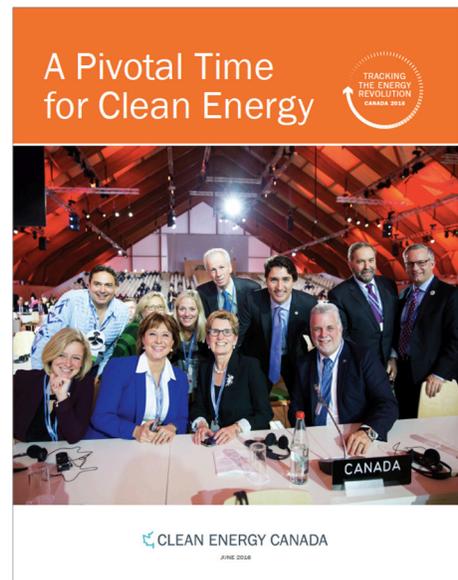


METHODOLOGY REPORT

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 (2011 to 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. ¹ Installed costs range from \$4.73 million/MW to \$5.42 million/MW.

¹ 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. ²
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 & SkyPower Aria PV Plant</i>	Solar	13	\$ 50.67	Ontario	BNEF
<i>Canadian Solar & SkyPower BeamLight PV Plant</i>	Solar	14	Calculated	Ontario	BNEF
<i>Canadian Solar & SkyPower CityLights PV Plant</i>	Solar	14	Calculated	Ontario	BNEF

² Ibid.

<i>Canadian Solar & SkyPower EarthLight PV Plant</i>	Solar	14	Calculated	Ontario	BNEF
<i>Canadian Solar & SkyPower SparkleLight PV Plant</i>	Solar	14	Calculated	Ontario	BNEF
<i>DIF GoldLight PV Plant</i>	Solar	14	\$ 47.46	Ontario	BNEF
<i>DIF Illumination PV Plant</i>	Solar	14	\$ 54.20	Ontario	BNEF
<i>Endura Ontario PV Portfolio</i>	Solar	1	Calculated	Ontario	BNEF
<i>Fiera Axium Kapuskasing PV Plant</i>	Solar	8	Calculated	Ontario	BNEF
<i>Grand Renewable PV Plant</i>	Solar	130	Calculated	Ontario	BNEF
<i>Potentia Toronto PV Portfolio</i>	Solar	5	Calculated	Ontario	BNEF
<i>RET DiscoveryLight PV Plant</i>	Solar	14	Calculated	Ontario	BNEF
<i>RET FotoLight PV Plant</i>	Solar	14	Calculated	Ontario	BNEF
<i>Saturn South Stormont PV Plant</i>	Solar	10	Calculated	Ontario	BNEF
<i>Solar Spirit PV Plant</i>	Solar	10	Calculated	Ontario	BNEF
<i>SunEdison Bruining 1 PV Plant</i>	Solar	18	Calculated	Ontario	BNEF
<i>TerraForm Marsh Hill PV Plant</i>	Solar	19	Calculated	Ontario	BNEF
<i>Armow Wind Farm</i>	Wind	180	\$ 484.74	Ontario	BNEF
<i>Bow Lake Wind Farm Phase I</i>	Wind	19	\$ 79.46	Ontario	BNEF
<i>Bow Lake Wind Farm Phase II</i>	Wind	39	\$ 154.14	Ontario	BNEF
<i>East Durham Wind Farm</i>	Wind	22	\$ 53.62	Ontario	BNEF
<i>Goshen Wind Farm</i>	Wind	101	\$ 275.76	Ontario	BNEF
<i>Goulais Wind Farm</i>	Wind	25	\$ 67.33	Ontario	BNEF
<i>Grand Valley Wind Farm Phase III</i>	Wind	40	\$ 107.72	Ontario	BNEF
<i>K2 Wind Farm</i>	Wind	270	\$ 727.12	Ontario	BNEF
<i>Springwood Wind Farm</i>	Wind	8	\$ 22.08	Ontario	BNEF
<i>St Columbian Wind Farm</i>	Wind	35	\$ 92.91	Ontario	BNEF
<i>Suncor Adelaide Wind Farm</i>	Wind	40	\$ 107.72	Ontario	BNEF
<i>Suncor Cedar Point Wind Farm Phase II</i>	Wind	100	\$ 269.30	Ontario	BNEF
<i>Whittington Wind Farm</i>	Wind	6	\$ 16.70	Ontario	BNEF
<i>Lower Mattagami</i>	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 2014 to 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

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