WORLD SMALL HYDROPOWER DEVELOPMENT REPORT 2013

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CANADA
2 Americas
2.4 Northern America

2.4.1 Canada
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Hydropower Implementing Agreement

Key facts

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>34,300,083¹</td>
</tr>
<tr>
<td>Area</td>
<td>10,000,000 km² approximately – about 7.5% is water</td>
</tr>
<tr>
<td>Climate</td>
<td>From relatively mild-temperate in south, to subarctic and arctic in north. In winter, temperatures can fall below freezing point throughout most of Canada¹</td>
</tr>
<tr>
<td>Topography</td>
<td>Mostly plains; mountains in the west and lowlands in the southeast¹</td>
</tr>
<tr>
<td>Rain pattern</td>
<td>Average annual rainfall is 865 mm. Western and south-eastern Canada has higher than average rainfall levels. The prairie provinces (Alberta, Saskatchewan and Manitoba) are drier, with 250-500 mm of annual precipitation.²</td>
</tr>
</tbody>
</table>

Electricity sector overview
Canada’s electricity mix includes hydropower, natural gas, oil, coal, nuclear power, biomass and wind power (table 1 and 2). Renewable energy sources account for 17 per cent of the country’s energy supply.³ Hydropower is the dominant source of electricity in Canada, representing 60 per cent of its electricity generation (figure 1). Coal and nuclear power are the second and third most important sources of electricity. Natural gas, bioenergy and wind have relatively small market shares but are increasingly important in the mix. Over time, the viability, importance and market share of each resource has fluctuated due to changes in fuel prices, technology and political direction.

Table 1
Installed capacity of renewable energy in Canada (Megawatts)

<table>
<thead>
<tr>
<th>Type of electricity generation</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>72 644</td>
<td>73 443</td>
<td>74 387</td>
<td>74 688</td>
<td>75 077</td>
</tr>
<tr>
<td>Wind</td>
<td>1 470</td>
<td>1 824</td>
<td>2 229</td>
<td>3 026</td>
<td>3 973</td>
</tr>
<tr>
<td>Tidal</td>
<td>3</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Solar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total thermal</td>
<td>48 885</td>
<td>49 060</td>
<td>48 714</td>
<td>51 211</td>
<td>51 365</td>
</tr>
<tr>
<td>Total installed capacity</td>
<td>123 002</td>
<td>124 347</td>
<td>125 350</td>
<td>128 945</td>
<td>130 543</td>
</tr>
</tbody>
</table>

Source: Statistics Canada⁴

Table 2
Electricity generation in Canada (Gigawatthours)

<table>
<thead>
<tr>
<th>Type of electricity generation</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>349 468</td>
<td>364 055</td>
<td>373 822</td>
<td>365 108</td>
<td>348 110</td>
</tr>
<tr>
<td>Wind</td>
<td>19</td>
<td>22</td>
<td>15</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>Tidal</td>
<td>2 448</td>
<td>2 977</td>
<td>3 750</td>
<td>6 575</td>
<td>9 461</td>
</tr>
<tr>
<td>Solar</td>
<td>..</td>
<td>..</td>
<td>..</td>
<td>5</td>
<td>156</td>
</tr>
<tr>
<td>Other types of electricity generation</td>
<td>..</td>
<td>..</td>
<td>..</td>
<td>1 918</td>
<td>2 976</td>
</tr>
<tr>
<td>Total thermal generation</td>
<td>240 699</td>
<td>249 705</td>
<td>241 101</td>
<td>221 879</td>
<td>228 301</td>
</tr>
<tr>
<td>Total electricity generation</td>
<td>592 634</td>
<td>616 759</td>
<td>618 690</td>
<td>595 514</td>
<td>589 032</td>
</tr>
</tbody>
</table>

Source: Statistics Canada⁴

Canada is one of the world’s largest exporters of electricity. Canada exports, on average, 40 TWh of electricity to the United States each year.⁵

Canada is a world leader in hydropower production, with an installed capacity of over 75 GW from about 475 plants. It reaches an annual average production of 350 TWh which equals to about 60 per cent of Canada’s electricity demand.⁵ According to the Canadian National Energy Board Scenarios, the share of hydropower in the electricity mix is expected to grow to 65 per cent by 2015, reaching 79.3 GW of installed capacity.⁶ Half of the hydropower plants have a generating capacity of over 10 MW and represent 99
per cent of the total capacity. With an estimated technical potential of over 163 GW, Canada still has significant untapped hydropower resources across all provinces and territories.

**Small hydropower sector overview and potential**

About 3,400 MW is the installed small hydropower capacity in Canada, contributing about 4.5 per cent to the total Canadian installed hydropower capacity (table 3). The small hydropower sub-sector contributes with CAD$ 150 million (approx. US$145 million dollars) to the Canadian economy annually through local and overseas projects. Annual investments in new small hydropower generation capacity represent an estimated CAD$200 million (approx. US$193.33 million dollars). The typical investment costs range from CAD$3000 to CAD$5000 per installed kW, with an overall cost of energy of CAD$0.07 to CAD$0.10 per kWh. However, capital costs for low-head projects or projects in remote areas are usually much higher and can exceed CAD$6000 per kW.\(^6\)

**Table 3**

**Installed small hydropower capacity in Canada**

(Megawatts)

<table>
<thead>
<tr>
<th>Province/ territory</th>
<th>AB</th>
<th>BC</th>
<th>MB</th>
<th>NB</th>
<th>NL</th>
<th>NS</th>
<th>NT</th>
<th>NU</th>
<th>ON</th>
<th>PE</th>
<th>QC</th>
<th>SK</th>
<th>YT</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>424</td>
<td>568</td>
<td>23</td>
<td>43</td>
<td>803</td>
<td>469</td>
<td>67</td>
<td>..</td>
<td>498</td>
<td>..</td>
<td>345</td>
<td>7</td>
<td>127</td>
<td>3,372</td>
</tr>
</tbody>
</table>

Source: Statistics Canada\(^7\)


Most small hydropower facilities provide decentralized power and are connected to local grids. These sites can respond quickly to demand fluctuations and are a reliable source of electricity for rural and remote communities. Small hydropower production also plays an important role in providing clean electricity to remote communities thus replacing costly and air-polluting diesel generation.

![Figure 2 Small hydropower capacities in Canada](image)

*Note: Data from 2011.*

The Canadian small hydropower industry includes around 20 equipment manufacturers and close to 70 engineering firms. Canada’s small hydropower sector is fully developed, covering a wide number of technologies, products and services across the small hydropower value chain.

Canada’s identified small hydropower potential is estimated at about 15,000 MW (figure 3 and table 4). Under the current socio-economic conditions, about 15 per cent of the identified small hydropower potential is expected to be attractive for development using currently available state-of-the-art technologies. Another 10-15 per cent of the feasible potential could be available with improved technologies (e.g. ultra-low-head new technology). Innovative technological advances are needed to improve the economic feasibility and address the high environmental/ecological requirements. Thus, the practical potential for additional capacity lies between 2,250 MW and 4,500 MW. The greatest potential for new small hydropower is located in British Columbia, where it is estimated that under half of the total potential could be developed for CAD$0.07 per kWh. The cost for the remaining sites in Canada is higher and varies from province to province.

There is significant potential for low-head hydropower in Canada, a portion of which could become economical viable with a reduction in equipment costs. A recent study of hydro potential in Ontario identified over 4,000 MW of low-head hydro potential, which includes some sites above 50 MW.\(^8\) Outside of Ontario, at least 2,700 MW of low-head hydro potential has been identified in past studies (including only sites up to 25 MW). Low-head hydro potential mainly exists in sluice gates, irrigation canals, drinking water pressure-release valves, and municipal wastewater outfalls on numerous rivers. There are approximately 10,000 existing low-head dams and hydraulic structures for flood control and water supply or irrigation, which offer significant opportunities to add hydropower generation.\(^9\) An overview on the overall small hydropower potential in Canada is given table 4.

Many existing sites require assistance or upgrade in maintenance and refurbishment. There are over 600 small and medium hydropower plants with units installed before 1965 which have a total refurbishment potential for increased capacity estimated at 1,000 MW, assuming an increase in plant production of 15 percent.\(^10\)
The estimated deployment of small hydropower in Canada by 2050 is given in table 5 according to Natural Resources Canada (NRCan), based on aggregated information from communication with various public and private utilities and companies across Canada. The installed capacity is expected to reach 7,700 MW in 2050, mostly due to developments carried out by independent power producers (IPP), provincial or municipal utilities, and remote communities.

Table 4
Small hydropower potential under 50 MW in Canada (Megawatts)

<table>
<thead>
<tr>
<th>Province/territory</th>
<th>AB</th>
<th>BC</th>
<th>MB</th>
<th>NB</th>
<th>NF</th>
<th>NS</th>
<th>NT</th>
<th>NU</th>
<th>ON</th>
<th>PE</th>
<th>QC</th>
<th>SK</th>
<th>YT</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential capacity</td>
<td>200</td>
<td>3 529</td>
<td>309</td>
<td>614</td>
<td>1 200</td>
<td>164</td>
<td>106</td>
<td>129</td>
<td>3 699</td>
<td>3</td>
<td>4 387</td>
<td>575</td>
<td>57</td>
<td>14 972</td>
</tr>
</tbody>
</table>

Source: Canadian Hydropower Association


Renewable energy policy
In Canada, incentives to develop clean, renewable or green power typically take one or more of the following forms: tax incentives, requests for proposal, standard offer programmes, net-metering and/or feed-in tariffs. The application and availability of these programs varies from province to province, and the schemes are subject to frequent amendments and adjustments.

Federal incentives and tax measures
The purchase of clean energy generation equipment, such as solar, wind and small hydro, qualifies for an accelerated capital cost allowance (Class 43.2). This allows a developer to write off 50 per cent of the cost of equipment per year (on a declining balance basis) against the tax liability.

Requests for proposal
A request for proposal (RFP) usually involves a specific acquisition target in terms of energy or power, a fixed term, minimum and maximum plant size restrictions and defined commercial operation dates. The proponent is expected to bid energy according to a fixed delivery schedule and defined tariff rates which may or may not include escalation.

Standard offer programmes
The standard offer programmes for renewable generation involve the purchase of energy using a guaranteed minimum price over a long-term contract. The price is often modified by technology and/or the size of the generator. Unlike the RFP, the standard offer price is available to all qualified proponents and may be modified by a defined escalation rate over its term. Typically, standard or standing offer programmes are aimed at small projects of less than 10 MW.

Net-metering
Net-metering allows small renewable generators to send electricity excess for their own use into the grid. This significantly reduces the costs associated with wind and solar applications as there is no battery or other storage device required. Small hydro with limited reservoir capacity could also benefit from net-metering. Net-metering is available in Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia and Prince Edward Island.

Feed-in tariff (FIT) programmes
These programmes provide guaranteed grid access and stable prices under long-term contracts (up to 40 years for hydro, for example) for electricity generated from renewable sources. Ontario’s FIT Programme is North America’s first comprehensive guaranteed pricing structure for renewable electricity production and is offered for projects under 50 MW.

Other support
The Canadian federal government through NRCan has been supporting small-scale hydro technologies. The support of NRCan by the Canadian industry to develop and commercialize advanced small and low-head hydro and water current technologies with industry by:

- Engaging in demonstration and deployment;
- Fostering the commercialization of new technology;
- Developing infrastructure to support innovation
such as standards and codes;
• Supporting the development of resource assessment data and tools;
• Supporting federal policy and programmes.

NRCan has actively cooperated with provinces, utilities, private industry, academic institutions and other organizations on key projects to reduce equipment and construction costs and increase turbine and site efficiencies as well as to support technology demonstrations at national and international level. This facilitates the realization of the additional capacities available within Canada, while at the same time helps the industry to strengthen its expertise in both products and services within Canada and abroad.

Barriers to small hydropower development
The above-mentioned incentives across Canada have helped to strengthen interest in small hydropower development. There has also been a positive policy shift to improve relations with First Nations’ and to include them as active hydropower project partners. However, developers encounter long lead times required for approvals. Also, projects can be arbitrarily derailed by opposition during public participation processes. The most common concerns about small hydropower projects are the impact of civil works construction on stream flow, aesthetics and prevention of fish movement towards their natural habitat. In recent years, provincial governments have begun to address some of these issues and barriers using a more streamlined and sustainable watershed management approach. The federal government has recently joined this approach.

Note
i. First Nation is a term that came into common usage in the 1970s to replace the word ‘Indian’ in Canada. Although the term First Nation is widely used, no legal definition of it exists.

References