SETTING NEW SIGHTS
WITH OUR CLEAN AND RENEWABLE ENERGY

Ahmed Daoud, Research Scientist, IREQ
Our energy

Over 99%

CLEAN AND RENEWABLE
Who we are

63
HYDROELECTRIC GENERATING STATIONS

INSTALLED CAPACITY OF HYDRO-QUÉBEC’S HYDROPOWER GENERATING FLEET

36,767 MW
# Hydro-Québec

## At a glance

<table>
<thead>
<tr>
<th>Net income</th>
<th>Workforce</th>
<th>Installed capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,846 million</td>
<td>19,786 permanent and temporary employees</td>
<td>37,309 MW</td>
</tr>
<tr>
<td>in 2017</td>
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<table>
<thead>
<tr>
<th>Electricity sales</th>
<th>Residential rate</th>
<th></th>
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<tbody>
<tr>
<td>205.6 TWh including 34.9 TWh in exports</td>
<td>7.07¢/kWh The lowest in North America</td>
<td></td>
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</tbody>
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* Annual Report 2017

From 87 generating stations operated by Hydro-Québec
Hydro-Québec’s strategies for 2018+

- Focusing our culture on customers and on our employees’ health and safety
- Seizing growth opportunities outside Québec
- Launching a new era of electrification in Québec
- Optimizing our resources and processes
A world-class research centre

Mission | Through R&D, make the most of existing and emerging products and services to keep Hydro-Québec on the leading edge of scientific advances and technological solutions related to all elements critical to improving the company’s performance in the short and long terms.

MAKING A DIFFERENCE for Hydro-Québec and our customers

Two research sites | 400 talents for creating value | Annual budget over $115 million
Cutting-edge expertise

IREQ’s solid expertise, in sharp alignment with the company’s divisions, bolsters Hydro-Québec through its energy transition challenges

• Simulation of facilities and equipment
• Energy resources and hazards management
• Asset sustainment
• Asset characterization and performance
• Grid development and simulation
• Grid control and management
• Inspection and maintenance robotics
• Electrification and integrated energy systems
• Digital systems
• Data science and high-performance computation

Teams are also dedicated to high-voltage testing and equipment calibration

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Experts are also in charge of development and partnership strategies, as well as technological vision and roadmapping
Our profession
Inventing and developing new ways of doing things

Knowledge Maturity of knowledge

- Technological innovation
- Strategic innovation
- Front-end
- Support/Expertise
- Testing

Products and services

Theoretical

Practical

Application of expertise

Theoretical

Practical
Services for Hydro-Québec and the industry

Research and development
– Technological innovation projects aligned with the needs of Hydro-Québec’s major business units and their customers

Support, expertise and testing
– Technical support to solve a broad range of equipment and operating issues

Innovation
– Areas that create value
– Position Hydro-Québec as an innovative player worldwide

Licensing and technology transfer
– Areas of R&D with important market value
Business environment

The market, new technologies, the demand for clean energy, trends in next-generation behavior, and emerging customer needs are transforming the power industry and, of course, Hydro-Québec.

Transformation triggers:
- Distributed energy resources
- Participatory customers
- Climate change
- Decarbonization
- Aging assets
- Market volatility
- Digital technology
- Creation of the TEQ (Transition énergétique Québec)

To bolster Hydro-Québec through these challenges, IREQ has developed a technological vision 2035 for the company.

This vision, harmonized with Hydro-Québec’s Strategic Plan, has three main orientations and will be reviewed each year.
Hydro-Québec’s technological vision 2035
3 orientations | 8 goals

01. AT THE HEART OF OUR TRANSFORMATION: OUR CUSTOMERS

02. OUR ASSETS: A STRATEGIC STRENGTH IN A CHANGING ENVIRONMENT

03. LOOKING TOWARDS THE POWER SYSTEM OF THE FUTURE
A changing market

1. Technology will enable customers to produce, use, store and sell power | participatory customer

2. Electricity suppliers will become more lifestyle-oriented service providers

3. The power grid will be a smart system, integrating advanced equipment features and customer connectivity to maximize all operations

4. Data will play a critical role in this change
IREQ
Energy Transition, Innovation and Efficiency
Project portfolio overview
<table>
<thead>
<tr>
<th>1</th>
<th>Experimental homes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Demand Response in CI buildings</td>
</tr>
<tr>
<td>3</td>
<td>Experimental Distribution Network</td>
</tr>
<tr>
<td>4</td>
<td>Lac Mégantic Microgrid</td>
</tr>
<tr>
<td>5</td>
<td>Efficient electrification</td>
</tr>
<tr>
<td>6</td>
<td>ConnEC</td>
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</tbody>
</table>
LTE experimental homes

- Platform for testing energy services and technologies of the future
  - In order to anticipate their impact on the grid and to help customers make technological choices
- Adapted into net-zero-energy houses to better understand the issues related to advanced smart houses, electric vehicles (V2H-V2G) and distributed generation
- Technologies being tested: a smart-home system, a bidirectional EV charging station, and photovoltaic solar panels
Demand Response in C-I Buildings

DR Program in order for Winter Peak Demand reduction

- 2015-2016: 26.7 MW (Goal 10MW)
- 2016-2017: 184 MW (Goal 130MW)
Experimental Distribution Network

- Controllable loads: 300 kW, ±150 kvar, 93 kW motor load
- Diesel generator: 320 kW
- Wind generation emulation: 149 kW
- Solar generation emulation: 250 kW
- Solar panels: 3 kW
- Induction generator: 93 kW
- Battery storage: 100 kWh, 250 kVA
- SCADA, switchgear, voltage regulators, underground distribution system, etc.
Lac-Mégantic Microgrid project

- About **30** buildings
- More than **300** kWh of energy storage
- Area of **150 000 m²**
- Up to **1 000** solar panels to produce electricity

Microgrid’s perimeter
Accelerate efficient electrification

High frequency heating

Electrolysis

Heat pumps

Electrochemistry

Electrodialysis
Accelerate efficient electrification
In this fast-changing world...

we must anticipate plausible changes in order to satisfy our customers and insure profitability.
We use personae-based scenarios to envision innovative products and services for our customers of the future. And we tell the story.

**Why?**
- Agility
- Innovation
- Education

**Who?**
- [Industrial icon]
- [Building icon]
- [House icon]

**How?**
- Energy & social sciences research
- Collaborations with universities
- Long term trends watch
- Understanding customer latent needs