche en énergie d'Hydro-Québec (IREQ) alone has a budget of more than $100 million per year. The research projects developed at the IREQ cover various technologies, including batteries for electric vehicles, energy storage, smart grids, etc.

9

AN INDUSTRY CONCERNED ABOUT GREENHOUSE GASES

Over the years, Quebec has made significant investments in sources of clean and renewable energy, mainly hydroelectricity and wind energy. As a result, 98% of power is generated from renewable sources. It represents only 0.5% of GHG emissions in Québec.

Furthermore, the Québec electric industry is known for offering "green" solutions that help reduce greenhouse gases.

10

THE GREATER MONTRÉAL AREA THE GATEWAY TO AMERICA

- less than an hour by car from the US border;
- less than an hour by air from Boston and New York;
- an intermodal transport hub: air, sea, road and rail.

The coming years will be part of a new economy based on the reduction of GHG emissions, with the goal of reducing consumption of thermal energy. Countries that quickly transition towards an economy with low GHG emissions will gain a distinct competitive edge. Quebec's electric industry has a considerable advantage in this race. More than four decades of electrical infrastructure achievements have enabled Quebec to emerge as a world power in the production of renewable energy. It has also fostered the development of "green" technologies, including the only ecological expertise of its kind in the world.

It is by building on this advantage that, in 2015, the government of Quebec set the goal of reducing its GHG emissions by 37.5% by 2030 compared to 1990 levels. Meeting this target will require the development of many low carbon energy technologies. And the companies of the Quebec electric industry will be the first to develop new and innovative solutions to help the government achieve its goal. ■

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High Power Laboratory
Aging Test & Short-Circuit

Insulated Gloves Test Laboratory

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IREQ: global technology leader and dynamic innovation hub

IREQ, Hydro-Québec's research institute, was established in 1970, at a time of ambitious hydroelectric generation and 735-kV transmission projects. It soon made a name for itself with its discoveries, know-how and innovation. IREQ has played a key role in tackling the challenges that stem from the complexity and special features of Québec's power grid; it has also opened up new markets for the company and generated wealth for Québec society by developing cutting-edge technologies and attracting the best minds from around the world to work here. Today, IREQ remains at the heart of the strategic issues facing Hydro-Québec and continues to innovate in support of the company's operations and future growth.

Source: Hydro-Québec archives

WORLD-CLASS RESEARCH CENTRE

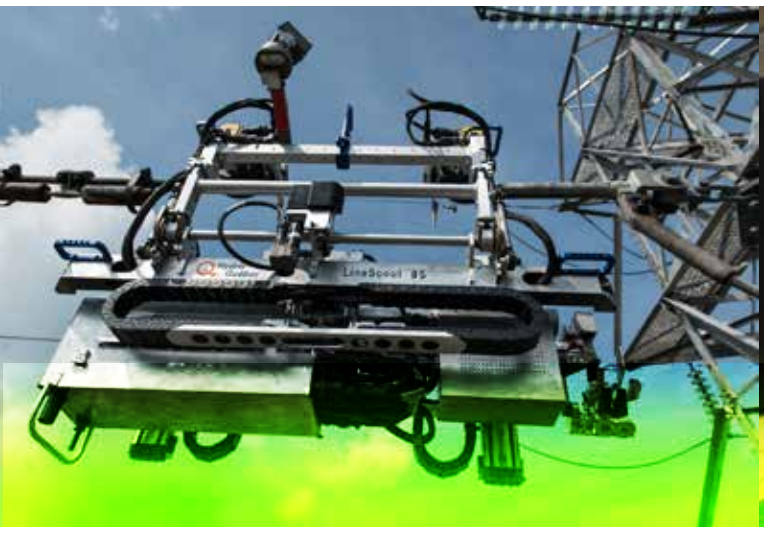
A world-class research centre in its own right, IREQ brings together a rich pool of top-notch scientists, engineers, technicians and specialists to leverage their knowledge in the following areas:

- Smart grids and big data processing
- Power system performance and long-term operability
- New customer services
- Renewable energy
- Battery materials and electric transportation
- Robotics for power system maintenance

By applying their knowledge to the development of advanced technologies, they support every facet of Hydro-Québec's operations, from power generation to customer service. In addition, they help the company grow through technology commercialization or joint ventures.

Examples high-performance methods and technologies developed:

- **PREDDIT, a tool for turbine damage prediction and integrated diagnostics** – PREDDIT measures turbine stress and improves our understanding of the root causes of turbine degradation, including cracking and cavitation. Measurement results have confirmed that it is possible to decrease the risk of damage by modifying generating unit startup procedures. Improvements to operating procedures and repair methods help to extend turbine service life by several years, thus reducing production costs.
- **HYPERSIM simulator** – Developed at IREQ, this simulator offers the most efficient open simulation architecture on the market, leading to optimized power system operation and better system development and design. HYPERSIM can simulate a transmission system and interface it with control systems ranging from the most simple to the most complex. IREQ continues to perfect this tool through partnerships.



Source: Hydro-Québec archives

Chief executive of Hydro-Québec's research institute since June 2015, Jérôme Gosset believes passionately in technological innovation; he has an extremely clear vision of the role that IREQ must play within both Hydro-Québec and Québec society. After graduating from École Polytechnique and Corps des Mines (France) in engineering, Jérôme earned a PhD in the field of plasma physics. He then held various management positions within French research organizations and businesses focused on energy. Leveraging IREQ's solid foundations and pool of expertise, Jérôme is setting far-reaching goals for the institute. He aims to turn it into a global technological leader, a dynamic innovation hub and a source of, not only for the company but for Québec as a whole.

Jérôme Gosset
General Manager of IREQ

Source: Hydro-Québec archives

- Building on improvements in measurement and information technologies, the **intelligent power line maintenance system** (MILE) can not only pinpoint faults before an outage occurs but can even determine their probable cause. This advanced power line maintenance tool helps to improve the quality and continuity of electrical service.
- In Québec, electricity use peaks during the winter. For this reason, Hydro-Québec is constantly seeking effective ways to reduce peak demand without sacrificing customer comfort. Our energy technology laboratory (LTE) has developed a **system that ensures closer modulation of building HVAC systems**. It is currently being deployed in several Hydro-Québec buildings and by some of its commercial and institutional customers.

OVERVIEW OF IREQ

- Two research facilities:
  - The main research institute (IREQ) in Varennes, a few kilometres outside Montréal
  - The energy technology laboratory (LTE) in Shawinigan
- World leader in battery materials innovation
- Cutting-edge expertise in robotics for power system maintenance
- Approximately 500 employees
- Annual budget over $100 million
- Some 100 ongoing projects
- Over 250 partnerships
- 1,100 patents
- Thousands of scientific papers
- National and international prizes and awards

MEN AND WOMEN OF SCIENCE

Ashok Vijh, a pillar of the research institute – Not only did Ashok witness the birth of IREQ from a front-row seat, he also played a key role in the process. For over 45 years, the work of this renowned scientist, who earned his PhD in electrochemistry, has helped turn the institute into a world-renowned research and development hub. His groundbreaking discoveries have revolutionized chemical engineering, engineering physics and electrical engineering. In fact, he has presided over the Royal Society of Canada's Academy of Science. This great researcher, who has received over forty prestigious awards, medals and distinctions, continues to pursue his calling with unabated passion. In addition to his projects, he dedicates a significant portion of his time to mentoring the next generation of researchers.

IREQ researcher Anne-Marie Giroux receives award from the Right Honorable David Johnston, Governor General of Canada.

On February 17, 2016, the Natural Sciences and Engineering Research Council of Canada (NSERC) awarded one of its prestigious Synergy Awards for Innovation to the Consortium on Hydraulic Machines, of which Hydro-Québec is a member. Anne-Marie Giroux received the award on the behalf of Hydro-Québec and the research team (Martin Beaudoin, Samuel Cupillard, Geneviève Gauthier, Paul Labbé, Robert Magnan, Luc Marcouiller, Arezki Merkhouf, Jean-François Morissette, Jonathan Nicolle and Maryse Page). Created in 2007 at Laval University, the Consortium has become a major global centre for research on turbines and a centre of expertise focused on the study of hydroelectric equipment.

Technicians at the energy storage laboratory (LSE) make a few adjustments to the automatic stacker used to make lithium-ion batteries.

Source: Hydro-Québec archives

In addition to its innovative work to improve the electric grid, IREQ is developing highly advanced technologies and fresh market niches with significant growth potential. Battery materials and robotics are two examples of this work.

World leader in battery materials

IREQ has become a world leader in the development of battery materials for electric vehicle and grid storage applications, thanks to its solid expertise in battery materials, its unique facilities that enable advanced work in this field, its considerable IP portfolio and its many international partners. IREQ's work in this area attracts worldwide attention and has drawn major players in the field to Québec, where they are striving to develop the technologies and facilities of the future. Technologies Esstalion, a joint venture of Hydro-Québec and Sony focused on large-capacity energy storage, was made possible by the breakthroughs achieved by IREQ in battery material technologies.

Forging the way in robotics for power system maintenance

Over the years, IREQ's expertise in robotics has led to several pioneering developments whose quality, efficiency and relevance have been demonstrated on Hydro-Québec's system as well as on other utilities' grids. The LineScout live-line inspection robot is an example of cutting-edge robotics that has attracted worldwide interest from industry and paved the way for various partnering agreements for the use and sale of the technology, thus generating significant spinoffs for the company. In fact, a new Hydro-Québec subsidiary, MIR Innovation, focuses on commercializing our technologies and know-how in robotics for the inspection and maintenance of power generation and transmission facilities.

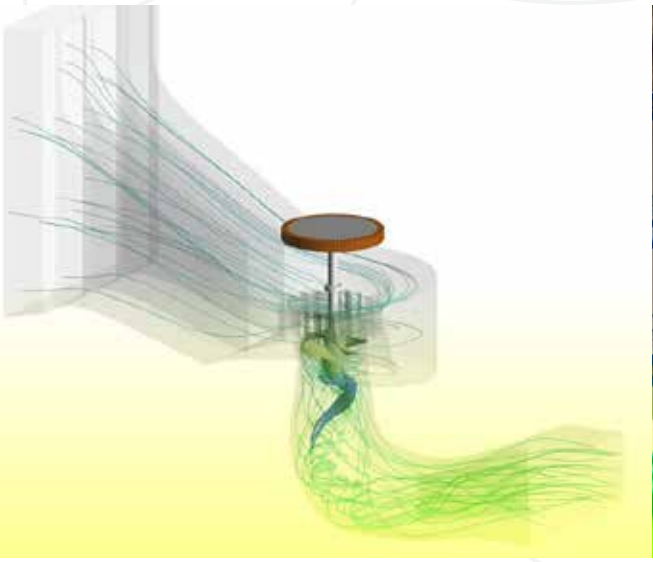
State-of-the-art facilities

To support the development of innovative technologies and promising niches, IREQ relies on unique facilities that allow analysis, testing and demonstration of ideas and equipment under a wide range of conditions. These highly specialized facilities, which are available to our partners and customers, are significant assets; they include:

- Electrical equipment test laboratories
- Overhead and underground distribution and transmission test lines
- The power system simulation laboratory, including the HYPERSIM simulator and a high-performance computing centre
- The robotics test laboratory
- The energy storage laboratory (LSE)

Two researchers work on the development of tools for estimating electrical equipment service life

Source: Hydro-Québec archives



A DYNAMIC BUSINESS PARTNER

IREQ has access to a vast global network of scientists and partners to develop and commercialize its technologies. This partnership-based approach allows it collaborate with key industry and R&D players around the world, thus showcasing Québec's technological know-how on an international scale. Through this approach, IREQ seeks to share resources and risks, benefit from complementary expertise, pool ideas, designs and know-how, and accelerate the development process, all the while ensuring access to markets. Today, IREQ can rely on more than 250 solid partnerships to develop the technologies that Hydro-Québec and Québec society will require in the future. Dynamic collaborative R&D drives growth!

Through university chairs and research contracts awarded to Québec universities, IREQ initiates and drives research focused on the issues and challenges facing the power industry. Such collaborations support some 200 students every year, increase scientific knowledge and provide highly skilled jobs for the benefit of all Québec society.

IREQ: RENEWED PROSPECTS

For over 45 years, Hydro-Québec has utilized its research institute to ensure its technological and commercial development. As new challenges in the power industry give rise to new opportunities linked to evolving technologies, markets, services and customer requirements, Hydro-Québec relies more than ever on IREQ to make a difference, create value through innovation and drive growth for the company and for Québec as a whole.

To fulfill this mission, IREQ focuses its efforts on:

- generating promising ideas and innovations through projects and intellectual frameworks that significantly enhance its ability to innovate and create value
- innovating in new ways by integrating all aspects of business models, applications and customers, as well as the commercialization of new products or services
- defining far-reaching strategies for scientific research focused on high-impact projects in promising areas

SAfter nearly half a century of success in R&D, IREQ is moving onward as a global technology leader and dynamic innovation hub. ■

Source: Hydro-Québec archives

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The history of electricity in Quebec

The beginnings of electrification were marked by intense competition between electricity and gas suppliers. In Montreal, the Royal Electric Company quickly establishes itself and obtains, in 1889, the public lighting contract for the entire city. This picture depicts the Dowd Street electrical apparatus plant in 1895.

Source: Hydro-Québec archives

By André Bolduc
Economist, journalist and specialist of the history of electricity in Quebec

The history of electricity in Québec began in the late 19th century. Originally the domain of numerous private companies, it took a new direction with their subsequent nationalization.

Chronology

1878-1897 – THE EARLY YEARS

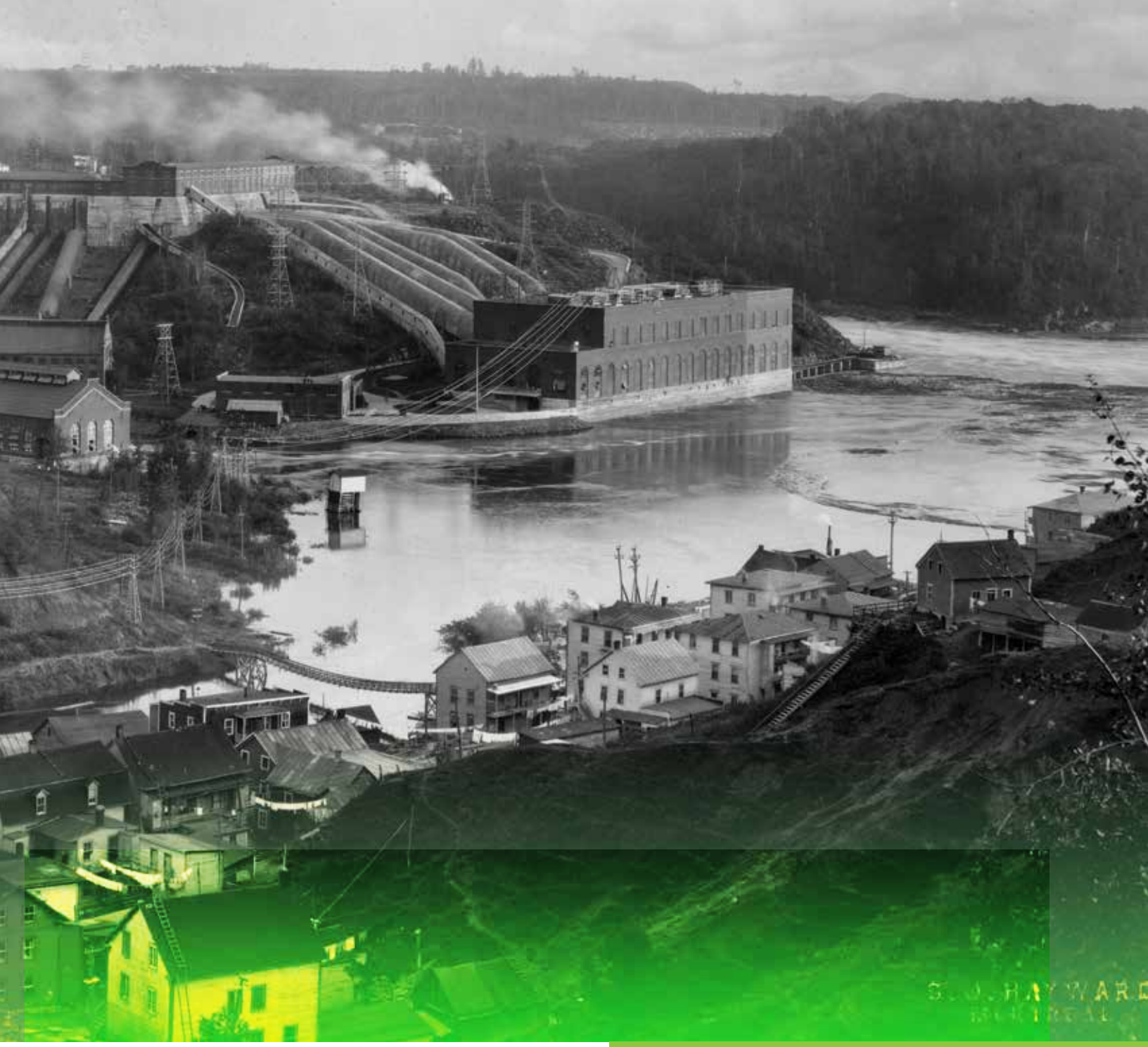
The Paris World Fair of 1878 showed the world a new way of creating light: with electricity. In Québec and around the world, fierce competition between gas and electric lighting took off immediately. Fledgling electric utilities vied with one another for street lighting contracts in an effort to establish a profitable distribution system as quickly as possible. Among the hundreds of companies that sprang up, only a few survived, and these formed powerful local monopolies. In Montréal, the Montreal Light, Heat and Power Company eliminated all its competitors, while elsewhere in Québec, the Shawinigan Water and Power Company laid the cornerstone of a vast industrial complex by harnessing the Rivière Saint-Maurice. Abundant water resources made hydropower a logical choice, and this choice had a decisive effect on industrialization in Québec and on the use of its timber and mineral resources.

On May 16, Craig conducted a public demonstration of the arc lamp in Montréal, this time at the Champ-de-Mars, the military parade ground. According to the following day's edition of the newspaper La Minerve, several thousand spectators expressed their satisfaction. The most enthusiastic described the lamp as a "midnight sun", and others spoke of it as an invention that would revolutionize their way of life.

The competition between gas and electric street lighting was as fierce in other parts of the province as in Montréal. On September 30, the Quebec & Levis Electric Light Company pulled off an impressive publicity coup by lighting Dufferin Terrace in Québec with 34 arc lamps, to the amazement of the numerous dignitaries and hundreds of spectators assembled for the event. The lamps were powered from Montmorency Falls generating station over a line some 30 kilometres long—a feat never before achieved in North America.

1898-1929 – CORPORATE CONSOLIDATIONS AND BIG PROJECTS

In the 1920s, over 80 generating stations sprouted along Québec's waterways, leading to a fivefold increase in power generation. Hundreds of electric utilities sprang up, but only a few survived and gave rise to powerful regional monopolies. In Montréal, the Montreal Light, Heat and Power Company soon eliminated all its competitors, while in the Mauricie region, the Shawinigan Water and Power Company laid the cornerstone of a vast industrial complex by harnessing the Rivière Saint-Maurice.



In 1898, American promoters obtained letters patent for the Shawinigan Water and Power Company. This link will open a new window., enabling Boston financier J.E. Aldred. to lay the foundations of a company that would become one of the most diversified industrial empires in Québec in the first half of the 20th century. A young engineer from Boston, Julian C. Smith, was credited with the remarkable concept for developing the Rivière Saint-Maurice. This technical triumph was the keystone of Shawinigan Water and Power's financial success.

The beginnings of electrification were marked by intense competition between electricity and gas suppliers. In Montreal, the Royal Electric Company quickly establishes itself and obtains, in 1889, the public lighting contract for the entire city. This picture depicts the Dowd Street electrical apparatus plant in 1895.

Source: Hydro-Québec archives

In 1901, the merger of the Montreal Gas Company and the Royal Electric Company was the brainchild of Herbert Samuel Holt. Holt laid the groundwork for what would become the vast industrial and financial empire of Montreal Light, Heat and Power Company (MLH&P). Faced with the immense potential for expansion offered by the electricity market, Holt succeeded in bringing together traditional competitors: gas and electricity. Arrogantly monopolistic, Montreal Light, Heat and Power consistently refused any form of collaboration with commissions of inquiry and agencies set up by the government to try to regulate the sale of electricity.

At the turn of the 20th century, a strong trend toward municipal ownership of electricity distribution systems was taking shape in Ontario. At the outset, the organizational model was simple: electricity generation was left to the private sector, transmission was handled by the Commission, and distribution was the responsibility of the municipalities. The “Ontario Model” found supporters in Québec, where a number of towns and cities chose to place the electrical services in their territory under municipal control.

In 1922, two renowned industrialists and financiers, William Price and James Duke, launched a joint project to build a powerful hydroelectric generating station on Île Maligne, at the headwaters of the Rivière Saguenay, which would meet the needs of their own pulp and paper mills and also provide power for the aluminum smelter that had just located in the region.

In 1926 at the initiative of the Canadian International Paper Co., Gatineau Power Company was formed to build and operate generating stations on the Gatineau and Ottawa rivers.

On April 15, 1944, T.-D. Bouchard, President of the Commission hydroélectrique de Québec, and the commissioners Georges C. McDonald, Raymond Latreille, L.-E. Potvin and John McCammon, take possession of the Power Building, the day after the nationalization of the Montreal Light, Heat and Power Consolidated.

Source: Hydro-Québec archives

1930-1944 – TOWARD NATIONALIZATION

The Great Depression of the 1930s shook North America to its roots. Industry slowed to a snail's pace and unemployment became chronic. Objections to electric utility practices became increasingly vigorous. The Liberal government of Alexandre Taschereau was forced to take action. Taschereau formed a commission of inquiry: the Lapointe Commission, which filed its report a year later. The report criticized certain practices of the electric utilities, but did not come out in favor of nationalization. Instead, it recommended the establishment of a provincial electricity commission to regulate all aspects of the power industry.

The Lapointe Commission's recommendations gave rise to a succession of regulatory bodies that failed to have much of an effect. Montreal Light, Heat and Power consistently refused to open its books. Télesphore-Damien Bouchard, an influential minister in Adélard Godbout's government, demanded its outright nationalization. Defiant, the monopoly conducted a virulent advertising campaign denouncing government intentions to expropriate its assets. Despite wartime problems and the incessant criticism directed against him, particularly in the business press, Godbout took action.

On Friday, April 14, after the Stock Exchange closed, the Liberal government of Adélard Godbout passed the Act to Establish the Québec Hydro-Electric Commission (or Hydro-Québec Act). This law provided for expropriation of all the gas and electricity production, transmission and distribution assets belonging to Montreal Light, Heat and Power Consolidated and its subsidiaries Montreal Island Power and Beauharnois Light, Heat & Power. The new provincial corporation, Hydro-Québec, inherited a gas distribution system and four hydroelectric generating stations: Chambly, Les Cèdres, Rivière-des-Prairies and Beauharnois.

Extract from *Le progress à la ferme* newspaper of 1953.
Source: Hydro-Québec archives

1945-1959 – HYDRO-QUÉBEC'S FIRST TRIUMPHS

On May 24, under Premier Maurice Duplessis, the Rural Electrification Act was passed. Less interventionist than his predecessor, Adélard Godbout, who had entrusted electrification to Hydro-Québec, Duplessis preferred to leave it up to the local communities to bring electric power to Québec's less densely populated regions, which were markets that held little appeal for private enterprise.

Hydro-Québec undertook to develop the Rivière Betsiamites (also called Bersimis) in the Côte-Nord region. This was a good chance for the company to learn about managing projects at remote work sites

and acquire expertise in transmitting large quantities of energy over long distances; the distance to the Montréal market was over 600 kilometres. Hydro-Québec became one of the first electric utilities in the world to use 315-kV transmission lines. A remarkable undertaking for the time, the overhead 315-kV transmission lines crossed the Rivière Saguenay along a 1.6-km stretch.

The belated electrification of the Gaspé peninsula and the Bas-Saint-Laurent region was carried out under the aegis of the Compagnie de Pouvoir du Bas-Saint-Laurent. Mitis-1 and Mitis-2 did not have enough generating capacity to power the industrialization of the region. At the government's request, Hydro-Québec laid an underwater cable between the Manicouagan peninsula and the village of Les Boules in the Gaspé region. This link allowed access to energy from the Côte-Nord region, but proved so unreliable that a backup thermal power plant had to be built. Subsequently, transmission lines were erected from Lévis to Gaspé to meet the region's electricity needs.

In the fall of 1959, Hydro-Québec announced the start of development of the Manicouagan and Outardes rivers in the Côte-Nord region (north shore of the Saint-Laurent). This huge undertaking would require the utility to perform a series of technological feats in the course of taming these northern rivers and transmitting high volumes of energy over several hundred kilometres to supply major consumer markets in the Québec and Montréal metropolitan regions.

By the start of the 1960s, Hydro-Québec possessed enviable expertise in the generation, transmission and distribution of electric power. Since its beginnings, the company had expanded continuously without depending on government resources or needing to increase its rates. It was well positioned to take on a broader mandate. Hydro-Québec's successes soon made it a symbol of the Quiet Revolution and earned it an international reputation.

1960-1979 – THE SECOND NATIONALIZATION

After the Liberal government of Jean Lesage came to power in June 1960, it gave Hydro-Québec an exclusive mandate to develop and operate hydropower sites not yet under concession to private interests. Supervision of the work at Carillon, a state-of-the-art hydro project on the lower Rivière des Outaouais (Ottawa River), was assigned to French-speaking Hydro-Québec engineers. Francization was moving forward at the corporation's head office and all its work sites. Carillon was also the project that confirmed Hydro-Québec's policy of outsourcing its engineering needs, which spurred the creation and expansion of Québec-based consulting engineering firms.

Begun the previous fall, work continued on the Manicouagan and Outardes. rivers, site of the most ambitious hydroelectric complex ever undertaken in Canada. The project gave rise to technical feats and world firsts that immediately raised Hydro-Québec's international profile. On the initiative of a young engineer, Jean-Jacques Archambault., Hydro-Québec made a critical technological breakthrough in the long-distance transmission of large quantities of electricity by raising the voltage to a record level of 735 kV. At lower voltages, transmission losses would have been sizable and many more lines would have been required.

On February 12, René Lévesque, then provincial Minister of Natural Resources, delivered a speech inaugurating National Electrical Week. To an audience that included executives of private electricity companies, he concluded that Hydro-Québec should be made responsible for the effective, orderly development of water resources and establishing uniform electricity rates throughout Québec.

Hydro-Québec, through successful takeover bids, acquired the private electricity distributors. As anticipated, the total cost of this second phase of nationalization was $604 million. Hydro-Québec took over the $250 million worth of bonds issued by the private companies. It recovered a little more than $50 million from the resale of assets unrelated to electric power. To reimburse the shareholders of the companies it acquired, Hydro-Québec sold $300 million in bonds on the American market. At the request of the American government, payment of the loan was spread over a period of more than a year, as a cushion against sudden changes in the exchange rate. The fact that Hydro-Québec consistently played by the rules while conducting this vast operation earned the new utility an enviable reputation in financial circles.

At the instigation of Lionel Boulet, Hydro-Québec decided to set up a world-class institute for research on electricity: the Institut de recherche en electricité du Québec (IREQ). Built at Varennes, where several 735-kV lines converge, IREQ initially consisted of about 60 general laboratories and one immense specialized laboratory, unique in the world, which was equipped to conduct experiments on high-voltage transmission and thereby provide the research to support Hydro-Québec's high-voltage grid. IREQ opened its doors to university researchers and equipment manufacturers, who collaborated with Hydro-Québec engineers to develop the many complex components required by a 735-kV transmission system.

Alluvial furrow in the Manicouagan River bed on the Manic-5 dam site (now known as Daniel-Johnson) around 1960.

Source: Hydro-Québec archives

At the onset of the 1970s, a work site of unimaginable proportions; a territory two-thirds the size of France, covering 350,000 km2; and the Grande Rivière, located 1,000 kilometres north of Montréal, surrounded by taiga and flowing over 800 kilometres from east to west. A logistical conundrum How to transport, within a reasonable time frame, all the machinery, materials and goods required to complete such a vast project? How to provide the workers with a minimum of comfort? The harsh climate had to be taken into account, as winters in the Baie-James region are long and cold. And the work site, because of its enormous size, posed all sorts of challenges: financing, concern for the environment, techniques for building in harsh surroundings, workers' living conditions, and relations with Aboriginal people were among the issues that had to be addressed. Premier Robert Bourassa. launched "the project of the century" in April 1971.

The "project of the century", which took 25 years (1971-1996) to complete, had an eventful history in many respects.

- **Access to the work site**

At first, a winter road and ice runways were used to bring in the materials required to start up the enormous work site. Later, a permanent road linking Baie-James to cities in southern Québec was built.

- **Management**

Excluded at first from managing the project, Hydro-Québec had to insist on becoming the majority shareholder in Société d'énergie de la Baie James (SEBJ), a corporation created to oversee development of the Baie-James region's hydroelectric potential. SEBJ became a wholly owned subsidiary of Hydro-Québec in 1978. Since then, it has been in charge of managing major construction projects for Hydro-Québec, both within Québec and abroad.

One year prior to the second nationalization, Jean Lesage, René Lévesque and Jean-Claude Lessard inaugurate the new Hydro-Québec Head Office located on Dorchester Boulevard in Montreal.

Source: Hydro-Québec archives

- **The environnement**

By virtue of its size, the project attracted the attention of ecologists here and all over the world. SEJB was careful to take environmental considerations into account, starting at the project planning stage. Later, mitigation measures of unprecedented scope were implemented to preserve the region's ecosystems. From an environmental standpoint, the thoroughness of the impact assessments conducted during construction made Baie-James one of the most closely studied regions on the face of the earth.

- **Relations with Aboriginal people**

Only after long negotiations did the Cree and Inuit agree to the development of the rivers emptying into Baie James. They did so by signing the Baie James and Northern Québec Agreement until 1975.

Signature of the James Bay and Northern Quebec Agreement in 1975.

Source: Hydro-Québec archives

1980-1996 – A TIME OF UNCERTAINTY

The recession of the ‘80s hits the industrial sector and, in turn, the energy sector with full force. As a result, Québec loses tens of thousands of manufacturing jobs; numerous companies declare bankruptcy while others are forced to drastically cut production. This is the economic backdrop against which Hydro-Québec must plan the province’s energy demand for the next twenty years. This unfavorable context forces Hydro-Québec to postpone phase two of the Baie-James project.

In March 1987, the Société d’énergie de la Baie James (SEBJ) began the second phase of the La Grande complex in the Baie-James region. The work took nine years to complete and led to the commissioning of five generating stations: La Grande-2A, Laforge-1, La Grande-1, Brisay and Laforge-2, making La Grande the most powerful hydroelectric complex in the world. La Grande was the site of many technological innovations, particularly related to construction techniques in a hostile environment. The complex contributes in large measure to Québec’s enviable supply of electricity, 97% of which is renewable and non-polluting.

Also in 1987, Hydro-Québec inaugurated its electrochemical and electrotechnologies laboratory (LTEE) in Shawinigan. The mission of this new research centre was to support the development of industrial applications for electricity, especially in mining, metallurgy, textiles, agri-food, chemicals, lumber, plastic and rubber. It provides facilities for Canadian companies to test concepts and to perfect and demonstrate electrical technologies and processes. In May 2002, its name became Laboratoire des technologies de l’énergie (LTE – Hydro-Québec’s energy technologies laboratory).

1997-… – RENEWED GROWTH

As of 1992, economic growth in the U.S. and Québec is in full swing. Hydropower development is back on the agenda.

To reciprocate with other North American energy producers, Hydro-Québec opened its transmission system and wholesale electricity market to competition. A new division, Hydro-Québec TransÉnergie, was created to provide non-discriminatory access to Québec's transmission grid. The U.S. Federal Energy Regulatory Commission (FERC) granted a subsidiary of Hydro-Québec, Hydro-Québec Energy Services (U.S.), a licence to sell wholesale electricity at market prices.

In the early '2000s, phase three of the Baie-James project is back on the agenda.. On February 7, the Québec government and the Grand Council of the Crees signed a historic agreement which marked the beginning of a new era of mutual respect and cooperation. The agreement also paved the way for the construction of Eastmain-1 and Eastmain-1-A generating stations and for partial diversion of the Rivière Rupert became operational respectively in 2006 and 2012. Total capacity of the La Grande complex reaches 17,418 MW.

Hydro-Québec Distribution, the first call for tenders

On March 26 and 27, Hydro-Québec Distribution put out its first call for tenders for electricity supply, with deliveries to start in 2006. Hydro-Québec Distribution estimates that by that year it will require 1,200 megawatts to meet the energy needs of its Québec customers. The division also stated its intention to issue a call for tenders for a total of 1,000 megawatts of power generated by wind farms over the next ten years.

Hydropower development has been around for over a century. Industry promoters initially establish themselves near urban consumption centres thereby attracting energy-intensive companies near more profitable hydroelectric developments. Throughout the 20th century, high-voltage power transmission becomes increasingly essential, since strong-flowing rivers with sufficient drop heights are farther and farther away. At the dawn of the 20th century, Hydro-Québec and its partners progressively turn their focus to renewable energies, maintaining transmission and distribution systems while constantly innovating in order to better meet Québec's energy needs. ■

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The future of energy: five visions

We asked students of ETS to share their vision on the energy.
Here is what our emerging professionals had to say…

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énergieÉTS

By David Herzog
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A new energy model

Currently, 85% of the energy consumed in the world is fossil-based. Regarding electricity production, 78% is from a non-renewable source (Source: AIE). This shows that our society is based on resources that are limited over time to meet its needs. With the agreements signed at COP21 to limit global warming, the global energy mix will therefore require an evolution toward a larger share of renewable energy sources. Moreover, we see a growing interest in carbon-free energy at

all levels of society, all the way to the most wealthy, with the Breakthrough Energy Coalition initiative as an example, a project which aims to invest in renewable energies. The question now is: how to achieve this in the decades to come?

Is Quebec an example for the future?

In this global goal to increase production of renewable energy, Quebec already has a head start compared to several countries. Because of its geographical attributes, Quebec has been able to develop electricity generation that is now 99% renewable. The fact that this production is mostly hydroelectric gives it the advantage of being a non-intermittent, renewable and storable energy source. The next big challenge for Quebec to reduce its dependence on fossil fuels will be the decarbonisation of its transport and heavy industries.

Efficient and innovative solutions

Electrical industries will have to address several technical challenges to make this energy transition possible. One of them will be adapting to the growing number of storage systems that will enable a major expansion of renewable energies, because production is not always in line with consumption. Another will be anticipating changes in the architecture of the electrical network toward decentralized production and storage, while maintaining a reliable network and quality electricity. It is in the light of all these elements that smarts grids will come into play to allow better integration and management of the new components of electrical networks. Following this, it will be necessary to prepare for the arrival of more and more electric vehicles on energy infrastructures. New technologies should then move towards “vehicle-to-grid” to allow the network to use the energy stored in the batteries of vehicles. In short, the whole energy model that we know today will have to evolve.

Invest now

To make this transition, it is necessary to continue to invest in research to improve existing technologies and to develop new ones. Investing now in the sector of renewable energy and electric vehicles will allow Quebec to be a window to the world. This will increase the awareness of stakeholders in these sectors, thus fostering the export of their know-how to new markets.

Making the transition

The transition to renewable energy is becoming more economically profitable every day with production costs that continue to decline. Every country will be able to gain energy independence by producing energy locally and in a renewable manner. For this transition to be successful, we must all go in the same direction with a common goal. Naturally, energy transition will not be instantaneous; it will be gradual, in the same way that fossil fuels entered our lives during the industrial revolution.

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By Martin Goudreault
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Benefiting from the change

To date, Quebec has a leadership position on the world stage of energy production, mainly due to the predominance of hydropower. This not only has economic benefits but also environmental ones. It should be noted that the installation of hydropower dams did not, however, occur without a clash to the environment. Still, today it is possible to enjoy clean electricity.

It will be necessary to make use of the predominantly green energy we have to reduce the environmental impacts of areas where the carbon footprint is less enviable. As described in the Inventaire québécois des émissions de gaz à effet de serre en 2012 et leur évolution depuis 1990 (Quebec Inventory of GHG Emissions in 2012 and their Evolution since 1990), produced by the ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec, the transport and industry sectors are the major targets to be reformed in the short and medium term.

Quebec still enjoys a leadership position in regard to its environmental record, but this cannot and must not ever be a pretext for stopping progress in this field.

Where do we go from here?

Building on existing expertise in the electrical industry in Quebec, while leaving a big place for innovation, will allow Quebec to position itself as a world leader when the crisis of global warming is in full swing. By moving forward with concrete projects and involving the population in this change, each stakeholder will serve as a model on the world stage. Investments in research and development will remain a priority to support the development of the energy portfolio. Moreover, it will be necessary to encourage Quebec entrepreneurship, a vector which favours the commercialization of new technologies.

The false debate

According to the More Bang for Your Buck report published by BlueGreen Canada, an investment of $1.3 billion in oil and gas production, refining or pipelines, would result in the creation of 2,340 to 2,860 jobs. In comparison, the same investment for the energy transition towards clean energy would create between 18,000 and 20,000 jobs. Energy transition can thus be seen as an opportunity for economic development rather than an obstacle to growth.

Following the landmark agreement of the Climate Conference in Paris, an increase of investments towards a green shift should be positive for the electrical industry. A new industrial revolution should soon emerge. However, this time, it will be cleaner.

By Jean-François Thibault
Bachelor's graduate in Electrical engineering
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Successful energy transition

The adoption of the Paris agreement raises hopes about the international community entering a new era. Obviously, the energy sector will remain a key activity in terms of economic development. However, to ensure the safeguarding of what Pope Francis calls our "common house," the nations of the world now agree that energy development must be done from a sustainable development viewpoint. The beginning of the energy transition that we are witnessing today is expected to peak in 2100 with the advent of a green economy, where the amount of greenhouse gases in the atmosphere will not increase continuously. If everyone plays their part, humanity will succeed in one of the biggest challenges of the twenty-first century: avoiding a surge in global warming. What should be undertaken in Quebec following the agreement? Let's take a look.

Gradually changing lifestyles

First, we must get used to changing our energy-related habits. The same goes for our companies. On the consumer level, energy efficiency efforts will be useless if our consumer behaviour does not change. Moreover, since Quebecers tend to be uninterested in science and technology, we must find a way to cultivate an interest – or at least an openness - to the changes that will be proposed to them and which they will be invited to participate and engage in. Indeed, it is not only technologies that will change, but also their implementation in society. For example, the integration of knowledge in local communities where projects are located is a method which ensures sustainable development as well as economic efficiency, equity and environmental protection.

Banking on entrepreneurship

Entrepreneurship will have a major role to play in the development and commercialization of technological innovations related to the energy sector. The advent of electric transport, the development of energy storage technologies, as well as local production of renewable electricity at lower costs are some examples of innovations that are gradually altering Quebec's energy landscape. Quebec has expertise in the electricity sector that could enable it to be successful in all of these areas. Consequently, it will be important to develop a more attractive business environment for entrepreneurship, particularly in the areas of the environment, natural resources and renewable energy. We will have to take an interest in certain areas such as training, funding, regulation, innovation, marketing and internationalization.

Success

Finally, we have the means to succeed. Quebecers are full of talent and audacity, just like their ancestor explorers. Let's use the new energy transition to develop our skills and to grow our economy in a sustainable way.

By Catherine Gignac
Bachelor's student in Mechanical engineering
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Building our energy future together

In 2015, the renewable energy sector remains a polemical topic that generates many questions both economically and socially. Although the subject can sometimes seem marginal, several industry pioneers have been able to promote their ideals on the subject. Technologies, innovations and resources are in place thanks to their talents. However, there remains challenging work to be done.

Energy overview

The future of energy can represent strong growth and bring positive benefits to our country. However, it could also take a different path. Everything will depend on the choices of society and on the research of businesses in the sector. I hope that these will be promising, but no one can predict the outcome. The collaborations involving different sectors as well as all the tools in place will lead us to success. However, the sharing of knowledge remains a key tool to ensure the sustainability of quality in the energy industry. This revolution that Canada is seeking to put into action must be strictly planned and must set achievable goals. As the expression says, "Rome was not built in a day!"

Adapting our innovations

The mistake we must avoid is that of copying any country in terms of their activities in the energy industry. We have a population, flora, fauna and climate that are very different from the rest of the world and these elements can sometimes represent serious constraints. So, our actions must be thought-out so as to avoid unnecessary work. The David Suzuki Foundation teaches us that it is with small gestures that big changes start. Beyond all the solutions that can be found, this wind of change will only take shape if we focus our energies in the right place.

By Ibrahima Kaba
Bachelor's student in Electrical engineering
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My vision on the potential of electric energy in Quebec

Today, it is obvious: electricity is very present in our daily lives. We are becoming increasingly dependent on this energy and demand is only getting higher. Thus, the need to produce more electricity while at the same time reducing the impact on the environment becomes even more important. We can consider that the province of Quebec - through Hydro-Québec, its Crown corporation - has succeeded by closing its last nuclear plant and producing 99% of its energy with water.

Electric energy in Quebec

The potential of electric energy in Quebec is very important, first because of its "inherited" wealth, with nearly 500,000 lakes and 4,500 rivers and second, because of its "acquired" wealth due to its infrastructure and expertise in the field. Indeed, the efforts made and the money invested in research and infrastructure in recent years by the government and businesses has allowed the province to get ahead of several countries worldwide.

Towards more electrification of our vehicles

For example, in terms of the electrification of transport, Hydro-Québec could already power a million electric vehicles, or about a quarter of the current vehicle fleet in the province, without any significant investment (Source: Hydro-Québec website - Electrification transport). Moreover, the establishment in March 2012 of The Electric Circuit, the first charging stations network in Canada, coupled with the desire of public transport companies to increasingly use electrical power for their vehicles demonstrate that it is only a matter of time until the electrification of transport in Quebec is widespread. Research currently being conducted on the storage of energy by research institutes and private companies could improve the efficiency and lifespan of batteries on the current market.

Targeting a more direct current grid

Another objective over the long term, achievable in Quebec, would be to have a larger high-voltage direct current network (HVDC). This would surely require a much larger initial investment, but would be advantageous in the long term. With advances in power electronics in recent years, it is much easier to transform electrical energy today.

In conclusion, the province, through Hydro-Québec, private companies and research institutes, remains an important player in the development and use of electric power. The current state of affairs suggests that this is only the beginning and that our best years are ahead of us.

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- EBC
- BBA
- Dassault System

They are all offering products and services that are ideal hydropower electric installation plans and specifications, construction and simulations.

In addition, EPIQ is pleased to announce that Jocelyn Gaudet, Chief of Technology at IREQ, will be in the EPIQ booth after his conference of Wednesday, July 27 at 11:45 AM.

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[1] EPIQ stands for Electric Power Industry of Quebec