Investment opportunities in the wind power sector in Canada

Wind Energy Institute of Canada
Madrid, Spain

Scott Harper, CEO
12 November 2013
Outline

• Introduction to the Institute
• Spanish and Canadian electricity system
• Canada’s Regulator framework
• Wind in Canada today and new opportunities
• Wind Energy R&D Park and Storage System
History of WEICan/AWTS

- The Atlantic Wind Test Site (AWTS) was formed in 1981 in North Cape, PEI as an experimental wind turbine test site.

- Through the 1980’s and 1990’s AWTS led Canada’s Research Activities in Wind Energy

- In the late 1990’s began working with the PEI Government on plans to develop a commercial wind farm. In 2001 the first MW sized wind farm East of Quebec was opened (8 – 660kW Turbines)

- In 2003 this farm was doubled in size – Total of 10.56 MW

- In 2003 discussions began on expanding on AWTS’s mandate and mission. Strategies completed by PEI Government and ACOA over the course of 2 years resulted in a Conceptual Plan for WEICan.

- Fall of 2005, funding announced and WEICan officially opened in Fall of 2006.

- Not for Profit organization – Governed by a volunteer Board of Directors and team of 10 permanent full-time staff plus students and interns and term positions (currently 13 on staff)
Canada

Wind Energy Institute of Canada
Mandate of WEICan

Mission Statement

• “WEICan advances the development of wind energy across Canada through research, testing, training and collaboration.”

Areas of Strategic Focus

• Research, Development and Demonstration
• Testing for Certification
• Training, Outreach and Public Education
• Technical Consultation and Assistance
## Spanish vs Canada Electricity

<table>
<thead>
<tr>
<th>Technology</th>
<th>Spain</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installed Capacity (MW)</td>
<td>Installed Capacity (%)</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>25 269</td>
<td>25</td>
</tr>
<tr>
<td>Hydro</td>
<td>19 576</td>
<td>19</td>
</tr>
<tr>
<td>Coal</td>
<td>11 400</td>
<td>12</td>
</tr>
<tr>
<td>Nuclear</td>
<td>7777</td>
<td>8</td>
</tr>
<tr>
<td>Fuel/gas</td>
<td>1492</td>
<td>1</td>
</tr>
<tr>
<td>Wind</td>
<td>21 288</td>
<td>21</td>
</tr>
<tr>
<td>Solar PV</td>
<td>4020</td>
<td>4</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>1199</td>
<td>1</td>
</tr>
<tr>
<td>Biomass</td>
<td>1063</td>
<td>1</td>
</tr>
<tr>
<td>CHP non-renewable</td>
<td>7152</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100 560</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Source: REE, 2012, Statistics Canada 2011*
### Spanish vs Canada Electricity

<table>
<thead>
<tr>
<th>Technology</th>
<th>Demand Coverage (GWh)</th>
<th>Demand Coverage (%)</th>
<th>Demand Coverage (GWh)</th>
<th>Demand Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>47 612</td>
<td>17</td>
<td>42 294</td>
<td>7</td>
</tr>
<tr>
<td>Hydro</td>
<td>23 333</td>
<td>9</td>
<td>372 076</td>
<td>61</td>
</tr>
<tr>
<td>Coal</td>
<td>51 356</td>
<td>19</td>
<td>72 467</td>
<td>12</td>
</tr>
<tr>
<td>Nuclear</td>
<td>60 941</td>
<td>22</td>
<td>88 291</td>
<td>15</td>
</tr>
<tr>
<td>Fuel/gas</td>
<td>0</td>
<td>0</td>
<td>13 701</td>
<td>2</td>
</tr>
<tr>
<td>Wind</td>
<td>43 112</td>
<td>15</td>
<td>10 087</td>
<td>2</td>
</tr>
<tr>
<td>Solar PV</td>
<td>8160</td>
<td>3</td>
<td>257</td>
<td>0</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>2455</td>
<td>1</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>Biomass</td>
<td>4452</td>
<td>2</td>
<td>2146</td>
<td>0</td>
</tr>
<tr>
<td>CHP non-renewable</td>
<td>32 138</td>
<td>12</td>
<td>5859</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>254 761</strong></td>
<td></td>
<td><strong>607 204</strong></td>
<td></td>
</tr>
</tbody>
</table>

Canada uses almost 3 times the electricity per person than Spain (16406 kWh/capita vs 5598 kWh/capita)

Net Export 25 700 GWh (4.1%)

• Energy is a provincial responsibility in Canada, so the technology mix varies greatly

<table>
<thead>
<tr>
<th>Technology</th>
<th>Quebec Demand Coverage (GWh)</th>
<th>Quebec Demand Coverage (%)</th>
<th>Ontario Demand Coverage (GWh)</th>
<th>Ontario Demand Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>290</td>
<td>0</td>
<td>20 837</td>
<td>14</td>
</tr>
<tr>
<td>Hydro</td>
<td>189 691</td>
<td>97</td>
<td>34 907</td>
<td>23</td>
</tr>
<tr>
<td>Coal</td>
<td>134</td>
<td>0</td>
<td>4036</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear</td>
<td>3525</td>
<td>2</td>
<td>84 766</td>
<td>56</td>
</tr>
<tr>
<td>Fuel/gas/oil</td>
<td>350</td>
<td>0</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Wind</td>
<td>995</td>
<td>1</td>
<td>3163</td>
<td>2</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0</td>
<td>0</td>
<td>257</td>
<td>0</td>
</tr>
<tr>
<td>Biomass</td>
<td>592</td>
<td>0</td>
<td>319</td>
<td>0</td>
</tr>
<tr>
<td>CHP non-renewable</td>
<td>0</td>
<td>0</td>
<td>3329</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>195 577</td>
<td></td>
<td>151 645</td>
<td></td>
</tr>
<tr>
<td>Export</td>
<td>30 100</td>
<td>15.4%</td>
<td>9900</td>
<td>6.5%</td>
</tr>
</tbody>
</table>

Source: Statistics Canada, 2011
## Price of Electricity

<table>
<thead>
<tr>
<th>Location</th>
<th>Price of Electricity (Domestic) $/kWh (without tax)</th>
<th>€/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quebec (Canada)</td>
<td>0.0676</td>
<td>0.0479</td>
</tr>
<tr>
<td>Ontario (Canada)</td>
<td>0.1312</td>
<td>0.0931</td>
</tr>
<tr>
<td>Prince Edward Island (Canada)</td>
<td>0.1451</td>
<td>0.1030</td>
</tr>
<tr>
<td>Spain</td>
<td>0.2665</td>
<td>0.1893</td>
</tr>
</tbody>
</table>

Source: Energy Portal
Regulatory framework

- Fully Deregulated Market
  - Alberta: Currently 1166 MW

- Feed-in Tariff
  - Ontario: 11.5 cents/kWh
  - Nova Scotia: 13.1 cents/kWh

- Capacity targets
  - Quebec: 4000 MW by 2015, currently 1000 MW built and 2000 MW contracted
  - Newfoundland and Labrador: 80 MW, 54.7 MW currently installed
  - Prince Edward Island: 500 MW by 2013, unlikely to be meet, currently 173.6 MW
  - Manitoba: 1000 MW by 2016, unlikely to be meet, currently 242 MW

- Percentage of production targets
  - New Brunswick: 10%, currently 4.8% (2013)
  - Saskatchewan: 8.5%, currently 3.0% (2013)

- Other
  - British Columbia: 350 MW new installation expected by 2015

Source: CANWEA, StatsCanada
Grid Requirements

- Grid connection requirements vary by province

- From the simple requirements of the 2000s the system operators now have stringent requirements on voltage and frequency control which can affect the financial viability of new projects

- Issues could be of a capital nature
  - Substation upgrades (Capacitor banks, Voltage regulators)
  - Transmission upgrades

- Operation concerns
  - Line loss charges
  - Curtailments
  - Ramp rates
  - Congestion management charges
Supply Chain

- LM Wind Power Blades-Quebec
- Marmen Energie Inc.: Wind turbine towers-Quebec
- RePower Blade Manufacturing: Ontario
- Enercon towers: Quebec
- Siemens Plant: Ontario
- Daewoo Shipbuilding and Marine Engineering Tower Manufacturing: Nova Scotia
- GE Wind Manufacturers: Ontario
- Many companies in the United States for all wind turbine parts
<table>
<thead>
<tr>
<th>Developers</th>
<th>Turbines Installed</th>
<th>Capacity (MW)</th>
<th>Manufacturers</th>
<th>Turbines Installed</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TransAlta</td>
<td>856</td>
<td>1229.5</td>
<td>Vestas</td>
<td>1336</td>
<td>2345.04</td>
</tr>
<tr>
<td>Enbridge</td>
<td>333</td>
<td>608.77</td>
<td>GE</td>
<td>1195</td>
<td>1811.1</td>
</tr>
<tr>
<td>Suez</td>
<td>246</td>
<td>480.6</td>
<td>Siemens</td>
<td>476</td>
<td>1119.3</td>
</tr>
<tr>
<td>International Power</td>
<td>192</td>
<td>314.76</td>
<td>Enercon</td>
<td>420</td>
<td>926.2</td>
</tr>
<tr>
<td>Canada Inc.</td>
<td></td>
<td></td>
<td>Acciona*</td>
<td>88</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Two joint ventures, with Suncor and Enbridge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wind in Canada Today (Oct, 2013)

- Wind farms: 171
- Number of turbines: 4,010
- Current per cent of Canada’s electricity demand met by wind: ~3.0
- Enough electricity to power over 2 million Canadian homes
- Global ranking for total installed capacity: 9

Source: Canadian Wind Energy Association - CanWEA
According to CanWEA – as of October, 2013

- More than more than 850 MW of new wind capacity has been added in 2013 to date.

- Approximately 15 projects are presently under construction and final commissioning in Nova Scotia, Quebec, Ontario, Alberta and BC representing an additional 800 MW of new capacity.

- If all expected new capacity achieves COD in 2013, Canada will have achieved a decade of average annual new capacity of 40% (823 MW), maintaining Canada's position as one of the world's leading wind energy markets.

- This trend is expected to be maintained until at least 2016.

- Anticipating 1,500 MW installed per year for each of the next four years.
Opportunities in Canada

Nova Scotia:
– Potential for four new projects in 2013, in addition to COMFIT projects totalling ~ 30 MW
– Over next several years, close to 400 MW of new wind capacity expected to come online in NS due to COMFIT and RFPs

Ontario:
– 4 new projects in 2013, totalling 322 MW, with an additional 105 MW remaining
– Numerous projects scheduled for 2014, representing a potential of over 1,000 MW of new wind capacity

Quebec:
– 4 new projects in 2013, totalling 517 MW, with an additional +500 MW remaining
– 8 projects proposed for 2014, representing over 400 MW of new capacity
Opportunities in Canada

- Canada’s ageing wind turbines are beginning to come out of warranty and maintenance coverage and are looking at their different options for proceeding into the future

Canada’s Wind Power Capacity

Source: Canadian Wind Energy Association
Investment in R&D

Canadian Investments in Energy RD&D

Source: Federal-Provincial IEA data 2011-12, Statistics Canada Industry data 2010
Canadian competitiveness

Global Market Attractiveness and Canadian Competitiveness for Energy Technologies

Wind in PEI Today

• According to CanWEA – as of October, 2013

  – 8 wind farms operating in PEI.
  
  – 94 turbines, 173.6 MW (of this 90 MW is currently contracted to neighboring provinces)
  
  – 30 MW currently being installed which will be operational in December, 2013.
  
  – 15-30% of PEI’s electricity demand depending on the year.
  
  – Peak winter demand is around 230 MW.
  
  – PEI has a high average wind speed, our site has an average wind speed of 8.09 m/s.
Wind Energy R&D Park and Storage System for Innovation in Grid Integration

- Major initiative – a 10 MW Wind R&D Park and Storage System for Innovation in Grid Integration.
  - Supported by NRCan’s Clean Energy Fund - $12M
  - Project budget is $24.6M
  - Support from the Province of PEI - debt financing

- Partners include Maritime Electric, New Brunswick System Operator, WESNet and others.

- Turbines were commissioned in March, 2013. Battery System is on order, expected commissioning date is in December, 2013.

- Project will provide WEICan with an asset to be made available for purposes of research, development and other innovation activities.

- We anticipate this project will have relevance across Canada as well as internationally.
Facilities

Institute’s Wind R&D Park

T4 and Substation
Aerial View of The Institute and Wind R&D Park
Wind Energy R&D Park and Storage System for Innovation in Grid Integration

- Battery from GE: Na-NiCl$_2$ (Durathon)
- Inverter from S&E: Purewave
- Battery max output/input is 1 MW with a storage of 2 MWh
- 85% efficient
- Lifespan is 4500 cycles or 15 years
• Options for the battery system include:
  – Time shifting
  – Power smoothing
  – Demand reduction

• Time-shift the electricity. Store the inexpensive night time generated electricity for use during peak times when the electricity is more expensive.

• Power smoothing. Ensure the power output does not change too quickly to allow the production and demand to be matched at all times.

• Reduce turbine peak consumption to reduce the station service demand bill.
Night-time electricity generation can be stored for use during the day when the price and demand is higher.

The need for time-shifting wind production

- At 5:30 AM, 30 MW more wind power than demand
- At 7:00 PM, 155 MW more demand than wind power
- At 5:30 AM, 38 MW more demand than wind power
- At 5:30 PM, 152 MW more demand than wind power
- Output from actual power and wind data.
- Opportunity to demonstrate energy storage to level out the peaks and valleys.
Power smoothing through charging when the wind is high and discharging when the wind is low.

- Power smoothing through charging when the wind is high and discharging when the wind is low.
Additional options for use of a battery system include:

- Prediction firming.
- Voltage control.
- Frequency regulation (primary regulation).
- Support the transmission network and delay or avoid transmission network upgrades.
- Reserve capacity (capacity payments).
- Substation on-site power (demand reduction).
Challenges include:

- Short lifetime of the battery (10-15 years).
- How to use multiple benefits simultaneously.
- New technology.
- Lack of experience.
- Finding financial incentives to improve power quality and supply capacity.
- The utility world is changing - smart meters, electric cars, a more demanding consumer. Can Spain show Canada how to better utilize wind energy and change our grid?
Questions?

Contact Info:

Scott Harper  
CEO, WEICan  
Tel: 902-882-2746 Ext #22

Email: scott.harper@weican.ca  
Website: www.weican.ca