CAMPUT 2016 Energy Regulation Course: Electricity Industry Overview

Geoff Smith
Director, Government Relations, CEA
The Canadian Electricity Association (CEA)

• Founded in 1891, the Canadian Electricity Association is the national forum and voice of the evolving electricity business in Canada.

• Mission Statement: A safe, secure, reliable, sustainable and competitively-priced supply of electricity is essential to Canada’s prosperity.
CEA’s Corporate Utility Members

ALTA LINK
ATCO Electric
ATCO Power
BC Hydro
Brookfield

ONTARIO Power Generation
TransCanada
Hydro Ottawa
Hydro Québec
ENMAX
EPCOR

FORTIS BC
FORTIS ALBERTA
horizon Utilities
hydro one
Manitoba Hydro

SASKATOON Light & Power
Newfoundland Power
Capital Power
NORTHWEST TERRITORIES Power Corporation

NEWFOUNDLAND POWER
A FORTIS COMPANY

Capital Power
NORTHWEST TERRITORIES Power Corporation

Novo Scotia Power
The Gas City

MEDICINE HAT ELECTRIC UTILITY

MARITIME ELECTRIC
A FORTIS COMPANY

TORONTO HYDRO

Saint John Energy
Énergie NB Power

Power Stream

OAKVILLE HYDRO ELECTRICITY DISTRIBUTION

Power Stream

OAKVILLE HYDRO ELECTRICITY DISTRIBUTION

Power Stream

OAKVILLE HYDRO ELECTRICITY DISTRIBUTION

Power Stream
Generating Electricity

- Affects of moving magnets past wire.
  - Moving magnets past a wire makes electrons move through it, thereby generating electricity.
- Energy can neither be created nor destroyed - it can only be transformed (converted) from one form to another.
# Canada’s Multi-Jurisdictional Environment

<table>
<thead>
<tr>
<th>Jurisdictional Division of Responsibility</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Provincial/Territorial Governments</strong></td>
<td><strong>Federal Government</strong></td>
</tr>
<tr>
<td>• Resource management within provincial boundaries</td>
<td>• Resource management on frontier lands</td>
</tr>
<tr>
<td>• Intra-provincial trade and commerce</td>
<td>• Nuclear safety</td>
</tr>
<tr>
<td>• Intra-provincial environmental impacts</td>
<td>• Inter-provincial and international trade</td>
</tr>
<tr>
<td>• Generation and transmission of electrical energy</td>
<td>• Trans-boundary environmental impacts</td>
</tr>
<tr>
<td>• Conservation and demand response policies</td>
<td>• Environmental impacts where federal lands, investment or powers apply</td>
</tr>
<tr>
<td></td>
<td>• Codes, standards and labeling relating to conservation and demand</td>
</tr>
<tr>
<td></td>
<td>• Other policies of national interest</td>
</tr>
</tbody>
</table>
# Canada’s Regulatory Regime for Energy Projects

<table>
<thead>
<tr>
<th>Planning</th>
<th>Environmental Assessment Process</th>
<th>Permitting</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Canadian Environmental Assessment Act - CEA Agency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>National Energy Board Act - NEB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Nuclear Safety and Control Act - CNSC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Impact reviews (YESAA, MVRMA Land Claim / CEAA)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Innuvialuit Final Agreement - INAC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Management Boards</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Territorial Lands / Water Act</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Species at Risk Act - EC/DFO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Metal Mining Effluent Regulations - EC/DFO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Explosives Act - NRCan</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fisheries Act - DFO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>NWPA - TC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Others: MBCA / IBWTA / CPRA / Offshore Accords / CEPA</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Permits required under other Acts trigger CEAA OGD participants*

Illustrative – some components would not apply to same project

NWPA – Navigable Waters Protection Act / YESAA – Yukon Environmental and Socio-Economic Assessment Act
Electricity Demand in Canada by Sector, 2014

Total Electricity Demand in Canada, 2014 = 491.22 TWh

- Residential: 33%
- Commercial & Institutional: 18%
- Industrial: 43%
- Agriculture: 2%
- Transportation: 1%
- Public Administration: 3%

*Numbers may not sum to 100 percent due to rounding

Canada’s Future Residential Electricity Needs

20 Years Ago
- 27.5M
- Residential Usage: 129,331 GWh/yr

Today
- 34.0M
- Residential Usage: 160,261.6 GWh/yr

20 Years Ahead*
- 42.0M
- Residential Usage: 197,969.47 GWh/yr

Reference: Graphics from BC Hydro: Lighting the Way. Estimates based on a business as usual scenario. Stats Canada Population Projections: Table 052-0005
Electricity Generation in Canada by Fuel Type, 2014

Total Electricity Generated in Canada, 2014 = 627.68 TWh

- Hydro: 60.6%
- Nuclear: 16.2%
- Conventional Steam: 14.6%
- Combustion Turbine: 6.5%
- Internal Combustion: 0.3%
- Tidal: 0.00%
- Wind: 1.8%
- Solar: 0.05%

*Numbers may not sum to 100 percent due to rounding.

Source: Statistics Canada, Electric power generation, by class of electricity producer, annual (CANSIM Table 127-0007), 2013

Retrieved Nov 26, 2015
Electricity Generation in Canada by Province and Fuel Type, 2014

Total Electricity Generation in Canada, 2014 = 627.68 TWh

*Point Lepreau nuclear generating station resumed power production on November 23, 2012, nuclear has been re-established as a major source (about 30%) of electricity in New Brunswick.

Source: Statistics Canada, Electric power generation, by class of electricity producer, annual (CANSIM Table 127-0007), 2013
Retrieved Nov 26, 2015
Installed Wind Capacity in Canada as of December 2015

Canada’s current installed capacity: 11,205 MW

(as of December 2015)
May not sum to total due to rounding

Source: Canadian Wind Energy Association, retrieved September 10, 2014
National Energy Board
Electricity Generation
Projection, 2010–2035

Source: Canada’s Energy Future:
Energy Supply and Demand
Projections to 2035, National Energy
Board, November 2011.

2010

2035

Uranium 14% 11%
Coal and Coke 14% 3%
Oil 1% 0.4%
Natural Gas 9% 15%

Biomass/Solar/Geothermal 2% 6%
Wind 1% 6%
Hydro/Wave/Tidal 59% 56%
Coal Fleet Profile (MW)

Coal Capacity Reduction - Retirement as per the Coal Regulation*

* Retirement age 45-50 years as per the 2012 Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations. Includes Ontario coal shutdown by 2014.
Greenhouse Gas (GHG) Emissions in Canada and the US by Sector, 2014

Total GHG Emissions in Canada, 2014 = \(732\text{ Mt CO}_2\text{ Equivalent}\)

- Transportation: 23.4%
- Oil & Gas: 26.3%
- Electricity & Heat Generation: 10.7%
- Agriculture: 10.0%
- Industrial Processes: 10.4%
- Residential: 6.3%
- Commercial & Institutional: 5.6%
- Waste: 7.4%


Total GHG Emissions in US, 2014 = \(6,108\text{ Mt CO}_2\text{ Equivalent}\)

- Transportation: 26.4%
- Electric Power Industry: 30.3%
- Industry: 21.3%
- Agriculture: 9.1%
- Commercial: 6.6%
- Residential: 5.7%
- U.S. Territories: 0.7%

Electricity leading all Canadian industrial sectors in reduction of CO$_2$
North American Electric Reliability Corporation (NERC) Regions

[Map showing the regions of North America with regions labeled: WECC, MRO, SPP, RFC, TRE, SERC, FRCC, NPCC]
Map copyright CEA.

Lines shown are 345kV and above. There are numerous interconnections between Canada and the U.S. under 345kV that do not appear on this map.
Manitoba-Minnesota Transmission Project

- Manitoba Hydro (MH): 500 kV line to U.S. border.
- Minnesota Power (MP): 500 kV line from border to Duluth.
- “Hydro by wire” from Manitoba enables “wind by wire” from North Dakota.
- Overall project enhances regional reliability and provides energy market benefits.
- 2020 expected in-service date.
Major Canada-U.S. Transmission Interconnections

Source: National Energy Board
Electricity Exports and Imports Between Canada and the U.S. (2014)

Data displayed are in gigawatt hours
Numbers may not sum due to rounding
Canada-U.S. Electricity Trade Revenue, 1990 – 2014

California Energy Crisis of 2000 and 2001 was the situation when California had a shortage of electricity.

2013 Canadian Electricity Export Destinations

- Alaska
- Arizona
- California
- Colorado
- Idaho
- Indiana
- Maine
- Massachusetts
- Michigan
- Minnesota
- Missouri
- Montana
- Nevada
- New England ISO
- New Mexico
- New York
- North Dakota
- Oregon
- PJM (Pen/NJ/Maryland)
- Pennsylvania
- Texas
- Utah
- Vermont
- Washington
- Wyoming
Building the Next Generation of Infrastructure: Capital Investment Requirements

<table>
<thead>
<tr>
<th></th>
<th>Billions of 2010 CDN dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Generation</td>
</tr>
<tr>
<td>2010 – 2030</td>
<td>195.7</td>
</tr>
</tbody>
</table>

Total Canadian Electric Sector Investment Required by 2030 =
293.8 Billion in 2010 CDN dollars, or **347.5 Billion in current CDN dollars**.

Source: The Conference Board of Canada, Shedding Light on the Economic Impact of Investing in Electricity Infrastructure, February 2012
The Economic Impact of Investing in Electricity Infrastructure

Source: Shedding Light on the Economic Impact of Investing in Electricity Infrastructure, Conference Board of Canada, 2011.

1970s/1980s: $10.5 billion
1990s: $9.2 billion
2000s: $10.8 billion
2012 to 2030: $15 billion
Total: $350 billion
Average Residential Electricity Price in Canada, 1998 – 2014 (cents/kWh)

Ontario Hydro: Electricity Rates by Province, Retrieved June 20, 2015

Notes: Based on 1,000 kWh monthly consumption
Average electricity price is an average of 11 major Canadian cities for years 1998-2008 and an average of 12 major Canadian cities for years 2009-2013; and may not represent an exact national average.
Selected World Residential Electricity Prices, 2014

<table>
<thead>
<tr>
<th>Country</th>
<th>US cents/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>40</td>
</tr>
<tr>
<td>Italy</td>
<td>35</td>
</tr>
<tr>
<td>Ireland</td>
<td>28</td>
</tr>
<tr>
<td>Austria</td>
<td>25</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>24</td>
</tr>
<tr>
<td>Japan</td>
<td>20</td>
</tr>
<tr>
<td>Belgium</td>
<td>19</td>
</tr>
<tr>
<td>Switzerland</td>
<td>18</td>
</tr>
<tr>
<td>France</td>
<td>17</td>
</tr>
<tr>
<td>Finland</td>
<td>16</td>
</tr>
<tr>
<td>Poland</td>
<td>15</td>
</tr>
<tr>
<td>Turkey</td>
<td>15</td>
</tr>
<tr>
<td>United States</td>
<td>14</td>
</tr>
<tr>
<td>Canada</td>
<td>12</td>
</tr>
<tr>
<td>Mexico</td>
<td>10</td>
</tr>
</tbody>
</table>


Hydro Quebec, *Comparison of Electricity Prices in North American Cities 2014*
Selected World Industrial Electricity Prices, 2014

- Italy
- Ireland
- Portugal
- United Kingdom
- Switzerland
- Belgium
- France
- Mexico
- Turkey
- Finland
- Denmark
- Poland
- Canada
- United States

Hydro Quebec, *Comparison of Electricity Prices in North American Cities 2014*
Note: The price increase for the residential electricity sector has increased 39% between 1999 and 2013, the lowest amongst property taxes, water and internet services for principle accommodation.

Source: Statistics Canada, Survey of Household Spending, 2014
Electricity Market Structures in Canada

Saskatchewan
- Wholesale open access
- Vertically-integrated Crown corporation

Alberta
- Mandatory Power Pool
- Wholesale & retail open access since 2001
- Fully competitive wholesale market

Manitoba
- Wholesale open access
- Vertically-integrated Crown corporation

Ontario
- Industry unbundling in 1998
- Wholesale & retail open access since 2002
- Hybrid regulation and competition model

Québec
- Wholesale open access
- Vertically-integrated Crown corporation
- Expanding IPP development

Newfoundland
- Vertically-integrated Crown corporation and investor-owned distribution utility

BC
- Wholesale & industrial open access
- Vertically-integrated Crown corporation serves 94% of customers

PEI
- Procures electricity from New England market and long-term contracts with New Brunswick

NB
- Wholesale open access
- Returning to vertically-integrated utility model

Nova Scotia
- Wholesale open access
- Investor-owned utility regulated on cost-of-service
EPRI: The Integrated Grid

• REALIZING THE FULL VALUE OF CENTRAL AND DISTRIBUTED ENERGY RESOURCES
New York: Reforming the Energy Vision (REV)

- New York will have a system operator at the distribution (retail) level. These Distributed System Platform (DSP) Providers will serve as a retail-level dispatcher for a grid supplied not only by traditional power plants, but also by a vastly expanded fleet of Distributed Energy Resources (DER).

- DER is defined in the REV order as:
  - "including end-use energy efficiency,
  - demand response,
  - distributed storage,
  - and distributed generation."
For more information:

Geoff Smith
Director, Government Relations
Canadian Electricity Association
t 613.688.2064
bradley@electricity.ca
www.electricity.ca