Hydro Quebec Roadmap and Vision for Active Distribution Networks

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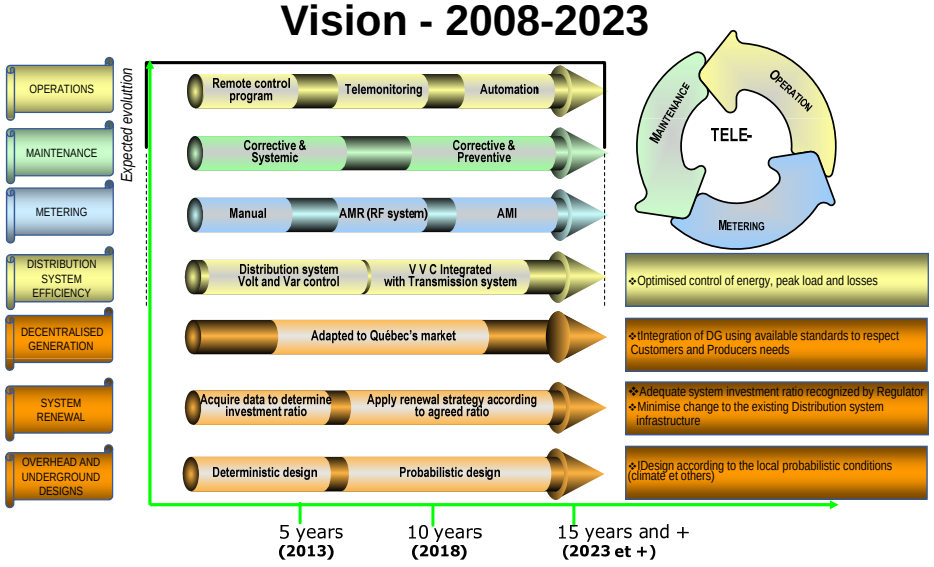
Prague, 8-11 June 2009

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

Hydro-Québec Distribution System Vision - 2008-2023



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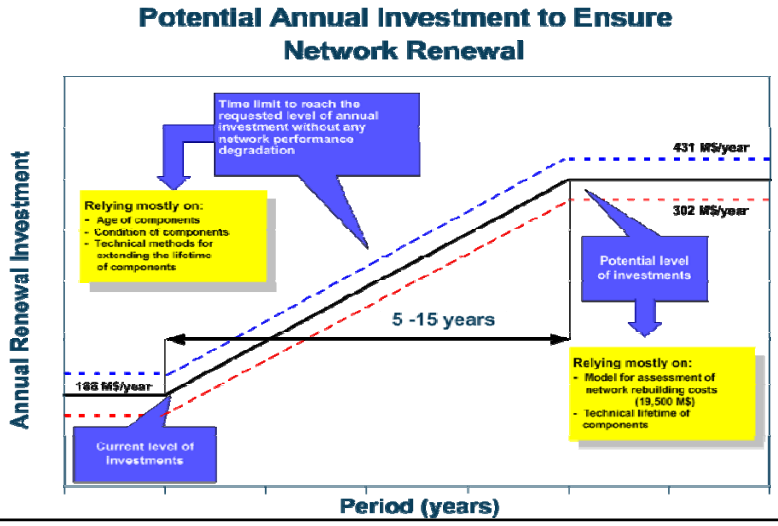
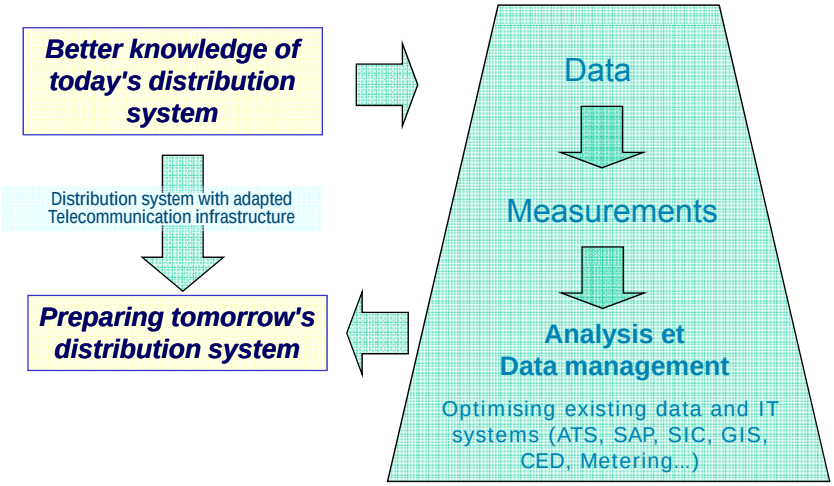
One integrated vision / 3 major strategies

- 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

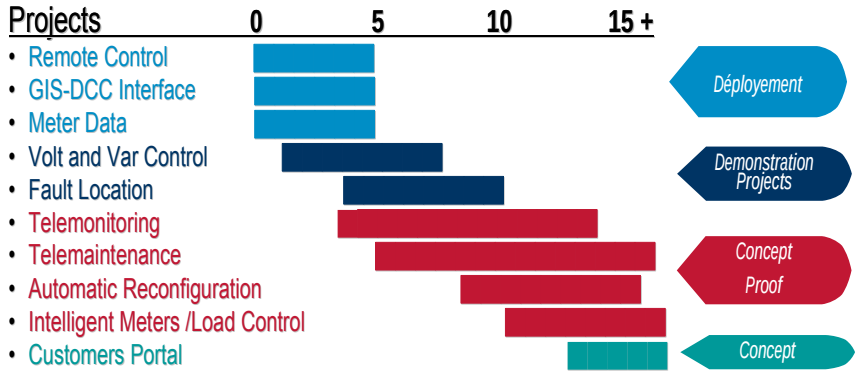
Asset management
Planning future investment ratio



Data Management



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).

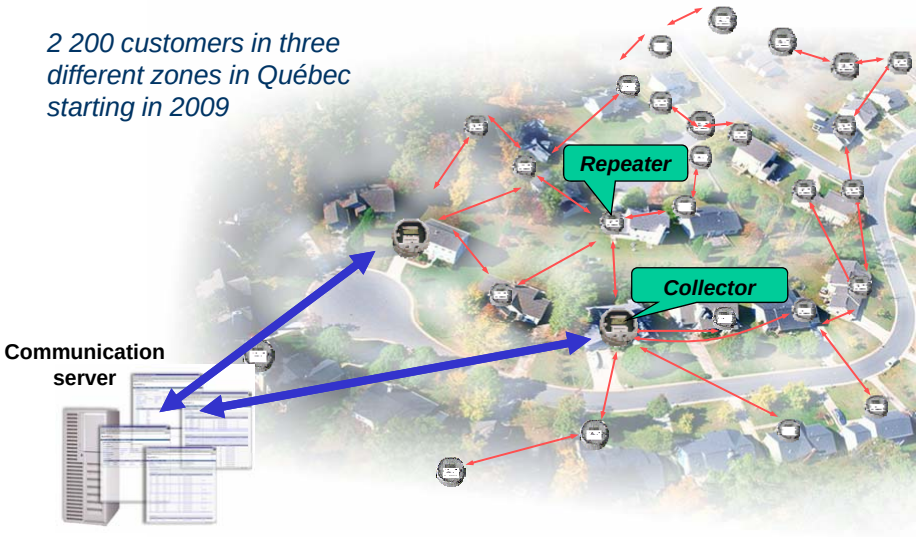
Improved appearance control cabinet

Standard control cabinet

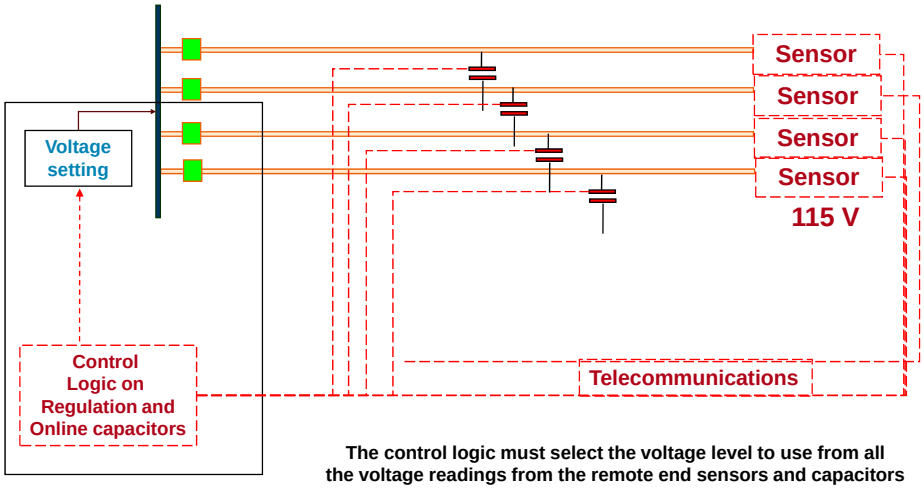
Standard design

Demonstration Project AMI

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

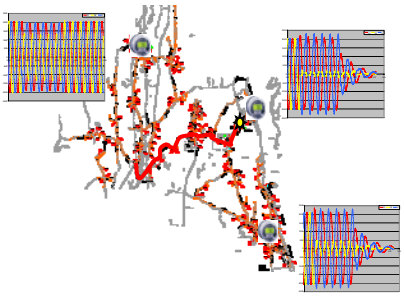


Volt and VARS Control (VVC) Intelligent System

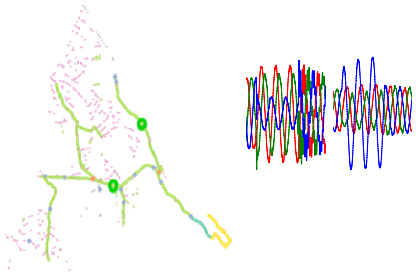


The control logic must select the voltage level to use from all the voltage readings from the remote end sensors and capacitors

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

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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

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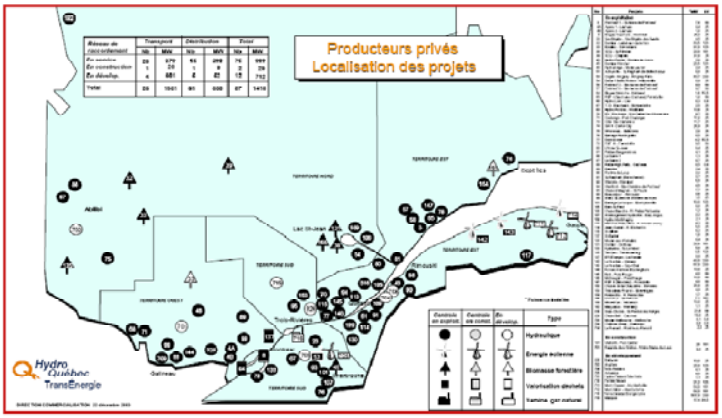
Present Distributed Generation in Québec



See below Web Site Address:

http://www.hydroquebec.com/transenergie/en/commerce/producteurs_prives.html

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 25MW per project expected on Distribution feeders)
- Hydro-Québec Distribution's Program:
    - Since June 2006 Net Metering Option (≤ 50 kW) – 9 customers

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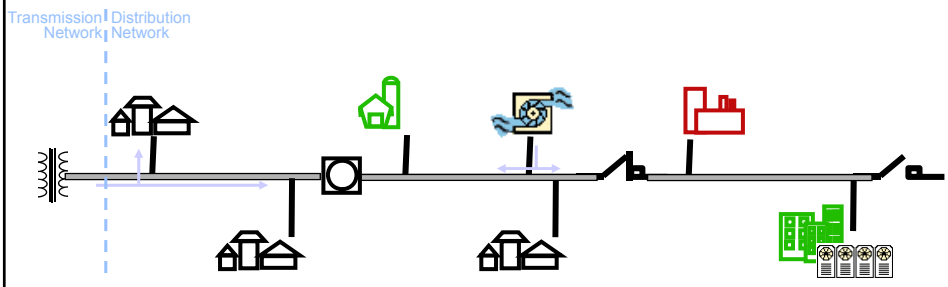
Net metering program in Québec



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

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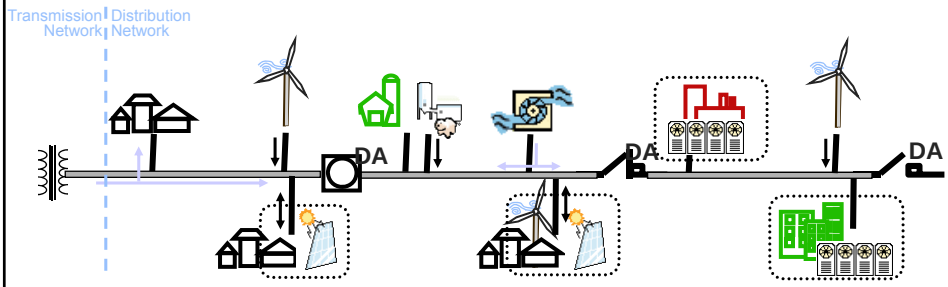

Tomorrow - More Dispersed Generation

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)

Planned Islanding CIRED Paper 2007

CIRED 19th International Conference on Electricity Distribution Vienna, 21-24 May 2007

Paper 0270

PLANNED ISLANDING AS A DISTRIBUTION SYSTEM OPERATION TOOL FOR RELIABILITY ENHANCEMENT

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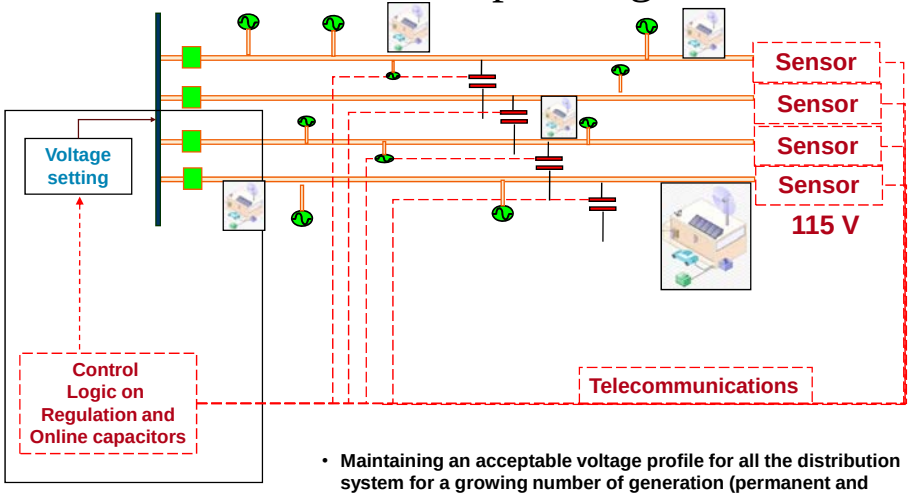
ABSTRACT

Recently, planned islanding—operating the distribution system in isolation from the main grid—has been recognized as a distribution planning tool that can be used to improve the reliability of the system. This paper considers the process of planned islanding and the necessary steps that need to be taken in order to make it a successful project. We draw on experience from Canadian utilities in this area and detail the studies that were carried out in order to plan for the operation of a planned island by the country's largest utility, Hydro-Québec (HQ). This project needed close collaboration between the Distribution and Transmission engineers to attain the reliability improvement for the distribution customers when a planned outage is needed on the transmission line. The outcomes of

Reliability improvement is the motivation for planned islanding case studies in Canada. BC Hydro has been one of the leaders in this area having successfully operated a planned islanding project for over a decade [2], and have gone as far as developing an islanding guideline, which is published on their corporate website, [3]. Planned islanding has also been performed at Hydro-Québec for many years; one of the latest projects is discussed in this article.

With its 35 GW of installed power generation, Hydro-Québec (HQ) is one of the most important utilities in Canada. Mostly hydraulic, HQ generation is almost entirely renewable energy. With the most extensive transmission system in North America [4], this utility provides electricity to more than 3.7 millions customers,

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) is a challenge**
- **Integrating the intelligent home including the electric car**

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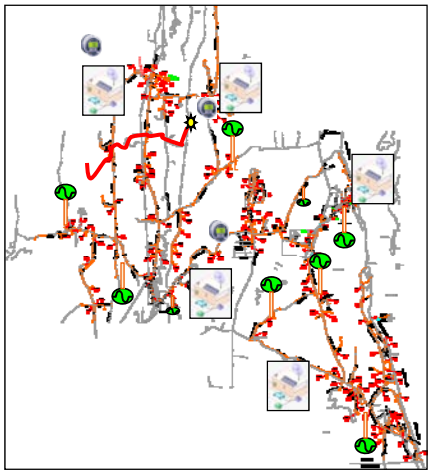
R&D Distribution Fault Location Based on Waveshape Analysis



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

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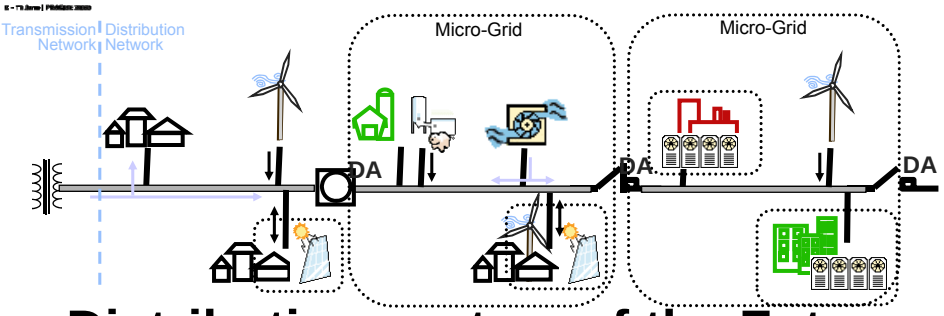


Distribution system of the Future

Future (Micro-Grids)

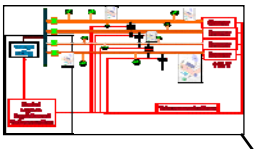
- DER widely spread through distribution network
- When Micro-grid operation is needed and justified (reliability, costs…)
- Some DER could provide energy to neighbours

Development needed

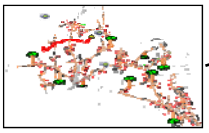
- Prediction and planning tools (intermittent and dispatchable productions vs. loads for islanding)
- Modification to interconnection standards to adapt to micro-grid configuration
- Evaluate safety risks
- Distribution automation (DA)
- Penetration of intelligent houses including electric vehicles
-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

Pushing the intelligence - Micro-Grid concept

Distribution Automation

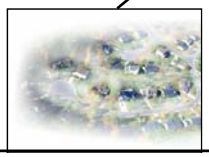


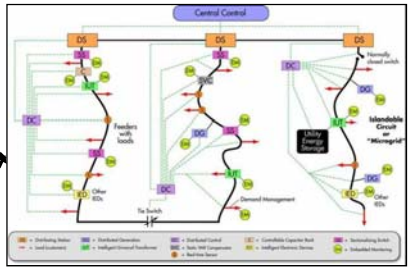
Volt and Var Control



Fault location

AMI





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

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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.

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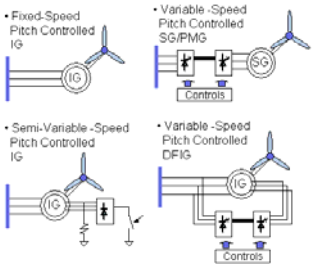
Hydro-Québec - IREQ Distribution Simulation

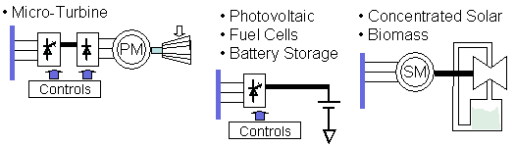
•World class power system network simulator

•Transmission and distribution DG and DER modeling and simulation experience

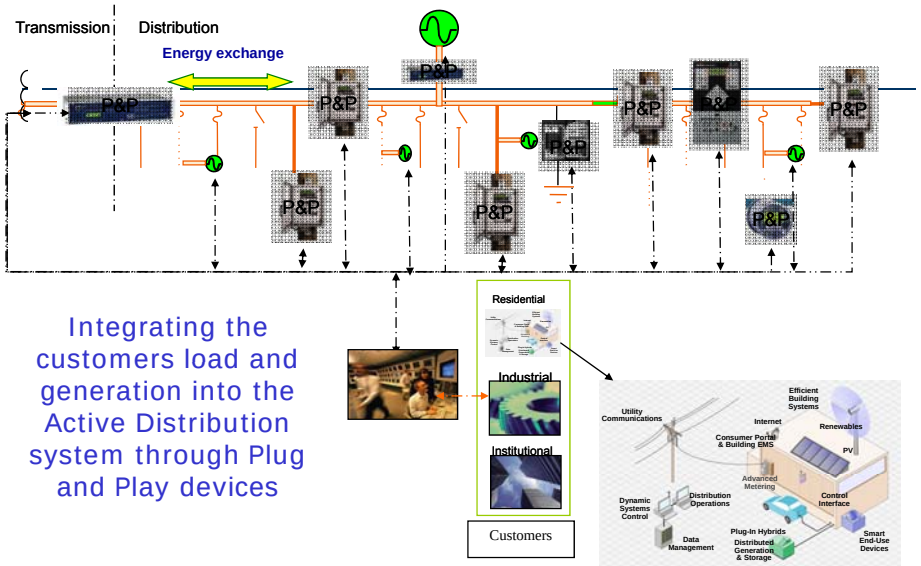
•Projects

- 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, Mauritanie)
- Design of various wind turbine model and other distributed ressources model. (Korea EPRI, The Mathwork inc. USA)





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