

Canadian Electricity Storage Program

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Canada has a number different types of electricity markets and a mixed number of generating sources serving urban areas like Toronto and rural areas in the far north. These present different opportunities and challenges for distributed energy technologies, including electricity storage, across Canada. The opportunities in remote communities and metropolitan cities alike include increased reliability, peak shaving, and firming renewable energy technology.

Electricity is largely a Provincial jurisdiction in Canada. As a result, the electric utilities and their grid systems follow provincial boundaries with interconnections between the 13 provinces and territories.

Figure 1: Canadian Electricity Grid (Courtesy of Global Energy Network Institute – GENI)

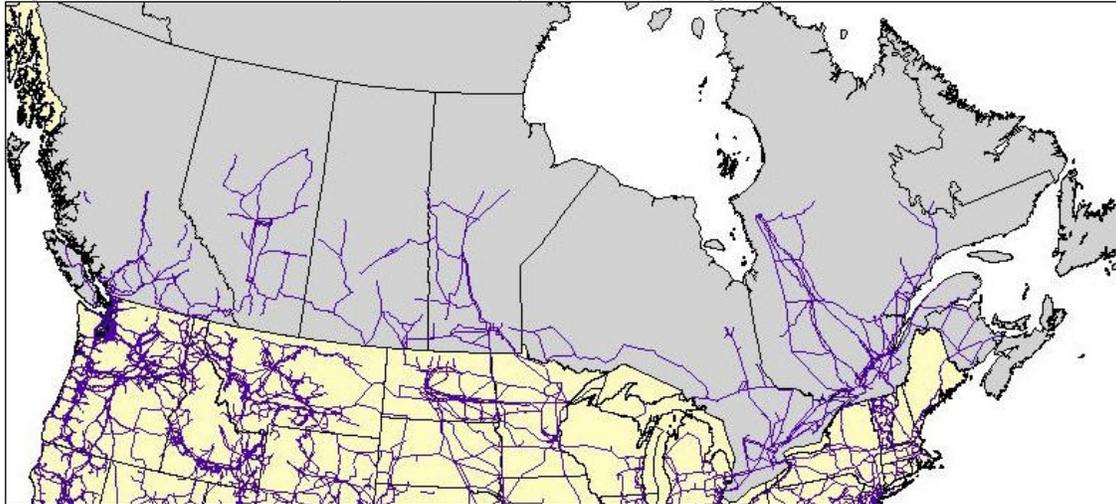
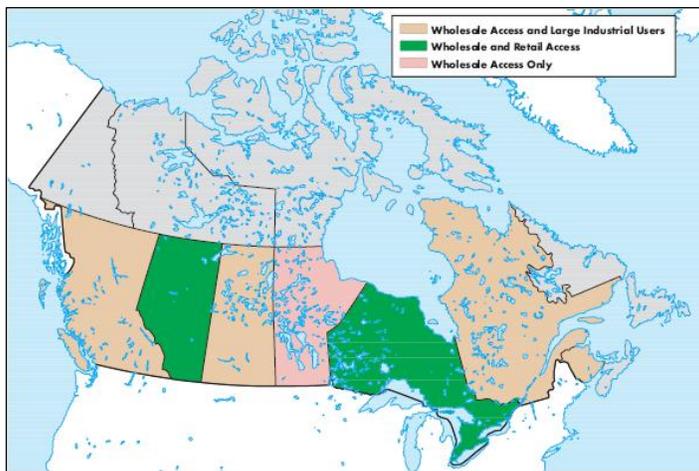


Figure 2: Status of Restructuring as of 1 April 2005 (Courtesy of the National Energy Board)



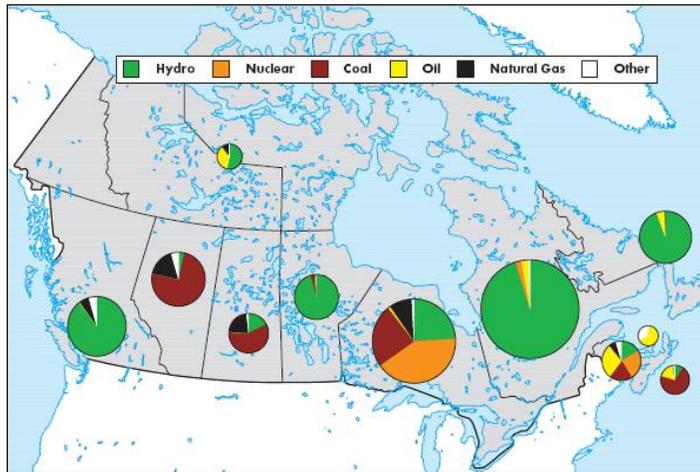
In the past, most utilities were vertically integrated and regulated, providing transmission, generation and distribution services. Nowadays, over 70% of utilities in Canada are still provincially owned while incorporating new market structures to separate these services and develop a competitive market. While these changes are underway, policies and regulations are adapted to meet the needs of the new structure and improve it. Of the provinces and territories in Canada, Alberta and Ontario are the furthest ahead in terms of restructuring to achieve a truly competitive wholesale market. Both

Provinces offer wholesale access to distribution companies or other large buyers to purchase electricity based on the best price. In addition, consumers are provided retail access to select from several suppliers of electricity. In British Columbia, Saskatchewan, Quebec and New Brunswick, wholesale markets are in place but access to the retail market is restricted to large industrial consumers. It is still debated whether restructuring to a competitive market will lead to the lower prices and increased innovation that is intended. It can be argued that although restructuring can provide market opportunities for electricity storage, traditionally

vertically integrated utilities can directly benefit from the multiple value streams that electricity storage technologies offer.

As to be expected, over half of the gigawatt hours delivered in Canada are provided by hydro power production facilities. However, this is not the case for each province or territory. While Quebec's source of electricity is predominantly served by hydro (over 95% or 169,491 gigawatt hours) [1], other provinces such as Alberta rely almost entirely on fossil fuels, meanwhile other provinces like Ontario and New-Brunswick have an uneven mix of generation from fossil fuels, nuclear, hydro, wind and other technologies.

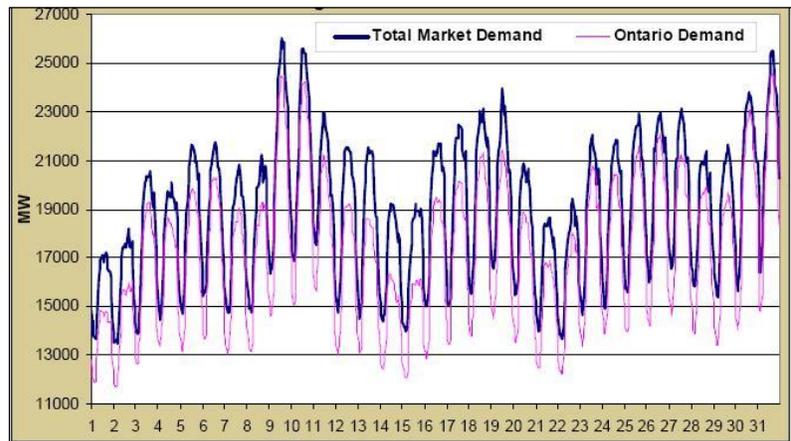
Figure 3: Canada 2003 generation by fuel (Courtesy of the National Energy Board)



The provinces are now feeling strong political pressures from environmental concerns and very real impacts on their health care system due to the pollution caused by generating stations. The Ontario Medical Association claims that coal-fired generation health impacts are estimated at nearly \$10 billion dollars annually. In response to this the Ontario Ministry of Energy announced the closure of the coal plants two years ago with a target date of 2007, which was later pushed back to 2009 and then finally to 2014. The reality of the situation is that coal plants represent 25% of the power generation for Ontario, and provide

roughly a third of the power necessary to meet the peak demand for the province, along with natural gas and peaking hydro plants. The government is actively pursuing new generation options, technologies to reduce emissions and demand side management programs to reduce the peak demand.

As a result of the restructuring and environmental drivers, the province of Ontario provides some of the most interesting market opportunities for distributed generation. The Ontario government has recently announced the long awaited CESOP (Clean Energy Standard Offer Program) initiative in 2007. The program is designed to complement RESOP (Renewable Energy Standard Offer Program) to promote the contribution of electricity to the Ontario grid from distributed generation resources less than 10 MW. CESOP is aimed at small Clean Energy Projects which derive power from burning natural gas or from the capture and use of by-product fuels or under-utilized energy. Eligible projects will receive a flat rate in addition to the Hourly Ontario Energy Price (HOEP) for the kilowatt hours of electricity they provide to the grid. The flat rate varies with time of day, and is intended to promote generation during peak times, thereby reducing peak demand on the grid. In the month of July 2007



for example, the IESO reported that the minimum hourly demand was 11,710 MW while the maximum hourly demand was more than double at 24,561 MW. The average on-peak HOEP for the same month was 5.77 cents per kWh. Combined with the CESOP on peak price of 8.10 cents per kWh, the total average rate received would have been 13.87 cents per kWh [2]. Twenty-year contracts will be awarded for CESOP and

the price rate will be amended on a yearly basis to take inflation into consideration. Electricity storage has not been identified specifically as part of CESOP, but could be considered.

Figure 4: Ontario hourly demand for the month of July 2007 (Courtesy of the IESO)

The northern parts of Canada provide a unique challenge in terms of generation and distribution due to their low population densities, load center distances apart from each other and to potential hydro sites. The territory of Nunavut for example receives one hundred percent of its electricity from diesel generation. Naturally, there is a lot of interest from communities in Nunavut to increase electricity production from wind generation. This is not only due to the high cost to purchase and deliver the diesel fuel, but also because of increasing environmental concerns from the effects of climate change which are significantly amplified in the north compared to the rest of the country. Any renewable energy resources installed however, such as wind turbines, currently require 100% emergency back-up power. This is typically provided by diesel generators but could be replaced by, or combined with, electricity storage technologies thereby reducing emissions and providing fuel savings.

Other provinces with market potential for electricity storage include those with large wind energy potential. Some of the best areas for wind generation in Canada include northern Manitoba, Quebec and Labrador as well as offshore locations.

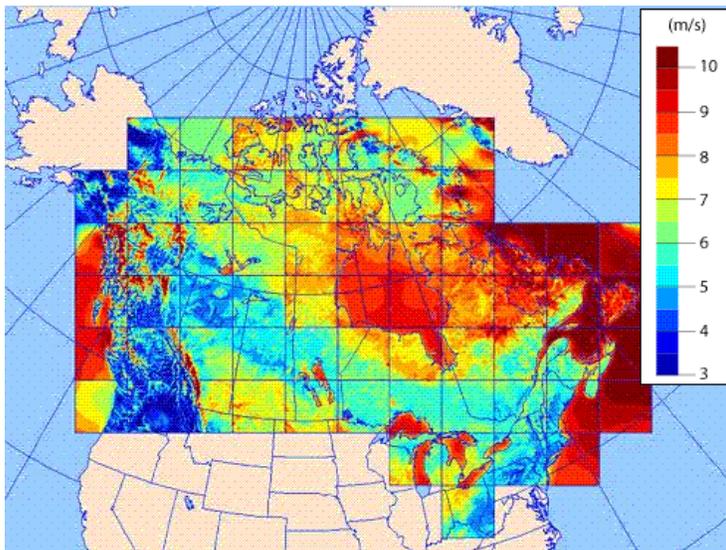


Figure 5: Mean wind speed at 80m (Courtesy of the Canadian wind energy atlas, windatlas.ca)

There are, of course, good wind energy development sites throughout areas Canada which is demonstrated by the number of installations throughout several provinces, possibly due to favorable market conditions or opportunities. Ontario, Alberta, Quebec, Saskatchewan, and Manitoba all boast large wind installation sites totaling 100-500 MW each. According to the Canadian Wind Energy Association (CanWEA), the total installed capacity in Canada is currently 1,588 MW. CanWEA's goal is to have 10,000 MW in place by 2010.

Figure 6: Installed capacity as of July 2007 (Courtesy of the Canadian Wind Energy Association)



Electricity storage offers capacity and transmission planning advantages for these large wind sites. In Ontario for example, the transmission from the northern part of the province to the load located on the shores of lake Ontario is already under stress. The standard offer programs have therefore limited the distributed generation projects and wind farms that can be located in those areas.

Although the generation and distribution of electricity is generally the mandate of the provinces, the energy sector is considered a natural resource by the federal government.

Unlike in the U.S. where the energy sector is represented by the US DOE, in Canada the energy sector falls within the mandate of the department of Natural Resources Canada (NRCan) along with forestry, minerals and metals, landmass, and other related industries. The CANMET Energy Technology Center (CETC) is the energy research arm of NRCan whose mandate is to “develop and demonstrate energy efficient, alternative and renewable energy technologies and processes”. To achieve this, CETC performs laboratory research as well as provides financial support for research and demonstration activities led by private industry, associations, and universities. The Distributed Generation group within CETC is responsible for research on distributed energy technologies that include electricity and thermal generation, and storage.

The distributed generation program at CETC expanded two years ago to include electricity storage, in collaboration with the National Research Council (NRC). Over the past two years the Electricity Storage Utility Group (ESUG) was formed and research projects and in-house technology trials were carried out. Research projects carried out at the CETC lab include testing a 3.3 kW vanadium-redox battery from VRB Power Systems and two U-Charge Lithium Ion batteries from Valence Technologies. In addition to the continued collaboration with the NRC, close links are held with other CETC research areas that have a keen interest in electricity storage such as wind energy and the integration of distributed generation resources.

The ESUG group coordinated by CEA Technology Inc. (CEATI) includes representatives from Canadian utilities interested in electricity storage technologies who provide advice and financing for electricity storage demonstrations. Two such demonstrations led by the U.S. and located in New York and Delaware were approved for support last year. Through consultations with ESUG, future opportunities for Canadian electricity storage projects have also been identified. Electricity storage projects being developed or underway in Canada include some led by several utilities: BC Hydro, Manitoba Hydro (PHeV's), and Halton Hills.

Recently the Minister of Natural Resources Canada announced a new technology funding initiative titled ‘ecoEnergy Technology Initiative’ totalling \$230 million over four years which will support R&D and Demonstration activities. A request for proposal for a storage project is under consideration in the Distributed Power Generation Program of the initiative. Of particular interest will be projects that exploit the multiple value streams typical of electricity storage projects. Results from funded activities will be shared with the regulatory authorities in the provinces so that tariff structures might be amended to accommodate electricity storage.

1 National Energy Board, *Outlook for Electricity Markets 2005-2006*, June 2005

2 IESO Ontario, *Monthly Market Report July 2007*, August 2007