The Smart Grid at Hydro-Québec Distribution

Antonio Pinho, Director – Asset Management

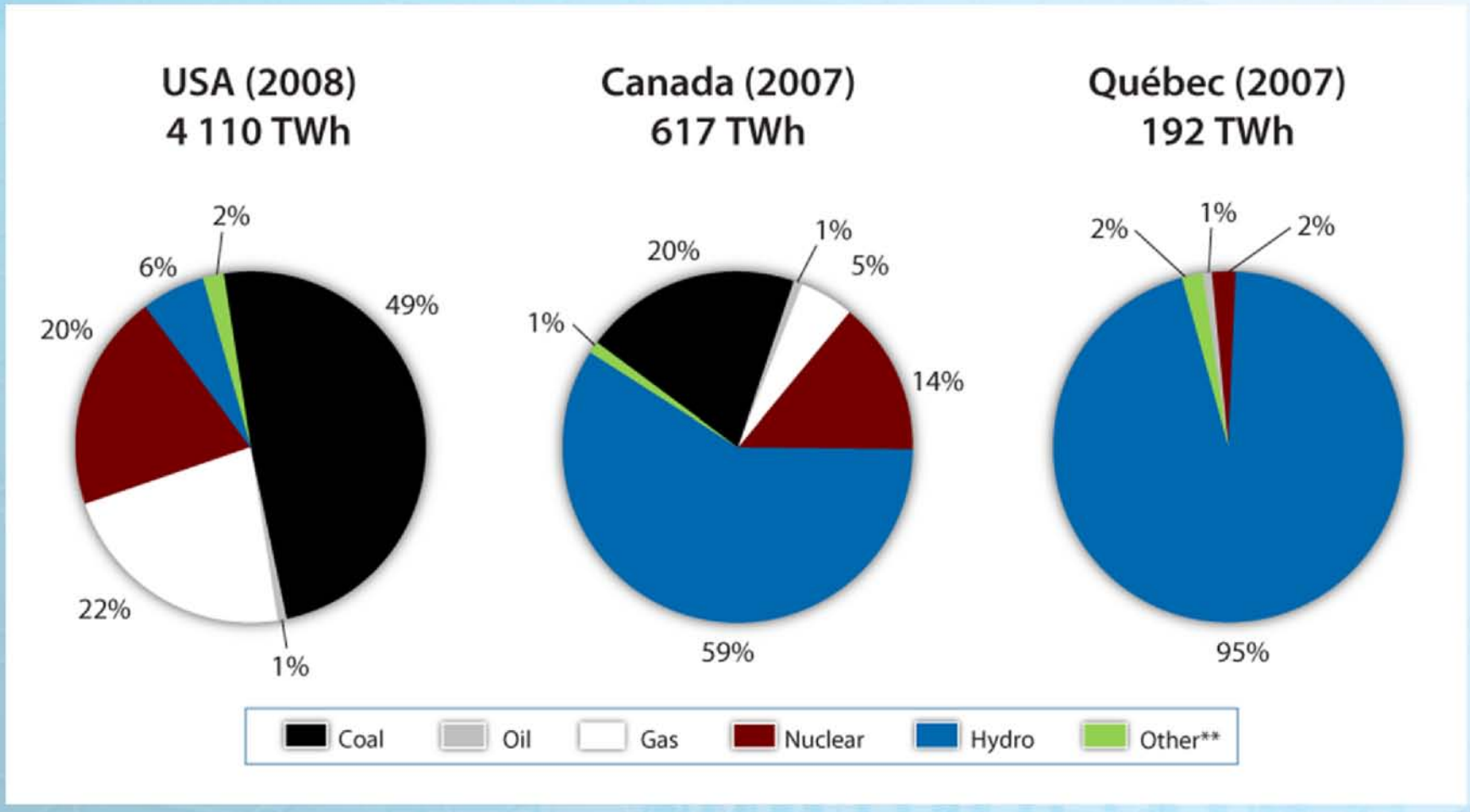
May 17, 2010

Objectives

- **Present the framework for the smart grid at Hydro-Québec Distribution.**
- **Overview projects.**

Hydro Québec Distribution

Comparison of Energy Options in North America



Snapshot of Hydro-Québec

- **Hydro-Québec is the largest power generator in North America.**
  (42,000MW, idem Southern Company)
- **Hydro-Québec is among the largest power transmission companies in North America.**
  (>$15 B in transmission assets)
- **Hydro-Québec is the largest electricity company in Canada.**

Québec Context

Area:
1,667,926 km2
(595,391 sq. mi)

Population:
7.7 million

No. of Hydro-Québec Consumers:
3.9 million

Hydro-Québec Distribution

- **111,205 km of lines**
- **540,000 transformers**

Hydro-Québec in Numbers

Year Ending December 31, 2009

- **Revenue** **$**12 B
- **Net income** **$**3 B
- **Total assets** $69 B
- **CAPEX** Program 2009-2013 $25 B

Hydro-Québec Strategic Plan 2009–2013

Energy efficiency

Renewables

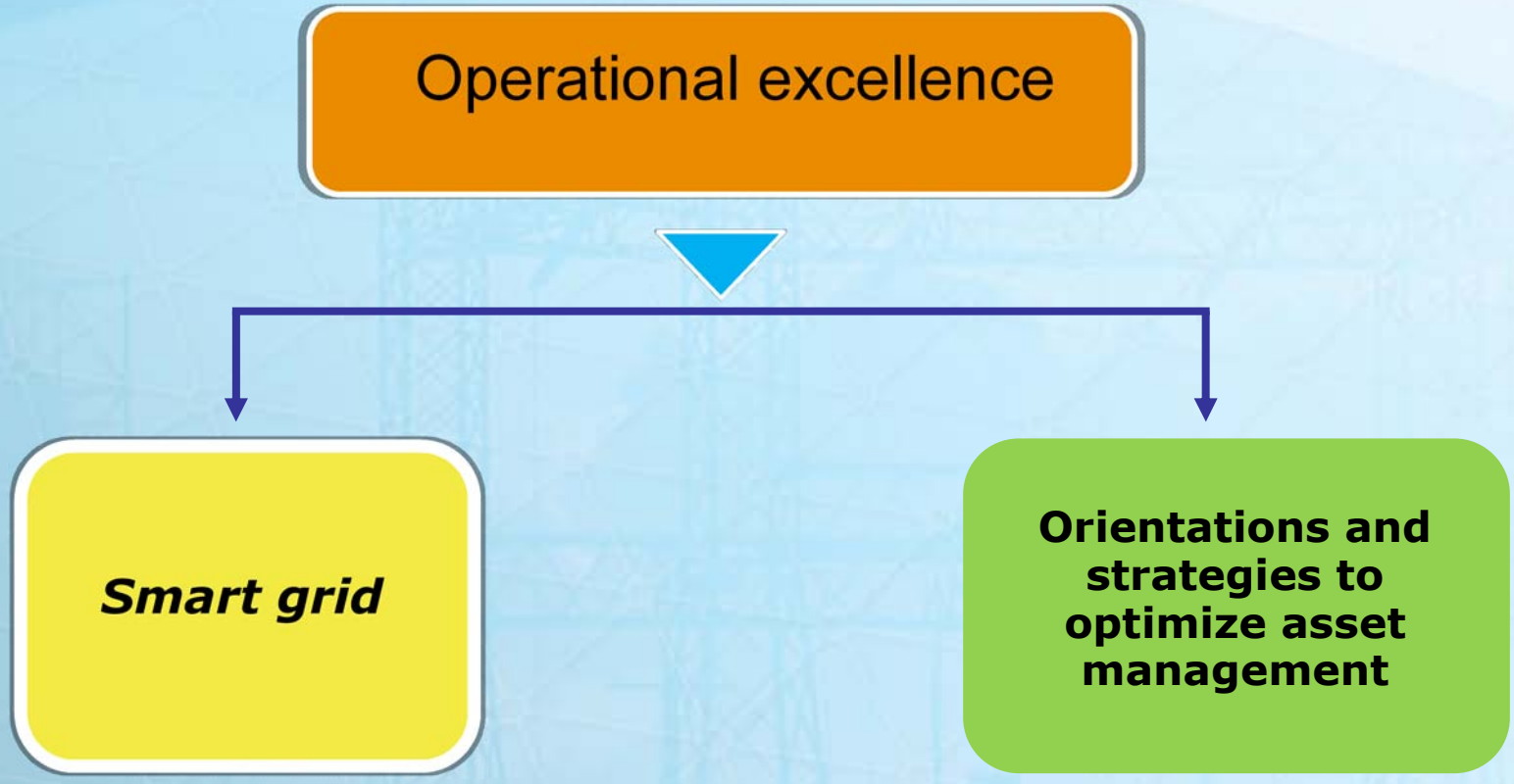
Technological innovation

Hydro-Québec Distribution

Objectives

- **Ensure quality customer service**
- **Step up energy efficiency initiatives**
  - Save 11 TWh of energy by 2015
  - Promote efficient, sustainable use of electricity
- **Meet electricity needs flexibly**
- **Improve division performance further**

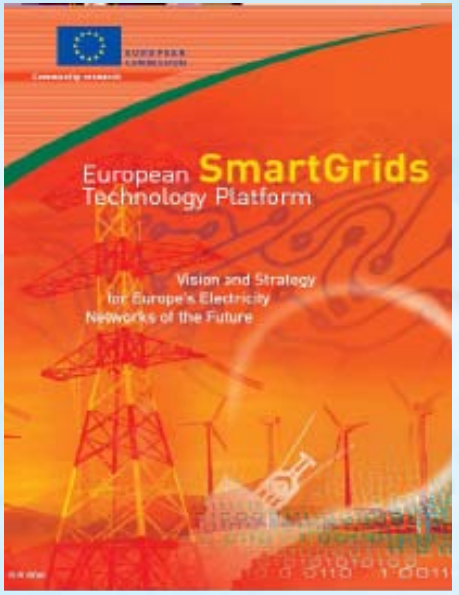
Priorities

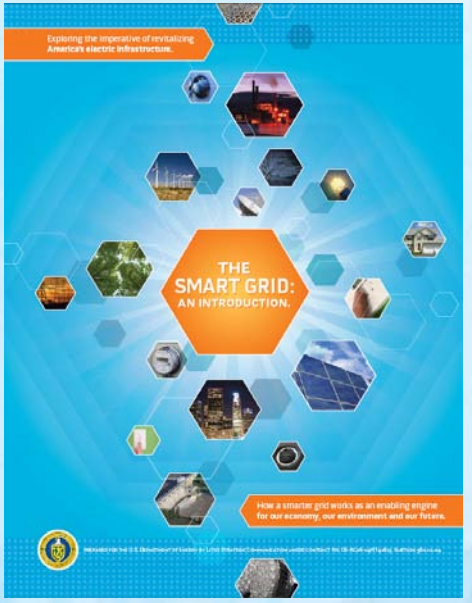

Operational excellence
Smart grid
Orientations and strategies to optimize asset management

Smart Grid in Industry

Global Context – Drivers

	Europe	U.S.	Canada
Availability of energy	X	X	X
Control of peak (power)	X	X	X
Political targets for green energy	X		





- **Development of dynamic grid management based on**
  - Networked meters
  - Distributed generation
  - Automatic grid restoration systems
  - Management of energy and power

Natural Resources Canada | Ressources naturelles Canada

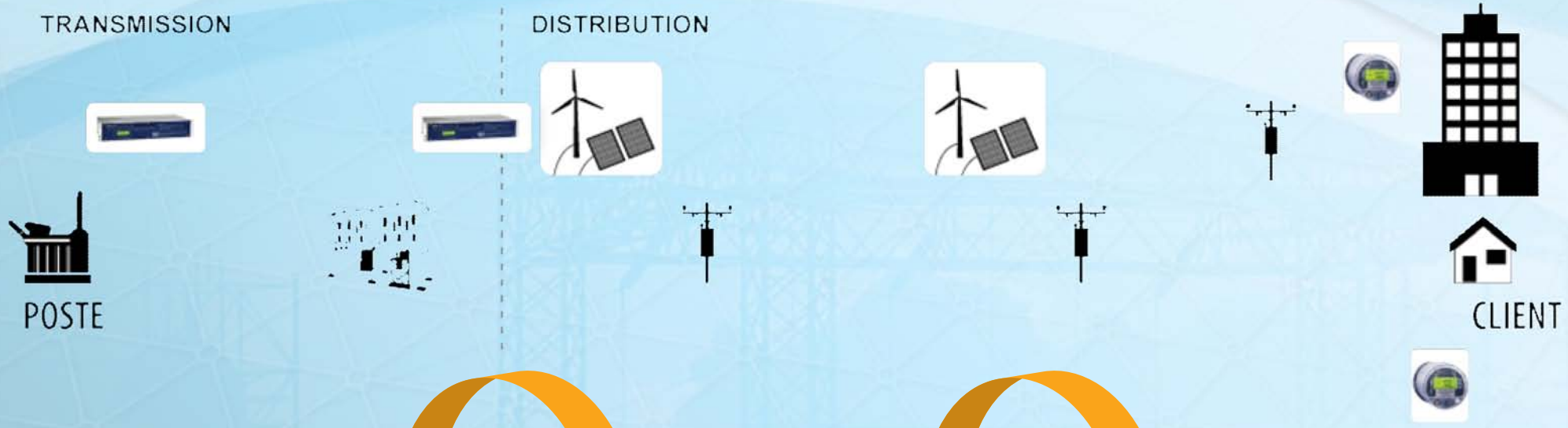
Definition of Smart Grid

- **No single definition but convergence toward the following goals:**
  - Reliable, high-quality power system
  - Optimized system capacity, including energy efficiency and interoperability
  - Customer generation integrated and consumption patterns modified
- **Smart grids are essentially perceived as being systems of networked meters since most distribution providers use this technology to meet the double challenge of:**
  - Availability of energy
  - Peak demand management

Smart Grid in the Québec context

- **Energy**
  - Potential and available hydropower vs. fossil fuels
  - Relatively low cost of energy (7¢–9¢/kWh)
  - Winter peaks managed by purchasing power from off-peak neighboring systems and by shedding interruptible power
- **Customers**
  - High level of customer satisfaction (≈ 8/10)
  - In Québec, the peak is associated with electric heating in winter (longer period, days vs hours)
- **Social context**
  - Favorable to renewable energy sources, including hydropower
- **Régie de l'énergie**
  - Promotes the development of technologies for the efficient use of energy

Technology Addressing Business Issues



With what?

Data

Voltage, fault current, load current, temperature, number of operations, alarms...

Existing systems

ATS, SAP, CIS, GIS (GDA1), CED, metering…

How?

Applications

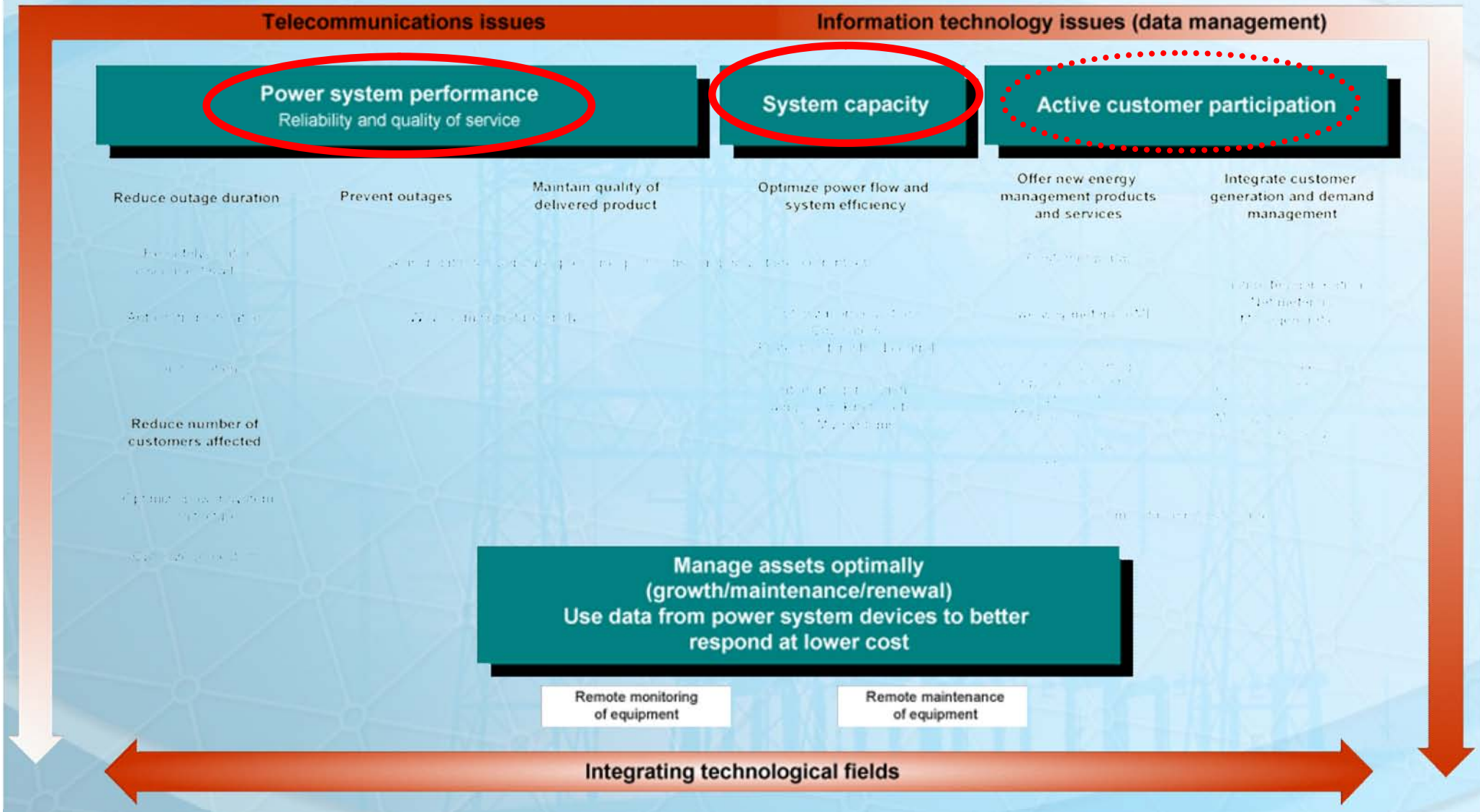
- Online supervisory control
- CATVAR (end-of-line voltage monitoring)
- Remote meter reading
- Fault location
- Product qualitative evaluation

Why?

Issues

- System performance
  - Reliability
  - Quality
- Optimization – power system capacity
- Active customer participation

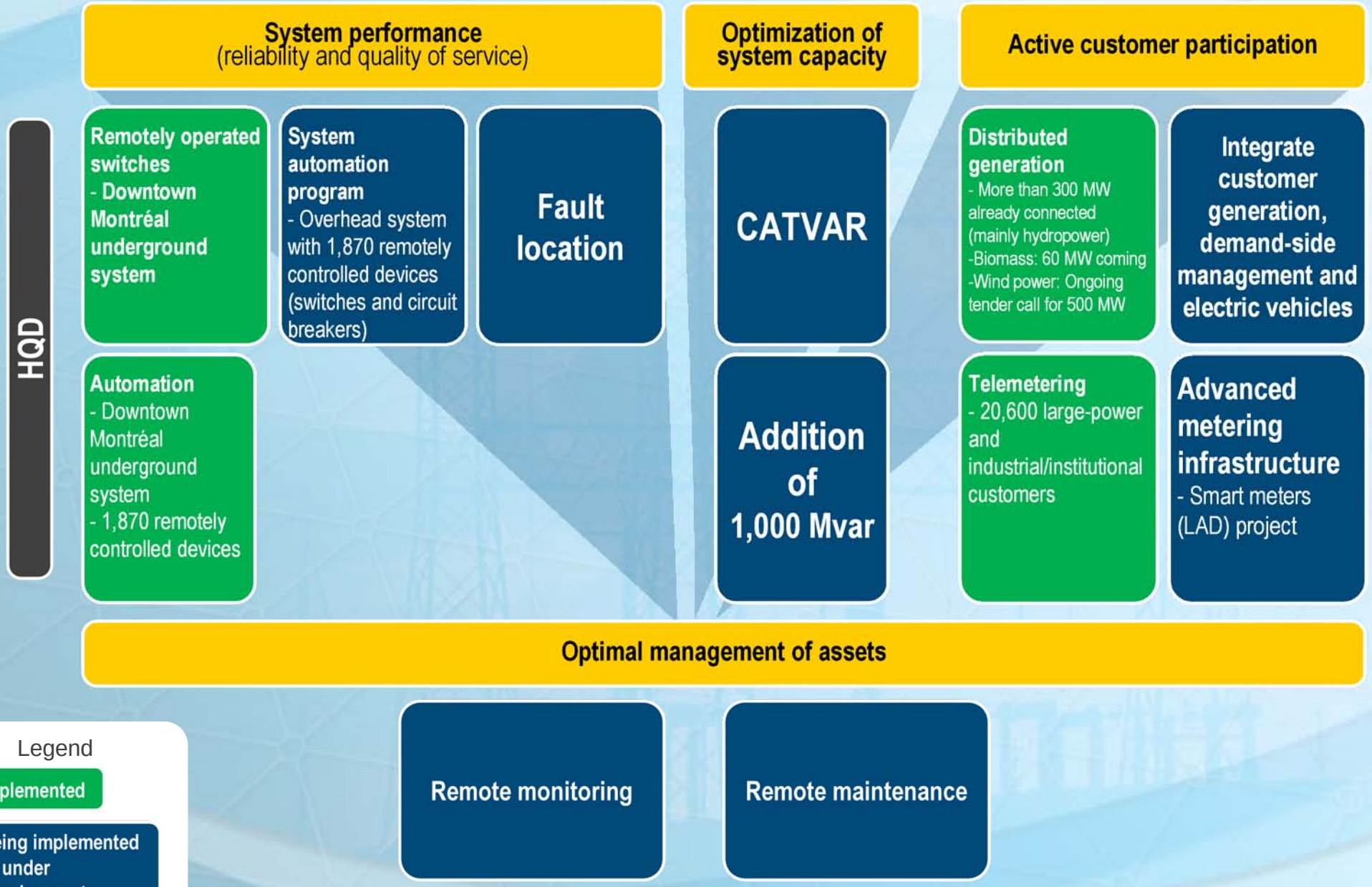
HQD Smart Grid – Framework



HQD Smart Grid – Issues

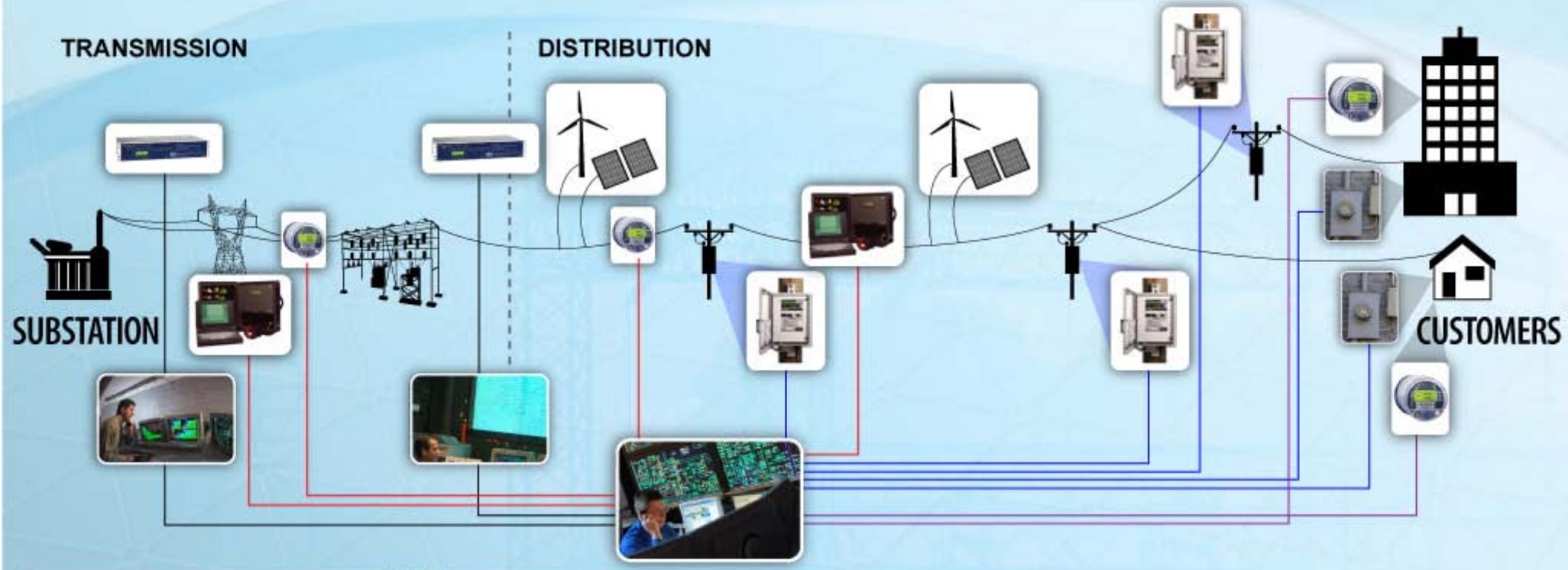
- **Telecommunications network**
  - Designing reliable, secure infrastructure
  - Minimizing capital expenditure and operating costs
- **Information technology**
  - Data management – quantity and quality
  - Besides conventional (alphanumeric) data, introducing on a large scale the management of vector and waveform data
  - Cyber security
- **Standardization**
  - Developing international interoperability standards through ongoing IEC and (U.S.) NIST efforts
- **Managing interaction between equipment and systems**
  - Managing how the various systems interact with one another and impact grid behavior
  - Integrating customer generation

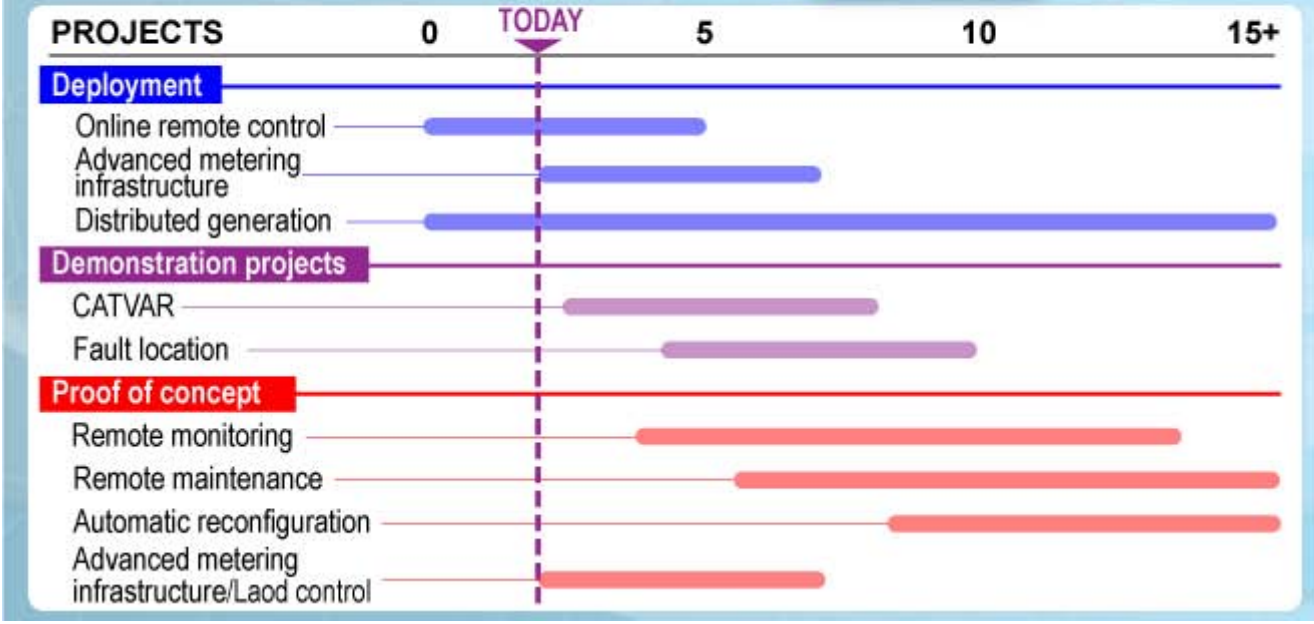
HQD Smart Grid Framework



Hydro Québec Distribution

Achieving a Truly Smart Grid



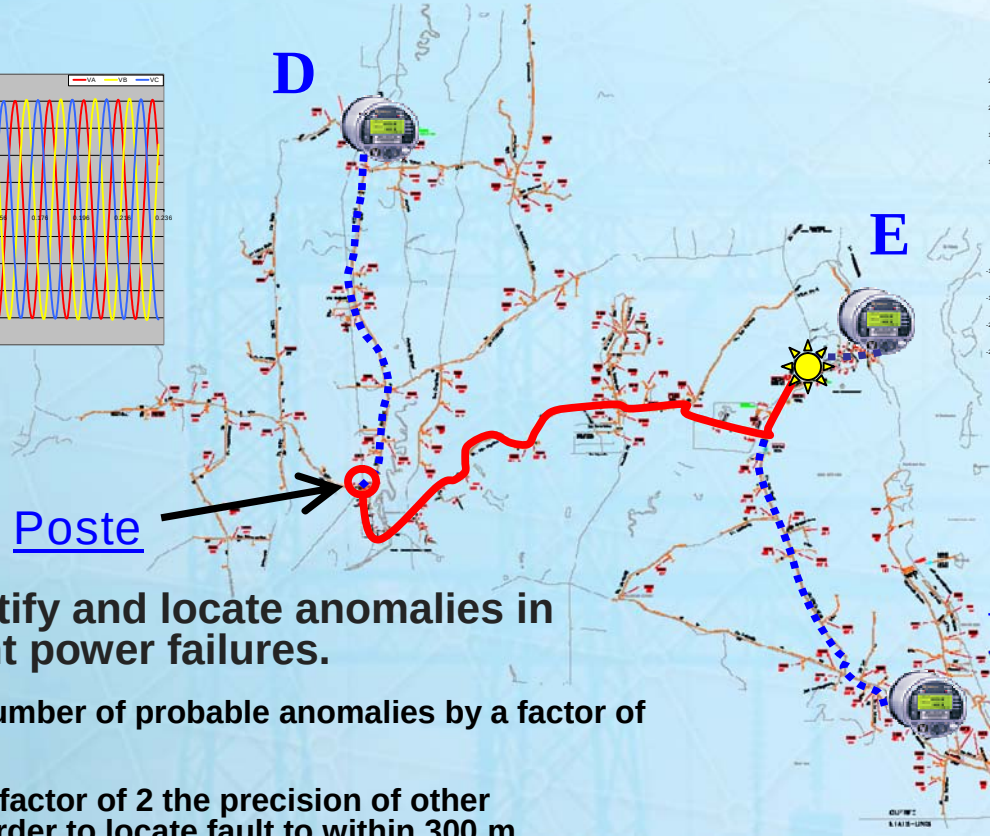


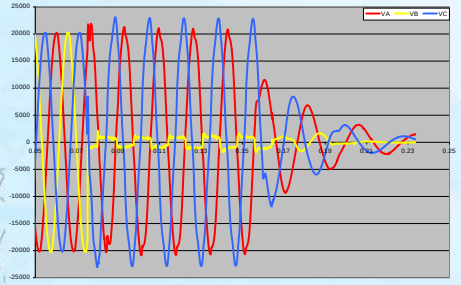
Developing a smart grid based on a plug-and-play approach supported by international standards

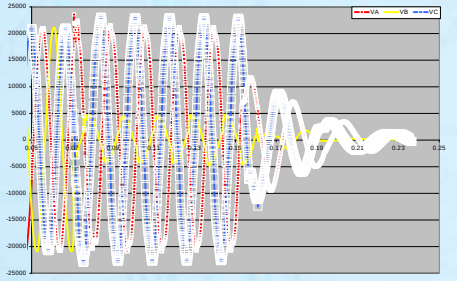
Power System Automation

- **Program approved by the Régie de l'énergie in 2005**
  - Objective: Reduce total interruption duration by targeting customers with over 4 hours of interruption annually
  - Program: Remotely control 3,750 points (switches and circuit breakers) on the medium-voltage distribution system by 2012
  - Current situation:
    - 1,870 remotely controlled points (March 2010)
    - 4,447 remotely controlled operations (2009)
    - Operation success rate: 92%
    - To date, the system average interruption duration index (SAIDI) has improved by about 10 minutes.

Fault Location by Triangulating Voltage Variations

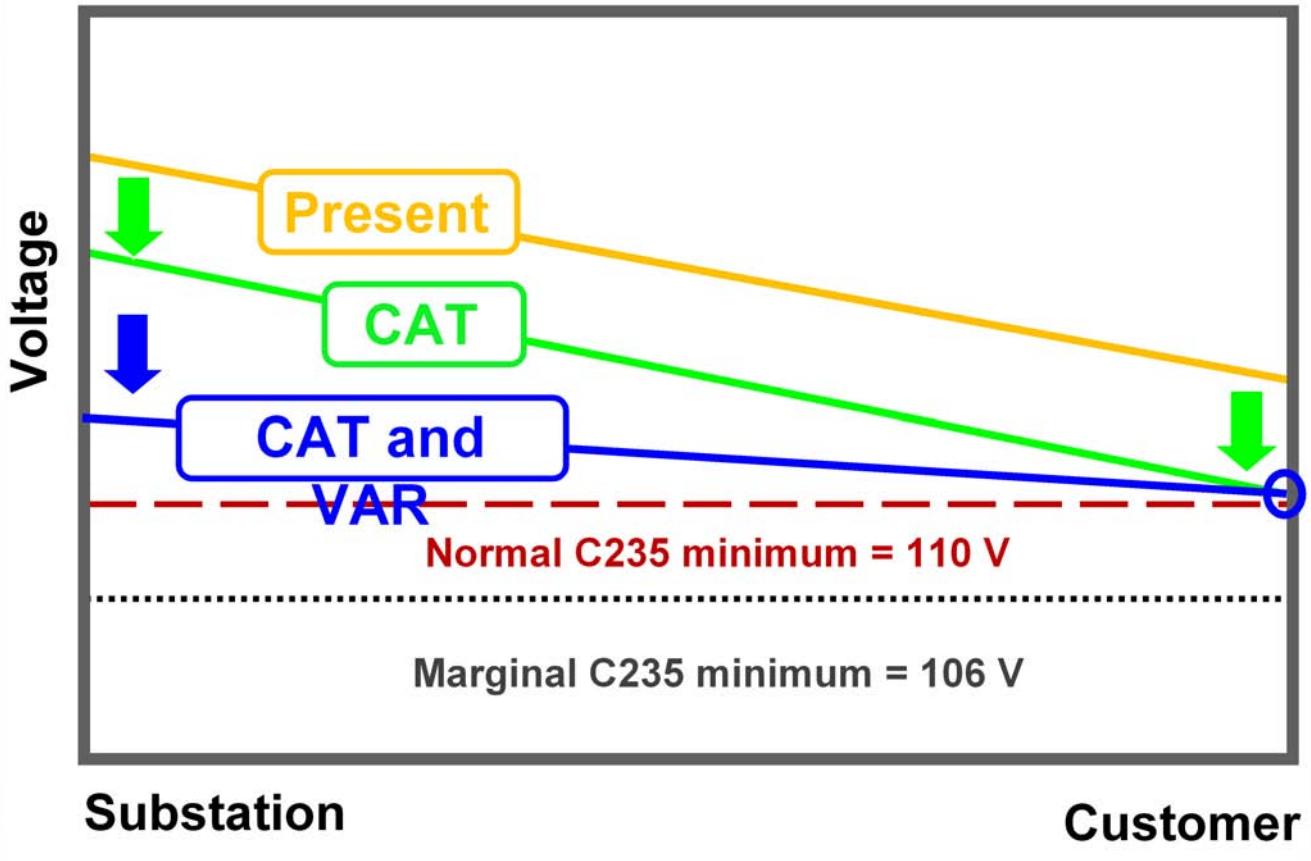






- **Objective: Identify and locate anomalies in order to prevent power failures.**
  - **Reducing the number of probable anomalies by a factor of 10 to 15**
  - **Increasing by a factor of 2 the precision of other parameters in order to locate fault to within 300 m**
- **Accomplishment: Innovative technology developed at IREQ**
  - Software analyzes waveforms over about 10 cycles for very precise fault location.
  - This results in significantly shorter response time.
  - The type of fault is identified for preventive maintenance purposes by comparing with recorded patterns.

CATVAR (distribution system voltage regulation and reactive power control)



- Target for 2015: Energy savings of 11 TWh
- Anticipated contribution of CATVAR: 2 TWh (≈ 20%)
- Development of design began in 2008
- Improvements demonstrated at Pierre Boucher substation
- Filing with the Régie de l'énergie in summer/fall 2010

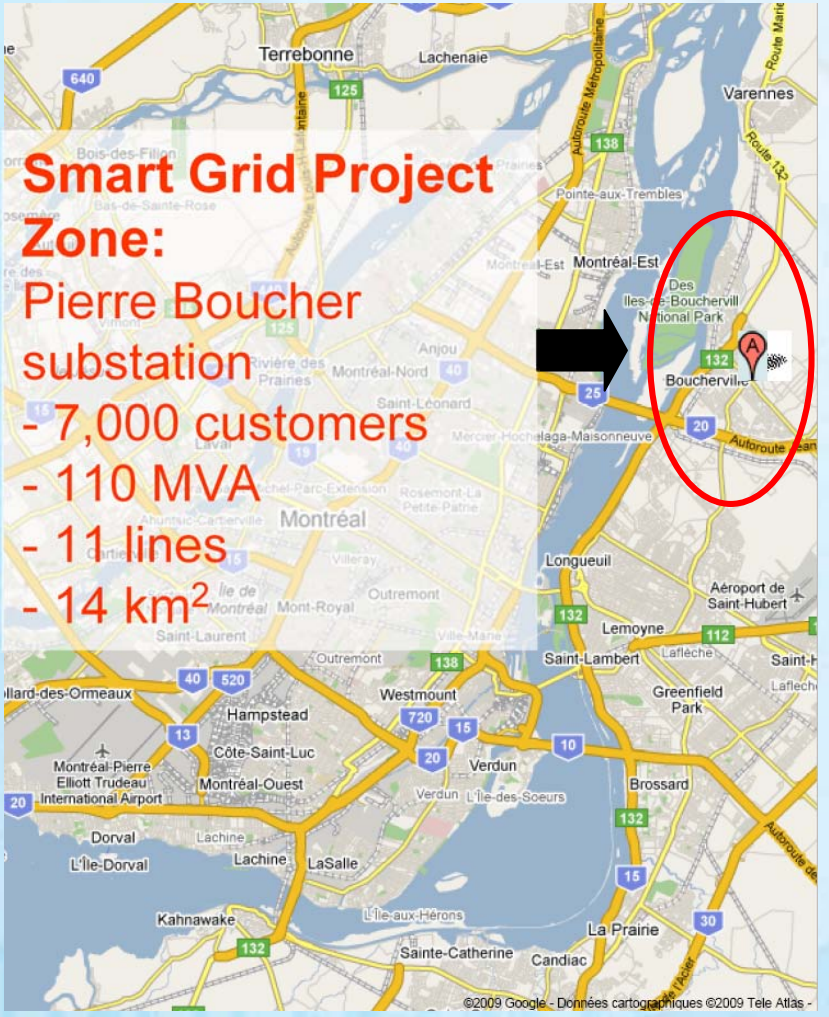
AMI Advanced metering infrastructure Deployment Smart Meters

Description

- **Gradual implementation of an AMI structure for 3.7 million customers to increase operational efficiency and to prepare for the future empowering of the customer (2012-2015)**
  - Reducing the cost for manual meter reading;
  - Reducing the cost for field connect/disconnect;
  - Replacement of end life meters;
  - Allow the evolution of the distribution network
- **Pilot projects will be performed during 2010-2012 to test the technology and the implementation of MDMS (Meter Data Management System)**

Smart Grid Project Zone

- **Zone identified by HQD in 2008 for testing the integration of smart grid applications**
  - Initial implementation of CATVAR
  - Near IREQ
- **Natural Resources Canada interested and participating through the clean energy fund agreement (2009–2015):**
  - DMS/VVO component: voltage control geared to integrating advanced functionality
  - Electrical vehicle charging component
    - Impact of Mitsubishi and Ford/EPRI electric vehicles on distribution systems and recharging infrastructure
  - Advanced networked meter function component
  - Renewable energy component
- **Besides these components, the area will be used to test other applications, including:**
  - System automation and automatic restoration
  - Fault location...
- **Negotiating to have the project included among EPRI Smart Zone demonstration projects, smart grid projects of international scope (Ireland, France, U.S. ...)**



Natural Resources Canada | Ressources naturelles Canada

Hydro Québec Distribution

Conclusion

- HQD has been committed for a number of years now in implementing a smart grid. Six projects have reached the demonstration or implementation phase.
- Projects are selected for developing the HQD smart grid based on business objectives and the energy situation in Québec.
- With the smart grid, more and more data will be available about the state and behavior of the power system. This will make it possible to fine tune system design and operation.
- Existing projects are making the distribution system increasingly interactive, paving the way for a truly smart grid.


Hydro Québec
Distribution
Questions?