

ELECTRIC GENERAL RATE APPLICATION 2015

Manitoba Hydro Undertaking #63

Manitoba Hydro to provide the calculations upon which the grid parity presentation slide was prepared, including the sources that were relied upon in its preparation.

Response:

The accompanying chart, drawn from Slide 52 of Manitoba Hydro Exhibit MH-67, illustrates the impact that a range of installed costs may have on the average cost of energy provided by distributed residential solar photovoltaic (PV) installations using a set of operational assumptions as outlined below. This information is provided from the perspective of a residential customer and assumes no short or long-term debt obligations (i.e. cost of capital) related to the solar PV installation.

Several of the distributed residential solar PV assumptions documented herein, will not apply to larger commercial or utility scale solar PV installations.







The following table, along with accompanying notes, provides the values and sources used to prepare the above chart. All values are in 2015 Canadian dollars.

Year	Residential	Residential Solar PV	Residential Solar PV
	\mathbf{Rate}^2	High Range ³	Low Range ³
2015	(\$ 2015 / KWN)	(\$ 2015 / KWh)	(\$ 2015 / KWh)
2015	0.074	0.267	0.160
2016	0.075	0.252	0.150
2017	0.077	0.238	0.139
2018	0.078	0.224	0.129
2019	0.080	0.207	0.117
2020	0.081	0.193	0.106
2021	0.083	0.190	0.105
2022	0.085	0.187	0.103
2023	0.086	0.185	0.101
2024	0.088	0.182	0.099
2025	0.090	0.179	0.097
2026	0.092	0.177	0.095
2027	0.094	0.175	0.093
2028	0.095	0.173	0.091
2029	0.097	0.171	0.089
2030	0.099	0.169	0.087
2031	0.101	0.169	0.087
2032	0.103	0.169	0.087
2033	0.105	0.169	0.087
2034	0.108	0.169	0.087
2035	0.110	0.169	0.087
2036	0.112	0.169	0.087
2037	0.114	0.169	0.087
2038	0.116	0.169	0.087
2039	0.119	0.169	0.087
2040	0.121	0.169	0.087

NOTES:

- 1. All values referenced in constant \$2015 CDN dollars.
- Energy Rate The Residential Rate for 2015 was based on PUB-Approved Tariff No. 2014-01 – Energy Charge – Effective May 1, 2014. Subsequent rate escalation assumes average annual rate increases of 2% above the rate of inflation. Retail sales taxes (Federal, Provincial and Municipal) commonly applied to energy purchases were not included in this analysis.



3. High and low range projections for average cost of energy provided by distributed solar PV installations was determined using projections for installed cost (capital), annual energy output (kW.h), and annual operating/maintenance costs as follows:

Installed Capital Cost Projections:

- a. Source of 2020, 2025, 2030 and 2035 high and low capital costs:
 - SunShot U.S. Department of Energy: *Photovoltaic System Pricing Trends* - *Historical, Recent, and Near-Term Projections 2014 Edition,* Presentation by National Renewable Energy Laboratory and Lawrence Berkeley National Laboratory (Page 28, September 22, 2014).
 - http://www.nrel.gov/docs/fy14osti/62558.pdf
 - Cost information provided within this presentation was represented in \$2010 U.S. dollars / kW DC (direct current), which was escalated and converted to \$2015 Canadian dollars for this analysis.
- b. Annual capital cost projections for years between the reference years (2020, 2025, 2030 and 2035) were determined using straight line interpolations. For example, 2021 capital costs were determined as an interpolation between the capital cost projections from 2020 and 2025.
- c. No financing charges (cost of capital) were included in this illustration. The addition of financing changes would increase the average cost per kW.h values provided in the attached table.
- d. Retail sales taxes (Federal, Provincial and Municipal) commonly applied to equipment purchases and installation costs (i.e. labor and materials) were not included in this analysis.

Annual Energy Output Assumptions:

- a. 2 kW (DC) residential roof-top distributed solar PV installations
- b. An energy capacity factor of 0.15 was used to establish annual energy output. This value represents the conversion of the available solar radiance applied to the installed direct current (DC) photovoltaic panel and converting to an alternating current (AC) annual energy output.

Source:

- PVWatts online calculator developed by the National Renewable Energy Laboratory (<u>http://pvwatts.nrel.gov/pvwatts.php</u>).
- Calculation based on solar radiation available in Winnipeg, Manitoba for roof-mounted, south-facing panels placed with a 20 degree tilt



- DC/AC Inverter efficiency of 96%
- c. Annual solar performance degradation of 1%

Source:

- SunShot U.S. Department of Energy: SunShot Vision Study, Chapter 4. Photovoltaics: Technologies, Cost, and Performance, Page 78, February 2012.
- http://energy.gov/sites/prod/files/2014/01/f7/47927_chapter4.pdf
- d. Residential solar PV system life of 20 years

Source:

- SunShot U.S. Department of Energy: SunShot Vision Study, Chapter 4. Photovoltaics: Technologies, Cost, and Performance, Page 78, February 2012
- http://energy.gov/sites/prod/files/2014/01/f7/47927_chapter4.pdf

Annual Operation and Maintenance (O&M) Assumptions:

a. Annual average maintenance cost of \$25 / kW / Year

Source:

- SunShot U.S. Department of Energy: SunShot Vision Study, Chapter 4. Photovoltaics: Technologies, Cost, and Performance, Page 78, February 2012
- http://energy.gov/sites/prod/files/2014/01/f7/47927_chapter4.pdf