FREE ELECTRONS

HYDRO-QUÉBEC

MAY 2023

Our vision

Mobilizing the collective strength of Quebecers to:

- accelerate the energy transition;
- stimulate the local economy; and
- build a sustainable future.

Our mission in brief

- **Provide our customers with a reliable electricity supply.**
- **Offer high-quality services at competitive prices.**
- **Contribute to Québec's collective wealth by making use of clean, renewable energy sources.**
- **Help neighboring markets reduce their carbon footprint by leveraging the attributes of our renewable energy.**
- **Draw on our expertise and state-of-the-art solutions to decarbonize the economy and optimize energy use.**

Hydro-Québec at glance

Electricity sales
216,2 TWh
Including 35,6 TWh in exports

Generating capacity
37 439 MW
From 88 generating stations operated by Hydro-Québec

99,6%
From renewable sources

Customers
4,5 Millions

Residential rate
7,59¢*/kWh
The lowest in North America

* 1 $CA = 0,69 €

GHG EMISSIONS BY GENERATION OPTION (G CO_2 EQ./KWH)

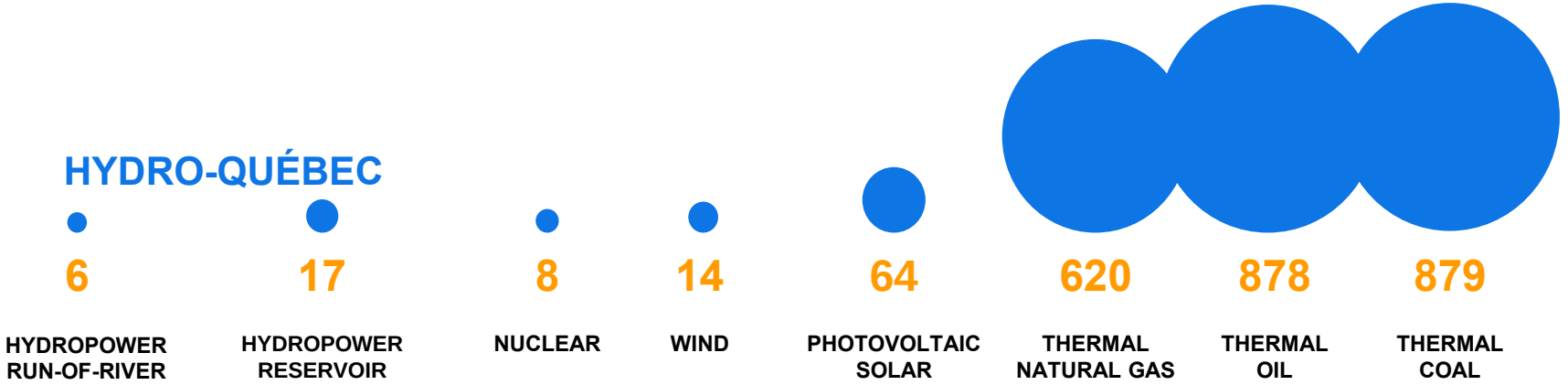
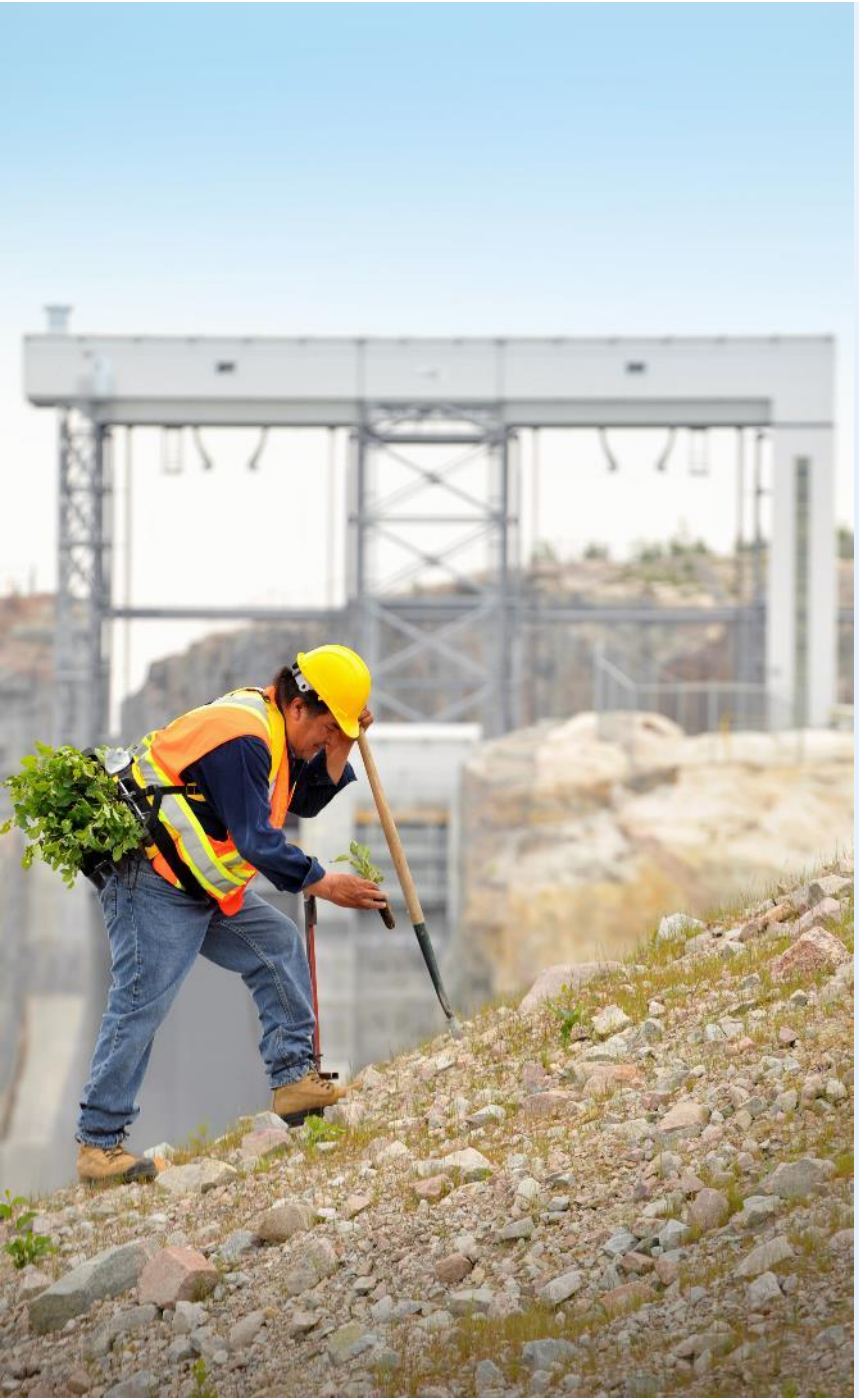


Illustration adapted from a study by the *Centre universitaire de recherche sur le cycle de vie des produits, procédés et services (CIRAIG), 2014*



Our values

The common good

Putting people and the community first.

Courage

Believing in our ideals and acting upon them.

Inclusion

Being a rallying force and a model of openness.

Innovation

Making positive changes, day after day.

The energy transition

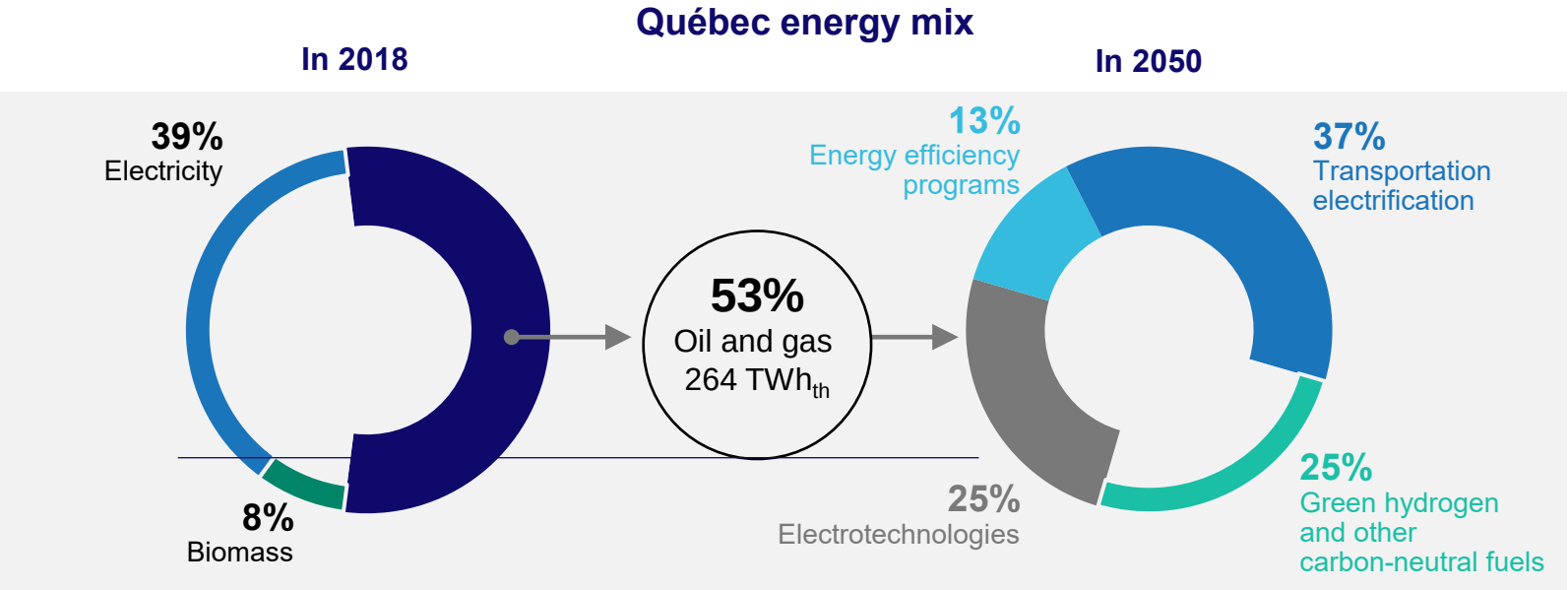
Three key components for power system operators:

Decarbonization
or the gradual phase-out of fossil fuels in favor of renewable energy sources with a smaller carbon footprint

Digitization
which leverages cleantech innovation to optimize power system operations and energy consumption

Decentralization
expanding the role customers play in generating renewable energy and managing their energy use

Decarbonation challenges



Objectives of the Québec government's Plan for a Green Economy

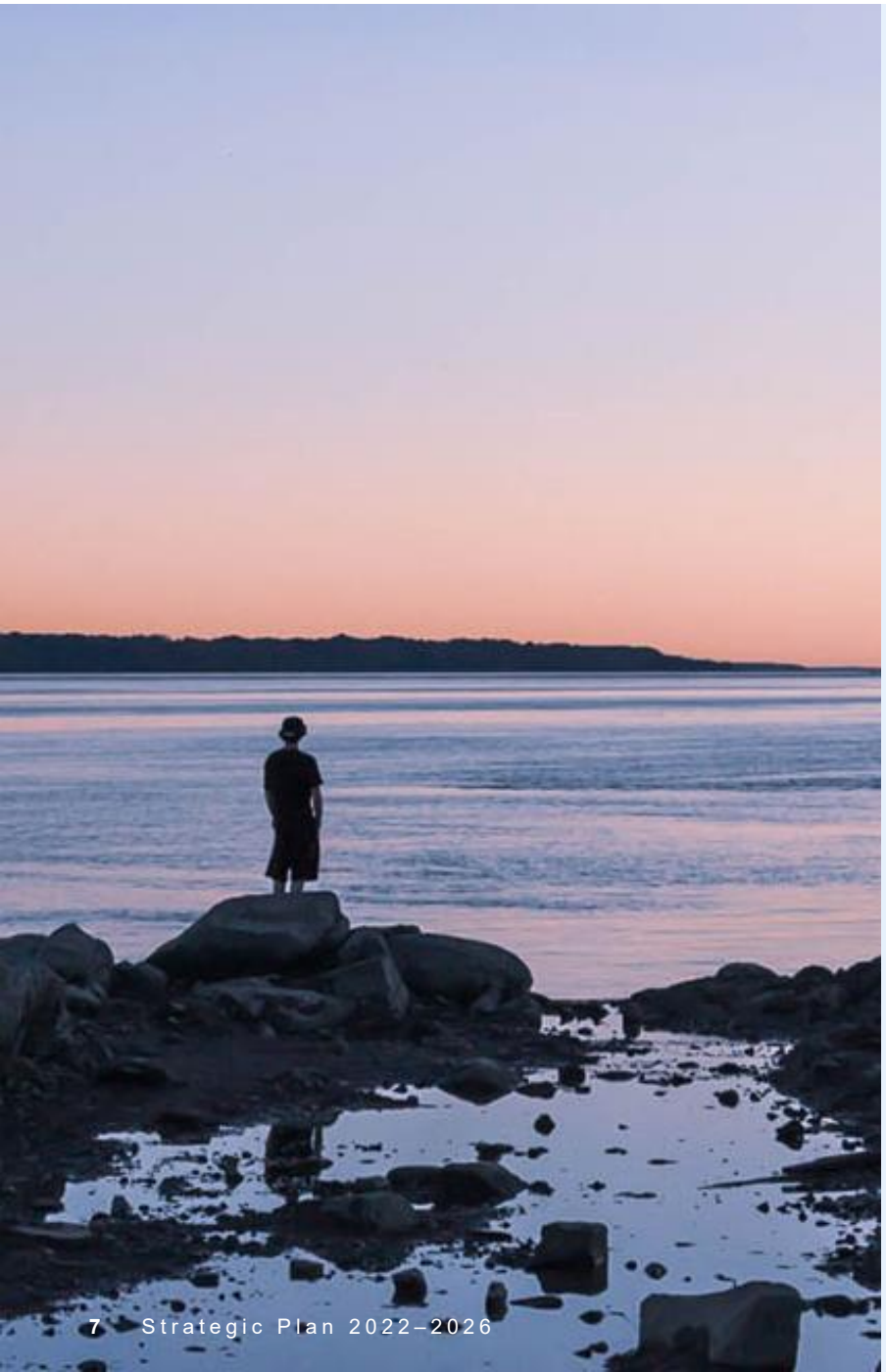
- Bring GHG emissions down 37.5% from 1990 levels by 2030
- Achieve carbon neutrality by 2050

A few specific objectives

- 1.6 million electric vehicles on the road by 2030
- 55% of city buses and 65% of school buses electrified by 2030
- 80% of energy supplied to off-grid systems to be from renewable sources by 2030
- 50% reduction in emissions linked to building heating systems by 2030
- 60% reduction in emissions from public buildings by 2030
- Develop other renewables

Over 100 TWh of additional clean electricity – more than half of our current annual generating capacity – will be required to attain carbon neutrality in Québec by 2050.

Hydro-Québec's Strategic Plan 2022-2026



Paradigm shifts

Paradigm 1
Our energy and capacity balances

Paradigm 2
Our supply costs

Paradigm 3
Our grid's design and operation

Paradigm 4
Our infrastructure investments

PARADIGM 1

Our energy and capacity balances

Then

Sizable volume of available energy: Focus on quantity

Now

Tighter energy and capacity balances: Focus on value

+20 TWh

Projected growth of electricity demand in Québec between 2019 and 2029

Massachusetts

9.45 TWh

New England Clean Energy Connect

New York

10.40 TWh

Champlain Hudson Power Express

2026–2027

The winter in which we will need new capacity supplies

2027

The year in which we will need new energy supplies

PARADIGM 2

Our supply costs

Then

Low supply costs

3¢/kWh

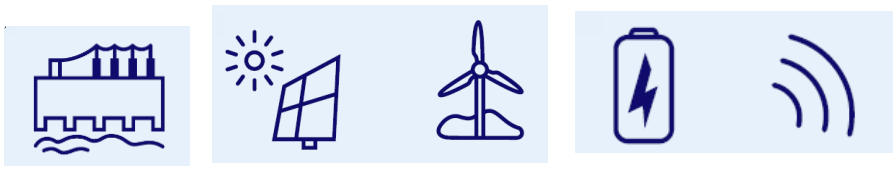
Cost of heritage pool electricity

Now

Increasing supply costs

New non-heritage electricity supplies will be needed to meet the growing demand.

We must bank on various solutions to meet growth in demand at the lowest cost.



11¢/kWh

Average non-heritage energy and capacity supply cost, taking into account the agreements in effect and the planned short- and long-term market purchases

PARADIGM 3

Our grid’s design and operation

Then

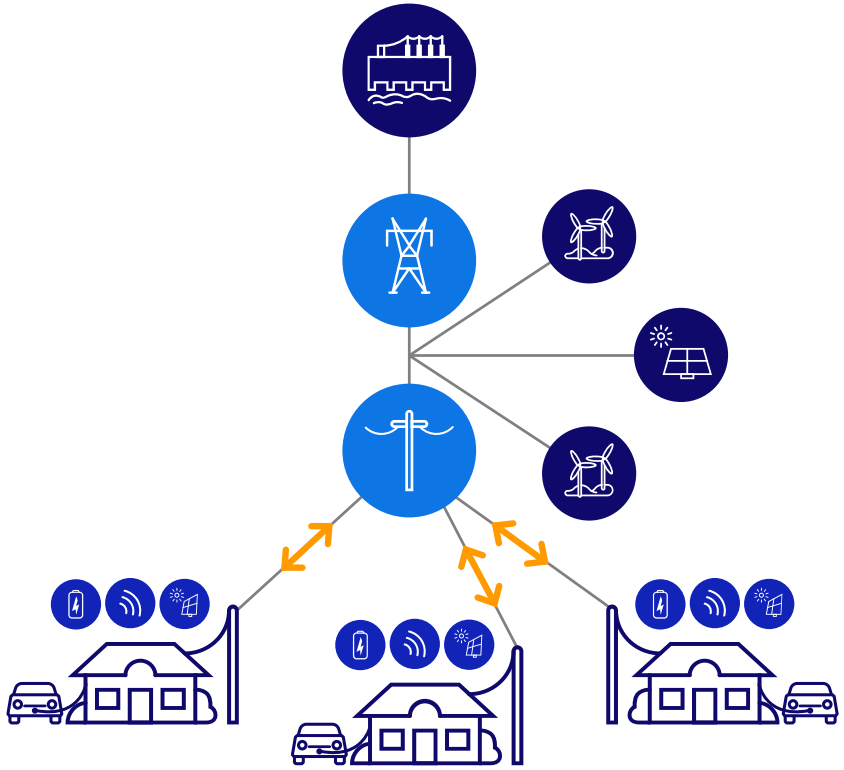
Traditional grid

Now

A more complex, more interactive energy system

Thanks to digital technologies, we can implement multiple solutions to optimize the operation of an increasingly complex energy system.

Our capacity for innovation is key to modernizing our assets and operations.



From a power system to an energy system

Integrated management of a network of energy and non-energy systems

Optimized operating limits through digital intelligence and uncertainty management

Cybersecurity where energy and digital technologies meet

An energy ecosystem for Québec that extends beyond borders and forms of energy

Weather and other contingencies integrated into planning and operations

Assets

Seamless **coexistence** of old and new assets

Assets adapted to **climate change**

Predictive asset maintenance, in part through digital twins

Field operations with minimized human intervention thanks to drones and robots

Customers

Distributed energy resources are stakeholders in the bidirectional system

More independent prosumer customers and energy trading platforms

Green, connected eco-districts that promote local community energy generation

PARADIGM 4

Our infrastructure investments

Then

Stable investment level

Now

Major increase in investments required

We’re entering a new era of growth as our assets approach the end of their useful life.

Resource allocation will be of paramount importance.

$5.0B

Average investments planned over the next five years (2022–2026)

$3.7B

Average investments over the past five years (2017–2021)

Hydro-Québec's research center (CRHQ)

A WORLD CLASS RESEARCH CENTRE

To make its vision come true, the CRHQ can count on its human capital, its evolving organization and its state-of-the-art infrastructure.

* 1 $CA = 0,69 €

Talents creating value
400
Researchers, engineers, technicians

Research & development campus
2
Varennes, Shawinigan

A catalyst for the innovation ecosystem
4 M$* / year
For academic partnerships

50 +
Industrial partnerships (industrialization and commercialization)

A significant budget
$130 million
+ 5 M$ external income / + License income

Balanced and challenging innovation portfolio
100+ projects
190 patents (actual and pending) / + 100 papers / year (peer reviewed)

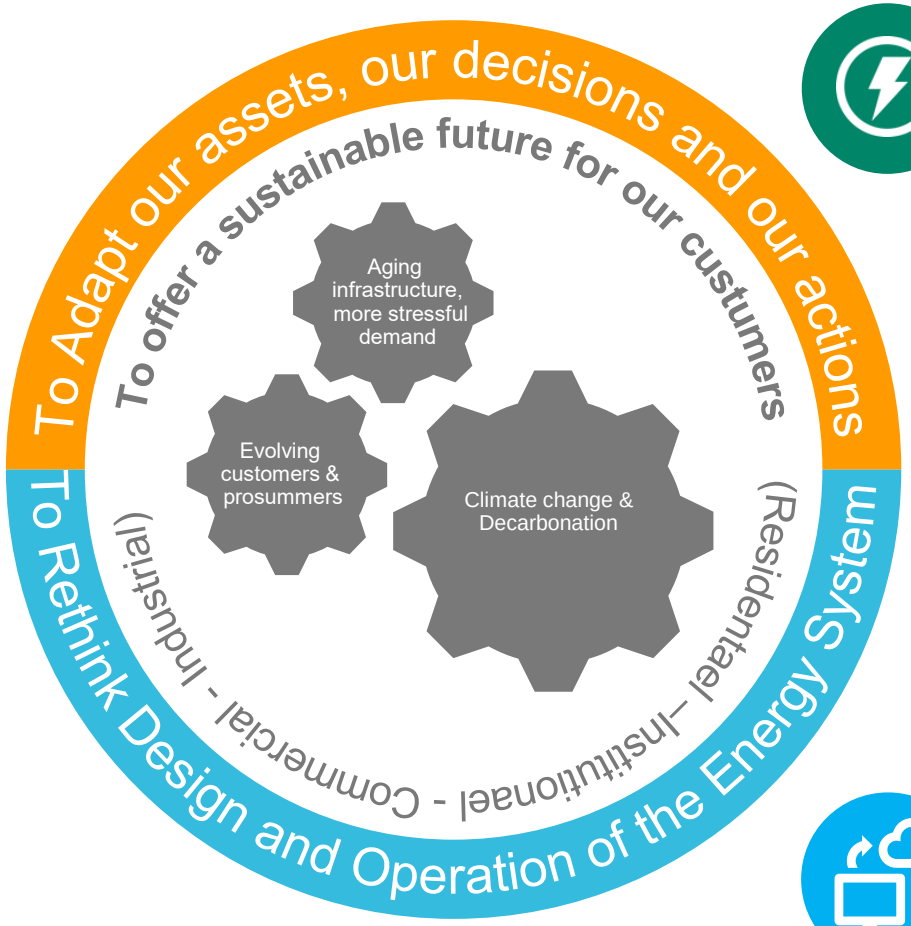

L'INSTITUT DE RECHERCHE D'HYDRO-QUÉBEC (IREQ), Hydro-Québec's Research Center (HQRC)


LABORATOIRE DES TECHNOLOGIES DE L'ÉNERGIE (LTE), Hydro-Québec's Energy technology laboratory


Hydro
Québec

CRHQ's Strategies

MAKING TOMORROW ENERGY SYSTEM A REALITY



Support the deployment and development of efficient electrification | Propose effective technological solutions for converting fossil fuel end-uses, which are affordable and adapted to the markets, limiting the growth of energy demand and leveling the power demand on the grid.

Develop Energy Flexibility and Communities | Improve the energy efficiency, flexibility and resilience of customers and energy system by supporting empowerment and participation while maximizing benefits for customers, Hydro-Québec and society.

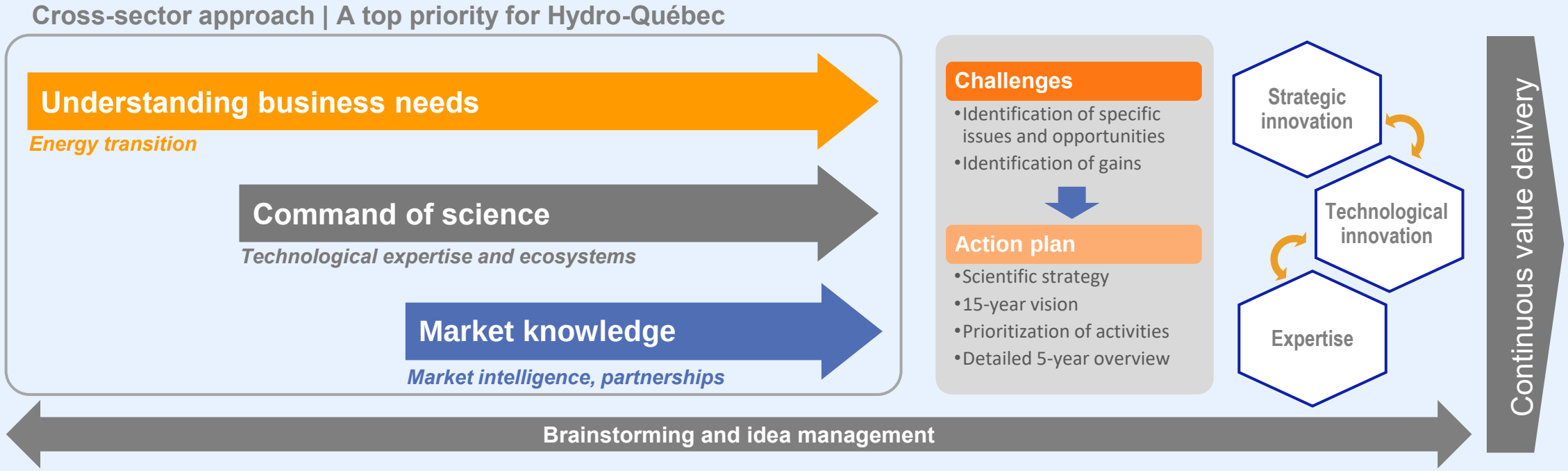
Modernizing our assets | Proactively develop our equipment and infrastructure by integrating new technologies in order to adapt our grid to the energy transition and climate change.

Improve decision-making and interventions on our assets | Continuously know the state of assets to support decision-making and carry out relevant interventions at the right time at all stages of the life cycle of our assets, at a lower cost.

Rethink the design and operation of the energy system | Develop a suite of tools and solutions to enable the integrated design and operation of the energy system of tomorrow, leveraging our digital capital, to maximize the use of our assets, distributed energy resources and other fuels.

Innovation programs

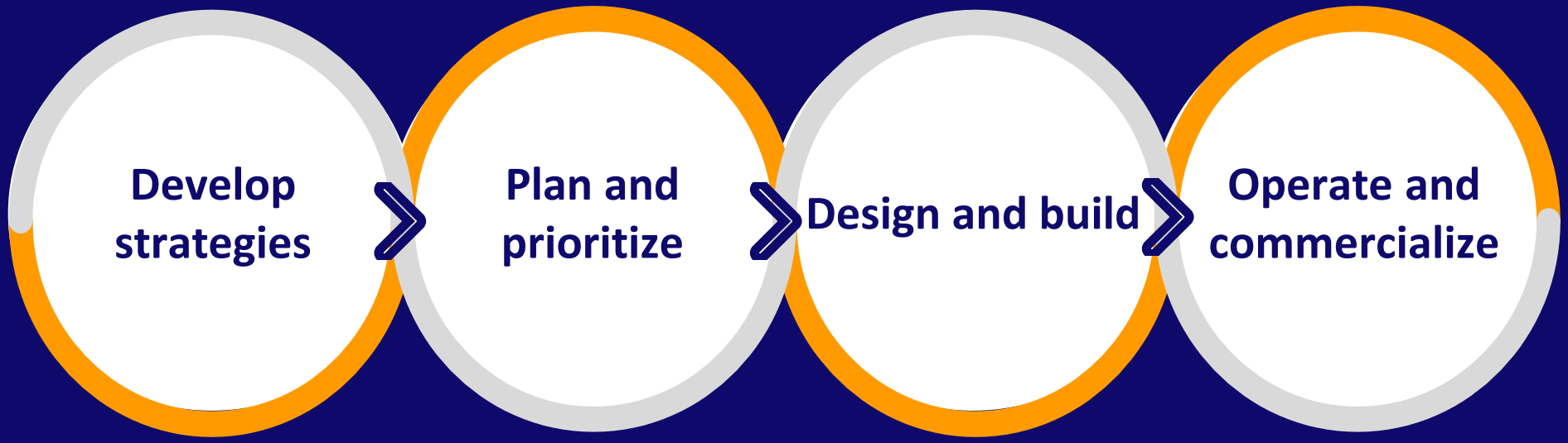
AN INNOVATION PROGRAM-BASED APPROACH



Current innovation programs

- End-to-end design of tomorrow's energy system
- Asset management and reliability
- Asset digital twins

Hydro-Quebec and CRHQ value chains



DRIVEN BY

CRHQ'S contributions

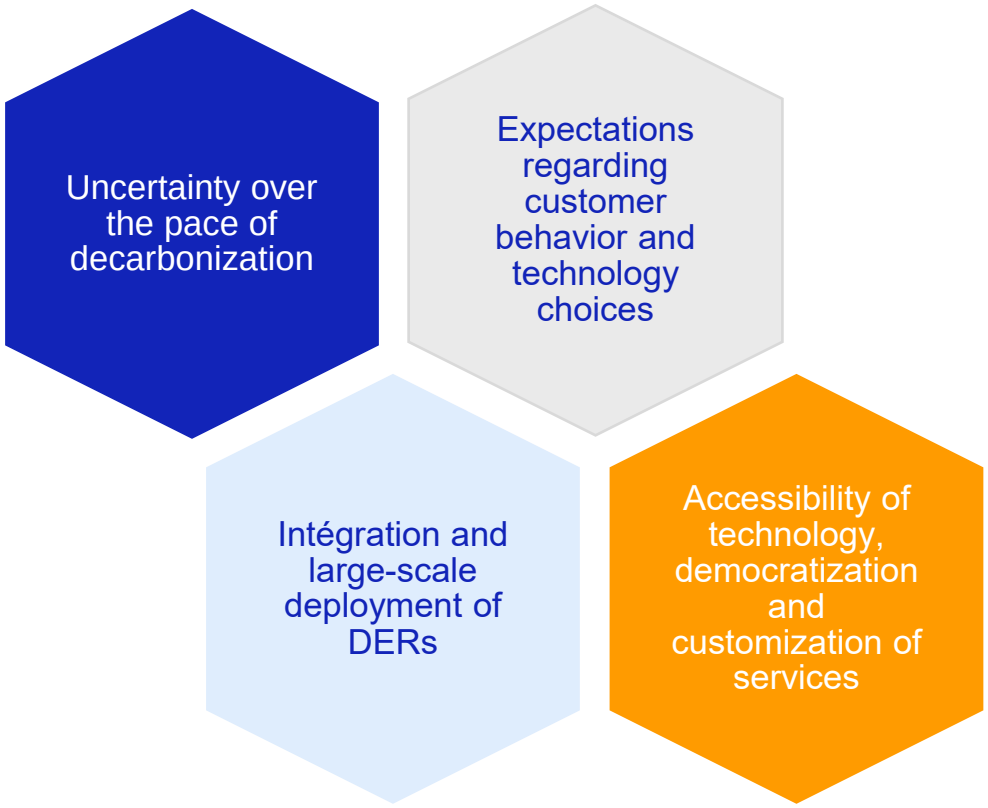
Other contributions | Influence

- Monitoring, brainstorming, innovation strategies
- Forecasting and strategic innovation projects
- Partnership management

R&D

- Technological innovation projects in collaboration with the ecosystem and users
- Assistance in implementing and deploying technologies
- Expertise and high-level technical support

Offering a sustainable future to our customers



To address these issues, the CRHQ is helping to :

- Reduce the dependency on carbon through **efficient electrification** and improve overall conversion factors
- Rethink consumption, **increase customer independence** and enhance customer flexibility and energy resilience
- **Promote accessibility** of new technologies by overseeing the integrity of the energy system
- Offer energy products and services that are **evolving**, **customized** and **tailored** to customer needs
- Carry out **technology and market watches**

CULTURES ÉNERGÉTIQUES DE LA SOCIÉTÉ QUÉBÉCOISE

TRANSITION ÉNERGÉTIQUE EN RÉSEAUX AUTONOMES

ÉNERGIE DES PETITES ET MOYENNES INDUSTRIES

Adapting our assets, decisions and actions

Changes to use of assets

Cost associated with ageing and obsolescence

A changing environment (climate change, external markets)

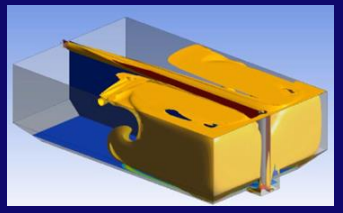
Integration of new dynamic assets into the existing system

To address these issues, the CRHQ is helping to :

- **Adapt the designs** of our assets to the effects of climate change and other developments
- **Integrate high-performance assets** that are adapted to changing uses where appropriate
- **Develop our situational awareness** of our assets
- **Optimize our decision making** and integrated asset management process regarding risks and uncertainty
- **Develop new ways of working** on our assets

LINEDRONE

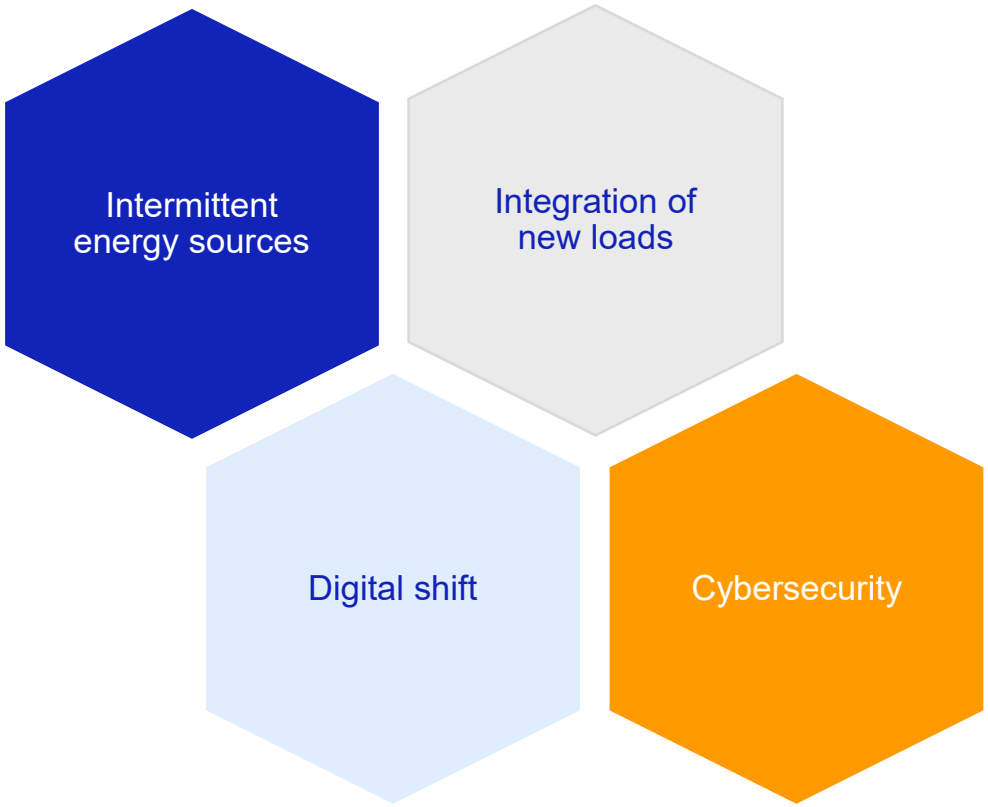
DIGITAL TWINS OF HYDROELECTRIC UNITS



OSEH

THAUR

Rethinking the design and operation of the energy system



To ensure system reliability, the CRHQ is helping to :

- **Properly integrate** intermittent renewables and heavy loads and manage greater variability and peak demand
- **Support the energy transition** of our equipment and major automated systems
- **Provide cybersecurity** for our technological operations

CYBERSÉCURITÉ

HYPERSIM

Rethinking the design and operation of the energy system

Interactions becoming more dense and complex

Optimization of real-time operations of a more distributed system

Capacity to interpret massive amounts of data

Climate change

To make the transformation affordable, the CRHQ is helping to :

- Prepare the system to become **multi-directional** and for interrelationships with other forms of energy
- **Develop** planning and operations to take advantage of DERs in order to improve the load factor in a context of a significant load increase
- **Maximize the use** of our system and push its limits through real-time interpretation of all available information
- Integrate probabilistic approaches
- Ensure the system's **resilience**

SCÉNARIO

OSER