Project Manager: Chad Abbey  
CANMET Energy Technology Centre - Varennes

Introduction
Distribution networks were originally conceived with the assumptions of unidirectional power flow and that they were passive in nature. The advent of distributed generation (DG) has disrupted these notions, in some cases to the extent that planning and operation of distribution networks, in addition to the tools and equipment associated with this process need to be completely re-evaluated. Because complete redesign and construction of the distribution network is not a practical option, the impact of these new technologies needs to be assessed as they are integrated and the system and processes related to its planning and operation need to evolve in consequence. CANMET Energy Technology Centre - Varennes through collaboration with national, provincial and international partners has strategically focused its resources to facilitate this process through the project entitled: impact of large-scale integration of distributed generation to the grid (IMPACT).

Activities & Results
Over the course of its existence, this project accomplished significant gains in the following areas: model development and validation, development and application of distribution system benchmarks, national research network building and international collaboration, and improving communication. Highlights of this project include:

- **Modeling and validation of distributed generation models;**
  - PV power quality modeling and validation for high penetration PV neighbourhoods
  - CYMDIST and MATLAB-SPS comparison of DG impact on voltage regulator operation

- **Software tools to streamline DG integration studies;**
  - Industry modeling and knowledge needs analysis
  - Collaborative project with CYME T&D International to enhanced tools
  - Development of a number of industry-based CYMDIST case studies

- **Distribution system benchmarks for impact studies;**
  - CIGRE C6.04.02 working group on benchmark development for the study of distributed generation
  - Canadian urban and suburban benchmark

- **Assessing the impact of DG**
  - Voltage regulation operation
  - Power quality
  - Protection and coordination
  - System stability

- **Provide solutions and industry guidelines**
  - CIGRE C6.04.01 working group on connection requirements
  - Guideline on protection coordination with DG

- **Investigate the potential for planned islanding and microgrids in Canada.**
  - Documented Canadian planned islanding case studies
    - BC Hydro Boston Bar
    - Hydro-Québec Senterre
  - Conjointly organized (EU-Commission, US-DOE, CEC-PIER, UC-Berkeley) and in 2006 hosted the 2nd International MicroGrid Symposium
  - Number of publications in the area
Discussion and Next Steps

This T&I project has made substantial progress during the past 4 years and led to a significant number of technical reports and publications in collaboration with national and international partners. As a result, the R&D research network was able to attract qualified experts, engage the industry and tackle key technical issues. The next step requires work to assess the role of DG and enable technologies to make the smart grid of the future a reality.

There are a number of PERD funded projects that have initiated this year that will support this transition, these include:
- Assessment of multi-inverter performance and development of standard requirements
- Distributed generation technology and assessment
- Microgrids and remote minigrids
- Active distribution networks

Budget

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Project Team
- F. Katiraei, CETC-V, Natural Resources Canada
- G. Joos, McGill University
- A. Narang, Kinectrics
- R. Iravani, University of Toronto
- W. Xu, University of Alberta
- L. Chang, UNB
- K. Mauch, Mauch Technical Services
- G. Simard, M. Gauthier - Hydro-Québec Distribution
- E. Lecourtois – LTE-Hydro-Québec
- R. Gagnon, Y. Brisette – IREQ-HQ
- H. Iosfin, S. Tang – BC Hydro
- R. Bahry – FortisAlberta
- M. Coursol, A. Morched – CYME T&D International
- CIGRE TF C6.04.01 members – Convenor: N. Hatziargyriou – 14 countries
- CIGRE TF C6.04.02 members – Convenor: K. Strunz – 14 countries
- CIGRE TF C6.11 members – Convenor: C. D’Adamo – 14 countries
- International Microgrid Symposium Organizing Committee – Chair: C. Marnay

References & Publications


**Figure 1** – Participants at the Second International Microgrid Symposium, held in Mont-Tremblant, June 23, 2006

**Figure 2** – CYMDIST Software Tool Flyer for DG Modeling Enhancements
Figure 3 – Single line diagram for the Canadian suburban benchmark distribution system

Figure 4 – PV neighbourhood model validation: (a) experimental and simulated PV inverter output currents at 50% power; (b) table summarizing model and physical inverter harmonic contents; and (c) curve fitting of load model to measured load data.