Active Distribution Networks: Canadian Example Projects

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Overview

- Background
  - Active distribution networks – integration of DER and distribution automation
  - Canadian context
- Utility projects
- Natural Resources Canada initiatives
- Standardization activities
- Summary
Power Systems in Canada

- **Electricity – provincial jurisdiction**
  - Mix of deregulated and vertically integrated companies
  - Provincially owned: BC Hydro, Sask Power, Manitoba Hydro, Hydro-Quebec, NLH
  - Competitive markets: Alberta, Ontario

- **Active distribution network drivers**
  - Smart meter initiatives
  - Conservation
  - Reliability
  - Ageing infrastructure – grid modernization
  - DER – feed-in tariffs, e.g. Standard Offer Program
Ontario – DER Integration
Canadian Utility Projects

- ADA technologies being implemented
  - AMR, AMI
  - Fast reconfiguration – S&C IntelliTeam products
  - Fault locating technologies
  - Voltage reduction schemes
  - Remote monitoring
  - Planned islanding

- Initiatives: Ontario Smart Grid Forum, CEATI Taskforce on Smart Grid, dedicated spectrum

- Utility examples: Hydro-Québec, Toronto Hydro, Hydro One, ENMAX, BC Hydro
Ontario Smart Grid Forum

- Participation
  - Led by IESO
  - Utilities, suppliers, government

- Objectives
  - Develop a high level vision of Ontario Smart Grid
  - Educate industry leaders on drivers, technologies, and opportunities
  - Identify enablers and barriers

- Outputs
  - Report on findings and recommendations
  - Website: http://www.theimo.com/imoweb/marketsandprograms/smart_grid.asp
CEATI Smart Grid Working Group

- Centre for Energy Advancement through Technological Innovation (CEATI) International

**Objectives**
- Definition of Smart Grid
- Action plan for development of the Smart Grid
- Identify technology gaps
- Successful strategies for implementation of the Smart Grid

**Status**
- Initial teleconference – Aug. 2008
- Kick-off meeting – Nov. 2008
Utilities Telecom Council (UTC) Canada request dedicated CI spectrum

- Spearheaded by 5 Canadian utilities
  - Intelligent grid: energy conservation, station security, distribution automation, real time outage management, new power generation (small distributed facilities).
  - Rural networks requires spectrum with good propagation
  - 700 MHz range comes with a premium

- Industry Canada proposal
  - 30 MHz contiguous frequency block in the 1.8 GHz band
  - Relax the SRSP (Standard Radio System Plans) 301.7 to accommodate point-to-multipoint topologies

- Widely supported by respondents
Hydro-Quebec Plan
Advanced Distribution Automation

Technologies

Data
- Voltages
- Load currents
- Fault currents
- Temperature
- Operations monitoring

Functionalities
- Voltage control
- Optimised load flow
- Fault location
- Equipment failure detection
- Power Quality evaluation

Business needs
- Improving reliability
- Reduce costs
- Energy efficiency
- Customer satisfaction...

Source: G. Simard, HQ Distribution
Hydro One

Source: Richard Bertolo, Hydro One Networks
ENMAX – IntelliTEAM II – A Distributed Control System

Team Structure

- A team consists of a line segment bounded by intelligent switches
- Switches can belong to one or two teams
- A team may have from one to eight switches
- Teams are building blocks
- Interconnected teams form a self-healing electrical network

Source: Dean Craig, ENMAX
BC Hydro – Volt/Var Optimization

VVO - In very basic terms:

- The amount of energy savings is contingent upon the voltage profiles for all feeders, load composition, time of year, and many other factors.
- Feeder will experience voltage drop, depending on conductor size, load, and distance. Peak load (solid line) has more voltage drop than light load (dashed line).
- Load tap changer at the substation can lower the voltage during light load, yet remain within operating limits at the service entrance.
- With VVO, load tap changers, capacitor banks and voltage regulators are continuously fine tuned throughout the year. The net effect is a flattening of voltage drop and lowering voltages at non-critical points resulting in substantial energy savings.
- There is some voltage uncertainty, minimized by metering at select service entrances.
- Implementation of SMI can provide enhanced accuracy to critical points along the feeder. This additional data, when properly applied to the VVO algorithm, will result in further energy savings benefit.

Source: Craig Befus, BC Hydro
NRCan - Grid Integration Program

- **Role of governmental lab**
  - Address technical and regulatory barriers to DG
  - Provide much needed research support to many distribution companies
  - Coordinate collaboration nationally and internationally

  - Active distribution networks
  - Modeling, simulation and validation of DER
  - Communication and DER standards support
Test Facilities

- **Low voltage test facility (CETC-V):**
  - Multiple inverters and interconnection testing
  - 120-kVA, 3ph Grid simulator
  - 5kW/15kW Solar Simulator
  - Adjustable RLC loads

- **Medium voltage test facility (IREQ-HQ):**
  - Distribution automation network testing
  - A radial 25-kV feeder (20 poles, 370m)
  - 300-kW, 600 V, resistive, inductive and motor loads
  - Power quality meters
DA / DER Standards Development

- IEC TC 57 – Extension of IEC 61850
  - WG 17 – object models for DER
  - Common information models (CIM) for distribution automation
  - Interoperability (near-term), Plug-and-play (long-term)
- IEEE 1547 series
  - IEEE 1547.2 – Application guide
  - IEEE 1547.3 – Communication models
  - IEEE P1547.4 – Design and operation of DER Islands
  - IEEE P1547.6 – DG in meshed/spot networks
Summary

- Two technology pushes
  - DER – policy driven
  - ADA – utility efforts to modernize the grid
- Improved integration needed
  - Support utilities in DER integration – pilots and demonstration, regulatory, standards
  - Leverage information communication technology investments
- NRCan project activities: Active distribution networks, modeling tools, communications, and support for harmonization of standards
Questions?

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