Hydro Quebec Roadmap and Vision for Active Distribution Networks

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Presentation outline

• Hydro-Québec's Distribution Vision 2008-2023
• Major Strategies
  • Asset Management
  • Data Management
  • Application and technology management
• Present activities and projects
• DER and DG integration at Hydro-Québec
  • Present situation and expected evolution
• Conclusion
One integrated vision / 3 major strategies

- Asset management
  - Planning future investment ratio

- Data management
  - Preparing data for tomorrow's active distribution network

- Applications and Technology management
  - "smart" engineering and "smart" management to select needed applications
Asset management
Planning future investment ratio

Potential Annual Investment to Ensure Network Renewal

- Relying mostly on:
  - Age of components
  - deteriorating components

- Technical methods for limiting the lifetime of components

Annual Renewal Investment

5-15 years

Potential level of investments

- Relying mostly on:
  - Model for assessment of network renewal costs
  - Technical lifetime of components

Current level of investments

Data Management

Better knowledge of today’s distribution system

Distribution system with adapted Telecommunication Infrastructure

Preparing tomorrow’s distribution system

Data
Measurements
Analysis et Data management

Optimising existing data and IT systems (ATS, SAP, STC, GIS, CED, Metering...)

Prague, 8-11 June 2009
Applications and Technology
Distribution Roadmap major projects

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Remote Control Program
Overhead System

921 remote control points installed up to now (3750 targeted for 2013).

Improved appearance control cabinet
Standard control cabinet
Standard design
Demonstration Project AMI

2,200 customers in three different zones in Québec starting in 2009

Volt and VARS Control (VVC) Intelligent System

The control logic must select the voltage level to use from all the voltage readings from the remote end sensors and capacitors.
R&D Distribution Fault Location
Based on Waveshape Analysis

Hydro-Québec concept: Decentralised monitoring based on voltage waveform only

EPRI concept: Centralised monitoring (in the substation) based on voltage and currents waveshapes

DER and DG integration in active distribution system

• Present situation at Hydro-Québec
• Expected evolution
Distributed generation at Hydro-Québec

- Since 1987, Hydro-Québec is managing distributed energy resources (DER).
- Currently, operating on Hydro-Québec network,
  - Installed capacity 827 MW
  - Distribution 306 MW
  - Transmission 521 MW
- Represents 2.4% of the entire Hydro-Québec's generation (36,000 MW)
- Most of this generation is hydroelectric

Present Distributed Generation in Québec

See below Web Site Address:
Renewable resources at Hydro-Québec

- Hydro-Québec promotes the use of Renewable Energy
  - Call for tenders for wind power
    - 2005-2015: 4 GW (on transmission system)
    - 2009: 500 MW (max 25 MW per project expected on Distribution feeders)
- Hydro-Québec Distribution's Program:
  - Since June 2006 Net Metering Option (≤ 50 kW) – 9 customers

Net metering program in Québec

Net metering is a program that allows customers to generate their own electricity and stay connected to the Hydro-Québec grid. It is designed to support the growth of renewable energy sources such as solar, wind, and hydroelectric. Customers can choose to install solar panels, small wind turbines, or other renewable energy systems and connect them to their home or business. The net metering program allows customers to receive credits for the excess electricity they generate, which can be used to offset their energy consumption or sold back to Hydro-Québec.
Today - Few Dispersed Generation

- Current situation
  - Low penetration
  - Most of this generation is permanent and steady (Hydraulic)
  - Use of stand-by generator only disconnected from the network
  - Very few islanding cases (not economical for producers)

- Development
  - Interconnection standards constantly adapted to new technologies
  - Being dispatchable, DER are easily managed for operation
  - Islanding allowed through current regulation for emergency back-up within each customer installation or rare special application

Tomorrow - More Dispersed Generation

Tomorrow
- Growing interconnection of intermittent and some new dispatchable generation (wind energy, solar energy, CHP, etc.) and possibly energy storage

Development needed
- Planning tools to check voltage control and fluctuation with permanent and intermittent DER
- Merging Distribution Automation (DA) with DER (including Electrical Vehicles)
Prague, 8-11 June 2009

Planned Islanding CIRED Paper 2007

Abstract

Recently, planned islanding—providing the backbone of smart distribution systems—has been one of the solutions to ensure a secure supply of energy. Islanding technology is a complex issue that has to be considered in order to improve the reliability of the system. This paper summarizes the process of planned islanding and the necessary changes that are needed to improve the reliability of the system. The paper also provides a review of planned islanding in order to identify the benefits and challenges associated with the implementation of these changes.

Keywords:

- Islanding
- Reliability
- Smart Distribution Systems

VVC with more dispersed generation

- Maintaining an acceptable voltage profile for all the distribution system for a growing number of generation permanent and intermittent of all sizes and anywhere on the system
- Integrating the intelligent home including the electric car
R&D Distribution Fault Location
Based on Waveshape Analysis

- The logic to locate fault can be affected by the growing number of dispatchable generation

**Future (Micro-Grids)**
- DER widely spread through distribution network
- When Micro-grid operation is needed and justified (reliability, costs…)
- Some DER could provide energy to neighbours

**Development needed**
- Prediction and planning tools (intermittent and dispatchable productions vs. loads for islanding)
- Modification to interconnection standards to adapt to micro-grid configuration
- Evaluate safety risks
- Distribution automation (DA)
- Penetration of intelligent houses including electric vehicles
- Change in regulation and by-laws to allow DER to provide energy to utility customers
Pushing the intelligence - Micro-Grid concept

- Volt and Var Control
- Distribution Automation
- AMI
- Fault location

• Micro-grid shall merge distribution automation applications and intelligent domestic applications

Hydro-Québec - IREQ Distribution Test Line

• Characteristics
  - Fully instrumented
  - Large motor load to evaluate inrush
  - Transformers for inrush
  - Capacitor bank for switching transients
  - Can apply faults
Active distribution tests performed

- Distribution Automation related tests (Hydro-Québec)
  - Distribution Automation
  - Volt and Var control
  - Pulse Closer technology (EPRI Project)
- DG/DER related tests
  - Hydro-One
    - Test on Reverse Power Flow in a Distribution Transformer due to Distribution Generation (DG) on step-down transformers (2008)
  - Canmet ENERGY projects:
    - Anti-islanding relays
    - Voltage regulation with DER.

Hydro-Québec - IREQ Distribution Simulation

- World class power system network simulator
- Transmission and distribution DG and DER modeling and simulation experience
- Projects
  - Development of reduced-model for the simulation of large wind farms for integration studies. (Hydro-Quebec TransÉnergie)
  - Modeling and power system simulation study of wind-diesel generator system on distribution network. (USA, Mauritania)
  - Design of various wind turbine model and other distributed resources model. (Korea EPRI, The Mathwork inc. USA)
Prague, 8-11 June 2009

**Long Term Vision of Active Distribution System**

Integrating the customers load and generation into the Active Distribution system through Plug and Play devices

Source: Electrical Power Research Institute (EPRI) USA

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**Conclusion**

- Hydro-Québec is having projects and is conducting researches related to active distribution system
- Development is needed for the following:
  - Adapting interconnection standards to new technologies
  - Tools to plan and operate large numbers of DER (intermittent and permanent on a distribution system)
  - Regulation changes to allow inter-customers energy flow
- Long term micro-grid vision
  - Integrating Distribution Automation applications (Volt and VAR Control, automatic reconfiguration…) with intelligent domestic applications (load and production management, intelligent appliances, electric cars…)
  - Develop Plug and Play equipment for Distribution equipment and intelligent houses