

METHODOLOGY REPORT

# Tracking the Energy Revolution (Canada 2016 Edition)

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## Outline

*Tracking the Energy Revolution—Canada 2016* is a data-rich summary of the biggest clean energy trends and news stories across the country from the past year. Clean Energy Canada compiled the information from a range of sources and aims to present it in a way that is meaningful to a broad audience.

The report includes citations for external sources where referenced directly, but it primarily features Clean Energy Canada’s own estimates and analysis. This “Methodology Report” summarizes the approach we took and the assumptions and results of these calculations. The sources and assumptions that apply to most calculations in *Tracking the Energy Revolution—Canada 2016* are outlined in Section 1, below. Section 2 presents our calculations and assumptions organized by report section.

## Section 1: Common Sources and Assumptions

This section includes estimates, assumptions and sources for new renewable energy capacity and spending.

### New Capacity

We estimate total and new capacity additions using a mix of sources including Bloomberg New Energy Finance, provincial capital project inventories, utility annual reports and renewable industry association data. The estimates include capacity for the following renewable energy types:

- **Biomass & Waste:** Biogas, biomass, landfill gas and waste-to-energy projects
- **Geothermal:** Electricity from geothermal heat
- **Large Hydro:** Hydro projects >50 MW
- **Small Hydro:** Hydro projects <50 MW
- **Solar:** Includes solar photovoltaic at the utility (>1,000 kW) and distributed (< 1,000 kW)
- **Wind:** Onshore

**Table 1: Total Installed Capacity by type of resource (2011 to 2015)**

| Total Capacity (GW)  |  | 2011  | 2012  | 2013  | 2014  | 2016  | Difference from 2011 to 2015 |
|----------------------|--|-------|-------|-------|-------|-------|------------------------------|
| TYPE                 |  |       |       |       |       |       |                              |
| Large Hydro          |  | 72.79 | 73.75 | 74.02 | 75.30 | 76.78 | 4.00                         |
| Wind                 |  | 5.36  | 6.29  | 7.89  | 9.75  | 11.27 | 5.91                         |
| Small Hydro (<50 MW) |  | 2.98  | 3.01  | 3.18  | 3.35  | 3.41  | 0.43                         |
| Solar                |  | 0.49  | 0.76  | 1.20  | 1.86  | 2.52  | 2.02                         |
| Biomass              |  | 1.81  | 1.78  | 1.78  | 1.98  | 2.02  | 0.20                         |
| Biogas               |  | 0.16  | 0.16  | 0.16  | 0.16  | 0.16  | 0.00                         |

**Table 2: Capacity additions by resource type each year**

| Capacity Additions (GW) |  | 2011 | 2012 | 2013 | 2014 | 2015 |
|-------------------------|--|------|------|------|------|------|
| TYPE                    |  |      |      |      |      |      |
| Large Hydro             |  | 1.22 | 0.97 | 0.27 | 1.27 | 1.49 |
| Small Hydro             |  | 0.01 | 0.03 | 0.16 | 0.18 | 0.06 |
| Wind                    |  | 1.35 | 0.93 | 1.60 | 1.86 | 1.52 |
| Biomass                 |  | 0.05 | -    | 0.00 | 0.20 | 0.04 |
| Biogas                  |  | 0.01 | -    | 0.00 | -    | -    |
| Solar                   |  | 0.21 | 0.27 | 0.44 | 0.66 | 0.66 |

## Spending

Table 3 summarizes annual spending per resource type and total spending per resource over the past five years. We estimated these values using the methodology discussed below.

**Table 3: Annual renewable energy spending in billions of dollars (CAD)**

| Resource Type | 2011 | 2012 | 2013 | 2014  | 2015  | Cumulative<br>(2011 to<br>2015) |
|---------------|------|------|------|-------|-------|---------------------------------|
| Large Hydro   | 1.89 | 3.39 | 2.40 | 3.19  | 2.95  | 13.82                           |
| Small Hydro   | 0.03 | 0.10 | 0.53 | 0.62  | 0.28  | 1.55                            |
| Wind          | 3.71 | 2.50 | 4.30 | 4.90  | 4.00  | 19.43                           |
| Biomass       | 0.24 | 0.00 | 0.00 | 0.19  | 0.10  | 0.53                            |
| Biogas        | 0.05 | 0.00 | 0.01 | 0.00  | 0.00  | 0.06                            |
| Solar         | 1.05 | 1.14 | 1.89 | 2.91  | 2.72  | 9.70                            |
| Total         | 6.97 | 7.13 | 9.13 | 11.81 | 10.05 | 45.09                           |

## How We Estimate Spending

We estimated spending using recorded spending wherever possible supplemented with capital cost multipliers when necessary.

**We defined spending as the value of projects commissioned in a given year** for wind, solar, small hydro biomass and biogas. For large hydro, spending includes annual spending per year, since large hydro projects can take several years to complete, with spending distributed over that time period.

Table 4 summarizes the cost multipliers we used for each clean energy source, when actual project data is unavailable.

**Table 4: Summary of project cost multipliers**

| Generation Type    | Million \$/MW Installed       | Source and Rationale                                                                                                                                                                                                                                                                  |
|--------------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conventional Hydro | Based on actual project costs | We use utility financial reports for expenses related to new capacity additions and expansions on large hydro facilities between 2011 and 2015. Transmission lines and existing facility maintenance are not included in the estimates.                                               |
| Run-of-river       | \$3.21                        | Based on the average values of four recent run-of-river projects, as reported by Bloomberg New Energy Finance. These deals fall within range of B.C. Hydro estimates for new run-of-river projects. Estimates range from \$2 million/MW to \$4.3 million/MW depending on the project. |
| Wind               | \$2.69                        | Based on Bloomberg New Energy Finance data for the average \$/MW for 15 wind project deals between 2013 and 2015. Projects range from \$1.96 million/MW to \$3.11 million/MW.                                                                                                         |
| Biomass            | \$4.74                        | Based on BC Hydro's resource options report. <sup>1</sup> Installed costs range from \$4.73 million/MW to \$5.42 million/MW.                                                                                                                                                          |

<sup>1</sup> BC Hydro (2013) Resource Options Report

|        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Biogas | \$4.74 | Installed costs range from \$2.67 million/MW to \$7.60 million/MW. The \$4.74 million/MW is an average value from construction estimates in BC Hydro's resource options report. <sup>2</sup>                                                                                                                                                                                                                                                      |
| Solar  | \$4.45 | This value is based off of the total value of 12 solar projects in Ontario commissioned between 2013 and 2015. This \$ million/MW number represents the value of projects built in a given year, which includes projects deals from the past six years. This approach does not capture the solar capital cost declines, since the projects built in any given year include projects conceived of years in the past when panel prices were higher. |

We used the factors above to supplement project-specific data summarized in Table 5.

**Table 5: Summary of projects included in the 2015 investment estimate**

| <i>Project Name</i>                                      | <i>Type</i> | <i>Capacity (MW)</i> | <i>Spending (\$m)</i> | <i>Location</i>  | <i>Source</i>  |
|----------------------------------------------------------|-------------|----------------------|-----------------------|------------------|----------------|
| <i>Castle Creek Small Hydro Plant Canada</i>             | Small Hydro | 6                    | \$ 20.00              | British Columbia | BNEF           |
| <i>Conifex Mackenzie Biomass Plant</i>                   | Biomass     | 36                   | \$ 100.00             | British Columbia | BNEF           |
| <i>Dasque Middle Small Hydro Plant</i>                   | Small hydro | 20                   | \$ 115.00             | British Columbia | BNEF           |
| <i>Tretheway Creek Small Hydro Plant Canada</i>          | Small Hydro | 21                   | \$ 115.00             | British Columbia | BNEF           |
| <i>Upper Columbia Capacity Additions</i>                 | Large Hydro | 1,000                | \$ 196.00             | British Columbia | Columbia Power |
| <i>Waneta Expansion</i>                                  | Large Hydro | 350                  | \$ 243.65             | British Columbia | BC Hydro       |
| <i>BluEarth Bull Creek</i>                               | Wind        | 29                   | \$ 78.10              | Alberta          | BNEF           |
| <i>Morse Wind Farm Phase 1</i>                           | Wind        | 12                   | \$ 30.00              | Saskatchewan     | BNEF           |
| <i>Morse Wind Farm Phase 2</i>                           | Wind        | 12                   | \$ 30.00              | Saskatchewan     | BNEF           |
| <i>Keyyask</i>                                           | Large Hydro |                      | \$ 704.00             | Manitoba         | Manitoba Hydro |
| <i>Okikendawt Small Hydro Plant Canada</i>               | Small hydro | 10                   | \$ 32.10              | Ontario          | BNEF           |
| <i>Agris Ontario Community PV Plant</i>                  | Solar       | 3                    | Calculated            | Ontario          | BNEF           |
| <i>BluEarth LunarLight PV Plant</i>                      | Solar       | 12                   | Calculated            | Ontario          | BNEF           |
| <i>Canadian Solar &amp; SkyPower Aria PV Plant</i>       | Solar       | 13                   | \$ 50.67              | Ontario          | BNEF           |
| <i>Canadian Solar &amp; SkyPower BeamLight PV Plant</i>  | Solar       | 14                   | Calculated            | Ontario          | BNEF           |
| <i>Canadian Solar &amp; SkyPower CityLights PV Plant</i> | Solar       | 14                   | Calculated            | Ontario          | BNEF           |

<sup>2</sup> Ibid.

|                                                 |             |     |            |         |      |
|-------------------------------------------------|-------------|-----|------------|---------|------|
| Canadian Solar & SkyPower EarthLight PV Plant   | Solar       | 14  | Calculated | Ontario | BNEF |
| Canadian Solar & SkyPower SparkleLight PV Plant | Solar       | 14  | Calculated | Ontario | BNEF |
| DIF GoldLight PV Plant                          | Solar       | 14  | \$ 47.46   | Ontario | BNEF |
| DIF Illumination PV Plant                       | Solar       | 14  | \$ 54.20   | Ontario | BNEF |
| Endura Ontario PV Portfolio                     | Solar       | 1   | Calculated | Ontario | BNEF |
| Fiera Axium                                     | Solar       | 8   | Calculated | Ontario | BNEF |
| Kapuskasing PV Plant                            | Solar       | 130 | Calculated | Ontario | BNEF |
| Grand Renewable PV Plant                        | Solar       | 5   | Calculated | Ontario | BNEF |
| Potentia Toronto PV Portfolio                   | Solar       | 14  | Calculated | Ontario | BNEF |
| RET DiscoveryLight PV Plant                     | Solar       | 14  | Calculated | Ontario | BNEF |
| RET FotoLight PV Plant                          | Solar       | 14  | Calculated | Ontario | BNEF |
| Saturn South Stormont PV Plant                  | Solar       | 10  | Calculated | Ontario | BNEF |
| Solar Spirit PV Plant                           | Solar       | 10  | Calculated | Ontario | BNEF |
| SunEdison Bruining 1 PV Plant                   | Solar       | 18  | Calculated | Ontario | BNEF |
| TerraForm Marsh Hill PV Plant                   | Solar       | 19  | Calculated | Ontario | BNEF |
| Armow Wind Farm                                 | Wind        | 180 | \$ 484.74  | Ontario | BNEF |
| Bow Lake Wind Farm Phase I                      | Wind        | 19  | \$ 79.46   | Ontario | BNEF |
| Bow Lake Wind Farm Phase II                     | Wind        | 39  | \$ 154.14  | Ontario | BNEF |
| East Durham Wind Farm                           | Wind        | 22  | \$ 53.62   | Ontario | BNEF |
| Goshen Wind Farm                                | Wind        | 101 | \$ 275.76  | Ontario | BNEF |
| Goulais Wind Farm                               | Wind        | 25  | \$ 67.33   | Ontario | BNEF |
| Grand Valley Wind Farm Phase III                | Wind        | 40  | \$ 107.72  | Ontario | BNEF |
| K2 Wind Farm                                    | Wind        | 270 | \$ 727.12  | Ontario | BNEF |
| Springwood Wind Farm                            | Wind        | 8   | \$ 22.08   | Ontario | BNEF |
| St Columbian Wind Farm                          | Wind        | 35  | \$ 92.91   | Ontario | BNEF |
| Suncor Adelaide Wind Farm                       | Wind        | 40  | \$ 107.72  | Ontario | BNEF |
| Suncor Cedar Point Wind Farm Phase II           | Wind        | 100 | \$ 269.30  | Ontario | BNEF |
| Whittington Wind Farm                           | Wind        | 6   | \$ 16.70   | Ontario | BNEF |
| Lower Mattagami                                 | Large Hydro | 438 | \$ 115.00  | Ontario | OPG  |

|                                                               |             |     |           |                           |               |
|---------------------------------------------------------------|-------------|-----|-----------|---------------------------|---------------|
| <i>EDF Mont-Rothery Wind Farm</i>                             | Wind        | 76  | \$ 154.00 | Quebec                    | BNEF          |
| <i>La Cote-de-Beaupre Community Wind Farm</i>                 | Wind        | 24  | \$ 63.29  | Quebec                    | BNEF          |
| <i>Northland Frampton Wind Farm</i>                           | Wind        | 24  | \$ 64.63  | Quebec                    | BNEF          |
| <i>Riviere-Du-Moulin Wind Farm Phase II</i>                   | Wind        | 200 | \$ 538.60 | Quebec                    | BNEF          |
| <i>St-Philemon Wind Farm</i>                                  | Wind        | 24  | \$ 64.63  | Quebec                    | BNEF          |
| <i>Temiscouata II Wind Farm</i>                               | Wind        | 52  | \$ 133.51 | Quebec                    | BNEF          |
| <i>Romaine 1</i>                                              | Large Hydro | 135 | \$ 900.00 | Quebec                    | Hydro Quebec  |
| <i>Muskrat Falls</i>                                          | Large Hydro |     | \$ 788.90 | Newfoundland and Labrador | Nalcor Energy |
| <i>Affinity Greenfield Wind Farm</i>                          | Wind        | 3   | \$ 8.62   | Nova Scotia               | BNEF          |
| <i>Barrachois Community Wind Farm</i>                         | Wind        | 4   | \$ 10.77  | Nova Scotia               | BNEF          |
| <i>Ellershous Wind Farm</i>                                   | Wind        | 16  | \$ 43.36  | Nova Scotia               | BNEF          |
| <i>Kemptown Wind Farm</i>                                     | Wind        | 6   | \$ 14.95  | Nova Scotia               | BNEF          |
| <i>Limerock Wind Farm</i>                                     | Wind        | 5   | \$ 13.47  | Nova Scotia               | BNEF          |
| <i>MODG Sable Wind Farm</i>                                   | Wind        | 14  | \$ 37.16  | Nova Scotia               | BNEF          |
| <i>North Beaver Bank Community Wind Farm</i>                  | Wind        | 8   | \$ 21.54  | Nova Scotia               | BNEF          |
| <i>Scotian WindFields Isle Madame Community Wind Farm</i>     | Wind        | 2   | \$ 5.36   | Nova Scotia               | BNEF          |
| <i>Scotian WindFields Martock Ridge Community Wind Farm</i>   | Wind        | 6   | \$ 16.16  | Nova Scotia               | BNEF          |
| <i>Scotian WindFields Nine Mile River Community Wind Farm</i> | Wind        | 4   | \$ 10.77  | Nova Scotia               | BNEF          |
| <i>South Canoe Wind Farm</i>                                  | Wind        | 102 | \$ 172.28 | Nova Scotia               | BNEF          |
| <i>Watts Barrington Wind Farms</i>                            | Wind        | 3   | \$ 8.62   | Nova Scotia               | BNEF          |
| <i>Watts New Glasgow Wind Farm</i>                            | Wind        | 6   | \$ 17.24  | Nova Scotia               | BNEF          |
| <i>Watts Wedgeport Wind Farm</i>                              | Wind        | 2   | \$ 4.31   | Nova Scotia               | BNEF          |

## Section 2: Calculations and Assumptions by Report Section

Each heading below corresponds with a section of *Tracking the Energy Revolution—Canada 2016* and references the corresponding page numbers. Beneath each heading we include **figures** and **tables** from the report that require further explanation.

### Following the Money—Clean Energy Spending Across Canada (p.4-5)

The **map figure** shows investments per province and the change between 2014 and 2015. The spending estimates and percent change estimates are based on the following data.

**Table 6: Provincial renewable energy investment**

|                  | 2011    | 2012    | 2013    | 2014     | 2015     | % Change<br>2014 to<br>2015 |
|------------------|---------|---------|---------|----------|----------|-----------------------------|
| British Columbia | \$1,034 | \$760   | \$826   | \$1,639  | \$790    | -52%                        |
| Alberta          | \$464   | \$587   | \$16    | \$706    | \$78     | -89%                        |
| Saskatchewan     | \$71    | \$0     | \$2     | \$0      | \$60     | -                           |
| Manitoba         | \$372   | \$1,344 | \$0     | \$318    | \$704    | 121%                        |
| Ontario          | \$3,199 | \$2,161 | \$4,240 | \$6,290  | \$5,321  | -15%                        |
| Quebec           | \$1,514 | \$1,938 | \$3,545 | \$2,118  | \$1,919  | -9%                         |
| Maritimes        | \$312   | \$310   | \$529   | \$744    | \$1,177  | 58%                         |
| North            | \$0     | \$31    | \$0     | \$0      | \$0      | -                           |
| Total            | \$6,966 | \$7,131 | \$9,158 | \$11,814 | \$10,049 | -15%                        |

### Spending Drops...To Second-Best Year Ever (p.6-7)

This section features three **figures**: 2015 Spending on Renewable Energy by Technology, Change in Total Annual Clean Energy Spending in Canada, and Growth in Total Clean Energy Capacity in Canada.

Table 1, Table 2 and Table 3 (above) contain the investment and cost data used to develop these graphs.

### Players on the Canadian Clean Energy Field (p.11)

This section contains three **tables**:

- Top 5 Corporate Renewable Electricity Developers in Canada (2015)
- Top 5 Corporate Renewable Electricity Operators in Canada (2015)
- Top 5 Crown Renewable Electricity Operators in Canada

The source data for the “Top 5 Corporate Renewable Electricity Developers in Canada (2015)” table comes from Bloomberg New Energy Finance. It includes those companies **that owned the most renewable energy capacity commissioned in 2015**.

The source data for the “Top 5 Corporate Renewable Electricity Operators in Canada (2015)” comes from Bloomberg New Energy Finance. It includes those companies that **owned the most renewable energy capacity in 2015 for projects built at any time**.



The “Top 5 Crown Renewable Electricity Operators in Canada” is based on the **renewable energy capacity that crown corporations report owning**. It does not include purchase power agreements or long-term contracts with renewable energy power producers. Further information on sources is summarized below.

**Crown Corporations in Canada**

| <b>Name</b>           | <b>Capacity (MW)</b> | <b>Source</b>                                                                                                                                                                                                                                                                                                           | <b>Comment</b>                                                     |
|-----------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| <i>Hydro Quebec</i>   | 36,100.00            | Hydro Quebec (2014) Generating Facilities as of December 31, 2014<br><a href="http://www.hydroquebec.com/generation/">http://www.hydroquebec.com/generation/</a>                                                                                                                                                        | Does not include contracted power, or Churchill Falls access       |
| <i>BC Hydro</i>       | 11,826.20            | BC Hydro (2016) Our Facilities.<br><a href="https://www.bchydro.com/energy-in-bc/our_system/generation/our_facilities.html">https://www.bchydro.com/energy-in-bc/our_system/generation/our_facilities.html</a>                                                                                                          | Does not include Columbia Power, does not include contracted power |
| <i>OPG</i>            | 6,426.00             | Ontario Power Generation (2014) 2014 Annual Report<br><a href="http://www.opg.com/news-and-media/Reports/2014AnnualReport.pdf">http://www.opg.com/news-and-media/Reports/2014AnnualReport.pdf</a>                                                                                                                       | Does not include contracted power                                  |
| <i>Nalcor</i>         | 6,367.00             | Nalcor (2016) Nalcor Operations.<br><a href="http://www.nalcorenergy.com/hydro.asp">http://www.nalcorenergy.com/hydro.asp</a> , Newfoundland Labrador Hydro (2016) Corporate Overview.<br><a href="https://www.nlhydro.com/about-hydro/corporate-overview/">https://www.nlhydro.com/about-hydro/corporate-overview/</a> | Includes Churchill and Newfoundland Hydro                          |
| <i>Manitoba Hydro</i> | 5,243.00             | Manitoba Hydro (2016) Generation Stations.<br><a href="https://www.hydro.mb.ca/corporate/facilities/generating_stations.shtml">https://www.hydro.mb.ca/corporate/facilities/generating_stations.shtml</a>                                                                                                               | Only hydro capacity, not thermal, does not include contracted      |