Technology Collaboration Programme
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International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in Canada
2019

Natural Resources Canada, CanmetENERGY in Varennes
Canadian Renewable Energy Association (CanREA)

Canadian Renewable Energy Association
WIND. SOLAR. STORAGE.
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What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6 000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Copper Alliance are also members.

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What is IEA PVPS Task 1?

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "Trends in photovoltaic applications" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the Canada National Survey Report for the year 2019. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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COVER PICTURE

The Old Crow Solar Project, a 940 kW system installed by the Vuntut Gwitchin Government in Old Crow, Yukon, 128 km north of the Arctic Circle. Photo credit: Solvest Inc.

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1 INSTALLATION DATA

The photovoltaics (PV) power systems market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, PV installations are included in the 2019 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2019, although commissioning may have taken place at a later date. All financial figures are in Canadian currency.

1.1 Applications for PV

This report considers only grid-connected PV systems. The amount of off-grid capacity is difficult to track and considered negligible compared to grid-connected capacity. However, off-grid solar PV applications (with or without battery storage), or hybrid systems including a small wind turbine or diesel generator, can be found throughout Canada. These systems are usually sited in remote northern communities, but are increasingly installed in less remote areas as costs come down and system installers and the public become more aware of opportunities. The residential off-grid market consists primarily of remote homes, cottages, and communications radios. The off-grid non-residential market consists of water pumping, road signals, navigational buoys, telecommunication repeaters, and industrial monitoring and controlling.

The continued decline in the cost of generating solar electricity has resulted in grid-connected PV systems approaching grid-parity throughout Canada, with applications varying by province. Ontario represented approximately 94% of Canada’s total cumulative installed capacity and approximately 73% of capacity growth in 2019. Other provinces and territories are also increasing their PV capacity and each have their own specific support mechanisms for renewables. However, with 10 provinces and 3 territories, a detailed look at PV in each jurisdiction is outside the scope of this report. Instead, a close look at Ontario's electricity infrastructure provides an overview of the majority of PV growth in Canada in previous years and an indication of future trends. Therefore, within the remainder of this sub-section, a breakdown of PV applications in Ontario will be provided.

Ontario’s grid-connected PV generating facilities are linked either to the transmission or distribution systems. Transmission-connected PV generation refers to large capacity projects connected to the high-voltage grid (lines with voltages greater than 50 kV). Distribution-connected generation, also called embedded generation, is small-scale generation contributing to local distribution systems and communities. Only around 2,2% (478 MW_{AC}) of Ontario's transmission-connected generating capacity was composed of PV. By contrast, PV constituted 63% (2 187 MW_{AC}) of total distribution-connected generation capacity. Growth in distributed PV was an important driver of expansion of PV power in Ontario in 2019. Figure 1 summarizes Ontario's distribution and transmission-connected PV capacity over the past two years. Net metering PV capacity for Ontario, not included in Figure 1, amounts to approximately 23,5 MW_{AC}. The national net metered solar PV capacity is estimated to be around 129,2 MW_{AC}.

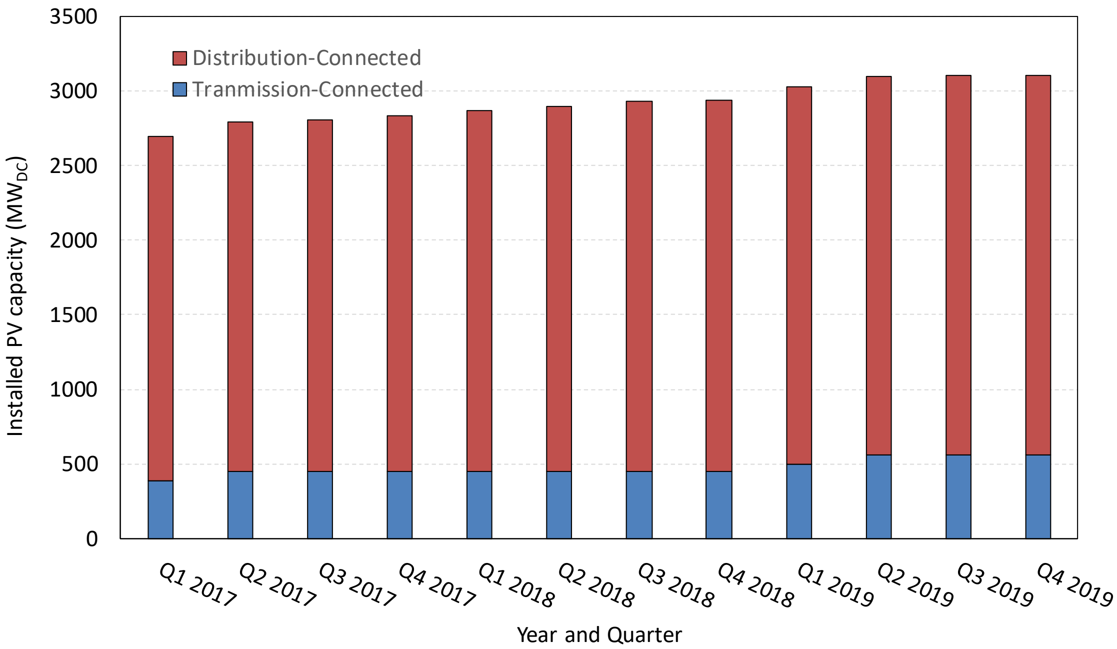

Figure 1: Distribution-connected versus transmission-connected PV systems (cumulative) in Ontario on a quarterly basis from 2017 and 2019. To convert from AC to DC, a conversion coefficient of 0,85 was used.

The renewable energy procurement strategy in Ontario has involved five different contract programs which cover wind, solar, bioenergy, and hydroelectricity projects (with the exception of the Green Energy Investment Agreement). Most programmes are run by the province's Independent Electricity System Operator (IESO).

1. The Feed-in Tariff (FIT) program, launched in 2009 with the Ontario government's Green Energy and Green Economy Act, was a method of procuring solar, wind, hydro, and biomass generating capacity in order to replace the province's coal-fired power plants. It applied only to projects of installed capacity greater than 10 kW. The FIT and microFIT programs provided, at different project size tiers, a guaranteed price for a fixed contract term for renewable electricity sold to the province. Contract periods range from 20 years for solar PV up to 40 years for hydroelectric projects. After a directive from the Ministry of Energy, the final application period for FIT projects occurred in 2016 after which point no further contracts were awarded. The price offered for PV electricity for FIT projects reduced as modules prices on the market dropped. For example, in 2009, a 500 kW capacity PV project would receive a rate of 65,3 ¢/kWh. By 2017, this rate had dropped by 67% to 20,7 ¢/kWh [1]. Approximately 38% (672 MW_{DC}) of systems in the FIT program are less than or equal to 500 kW. The remaining 62% (1 079 MW_{DC}) are larger than 500 kW and consist mostly of facilities greater than 10 MW.
2. The microFIT program was launched in 2009 and applied only to smaller projects of installed capacity less than 10 kW. This support program was mainly of interest to homeowners. Nearly all microFIT contracts and installed capacity is photovoltaic. MicroFIT concluded at the end of 2017.

3. The Green Energy Investment Agreement (GEIA) was initiated in 2010 between the Ontario government and Samsung and the Korea Electric Power Corporation. Although the agreement has undergone several alterations since then, the goal was to develop 2,5 GW of wind and solar generating capacity in the province and create clean energy manufacturing jobs. So far, four manufacturing plants have opened and the agreement is expected to continue contributing to the renewable energy sector over the next 20 years [2].
4. The Renewable Energy Standard Offer Program (RESOP) was launched in 2006 by the Ontario Power Authority in order to provide a stable pricing regime over a twenty-year period for electricity from renewable energy projects. RESOP was later succeeded by the FIT, microFIT and LRP programs [3].
5. The Large Renewable Procurement (LRP) program was launched in 2014 to replace the FIT program for projects with generating capacity exceeding 500 kW. The first phase of LRP operated from 2014 to 2016. The second phase of the LRP was suspended in 2016 and the program has since been cancelled. The LRP program was designed to ensure a better price for large-scale systems and to control the number of installation projects.

Figure 2 shows the installed PV capacity in Ontario divided by program type (excluding net metering). The majority of the installed PV capacity and capacity growth in Ontario has been achieved through the FIT and RESOP programs.

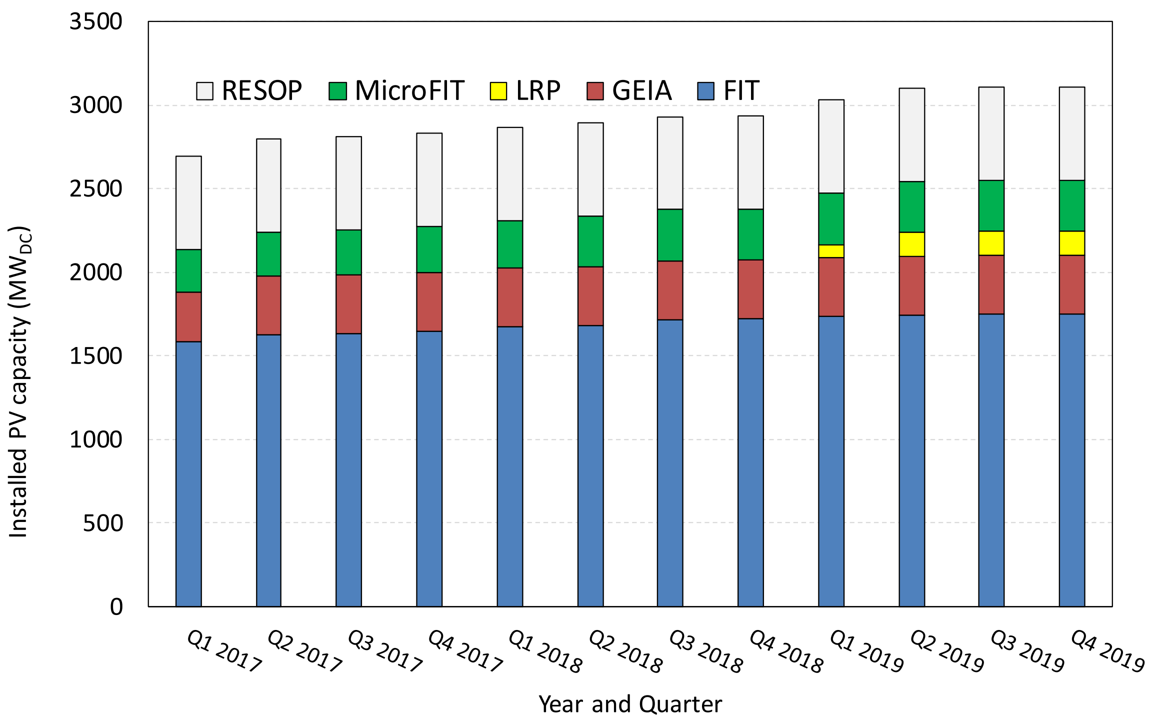

Figure 2: Ontario's cumulative installed PV capacity reported on a quarterly basis

Ontario's annual PV capacity additions peaked in 2015 at 671 MW_{DC} and declined to 170 MW_{DC} in 2019. Photovoltaic output is high during summer periods of peak demand. Thus, PV provides important relief to the electricity grid. As the amount of grid-connected PV capacity in Ontario increases, summer peaks are reduced and shifted later into the day [1]. Peak demand in Ontario is also greatly affected by the Industrial Conservation Initiative (a demand response program for industrial customers implemented in 2010) and to a lesser extent by the province's time-of-use rates for other consumers. The ability for embedded PV generation to offset electricity demand during peak periods in Ontario is estimated by monthly Solar Capacity Contribution values (Table 1) [2]. Comparing the average daily energy demand in Ontario between 2002 to 2016, there was a decrease in evening and nighttime hourly demand of approximately 1 500 MW. However, during peak load periods around midday, grid-connected PV caused a demand decrease by as much as 2 700 MW [3].

Table 1: Typical PV capacity contribution values during peak periods for transmission-connected PV (380 MW). Distribution-connected PV was not included in the calculation.

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
SCC	0,0%	0,0%	0,0%	1,3%	2,9%	10,1%	10,1%	10,1%	8,6%	0,0%	0,0%	0,0%

Although provincial government support of PV incentive policies varies with election cycles, installation and industry development across Canada will continue. Based on data from Ontario, British Columbia, Quebec, and other provinces, it is expected that future increases in installed capacity will be predominantly distribution-connected rather than transmission-connected.

1.2 Total PV power installed

The national cumulative installed PV capacity at the end of 2019 was 3,33 GW_{DC}. This represents a growth of approximately 7.5% over the previous year. Table 2 shows the increase in installed PV capacity for 2019 which was 232 MW_{DC} (composed of 115,3 MW_{DC} of transmission-connected and 116,6 MW_{DC} distribution-connected capacity). Off-grid PV is not tracked and is assumed to be negligible compared to the grid-connected total.

Table 2 summarizes Canada's centralized and decentralized PV capacity. Centralized PV installations are assumed to only inject electricity without self-consumption by the consumer. Distributed PV, by contrast, allows self-consumption. Centralized PV capacity was assumed to be almost entirely from Ontario, and was determined as the sum of all RESOP, GEIA, and large-scale FIT (>0,5 MW_{AC}) systems. The only addition to the centralized PV power total from outside of Ontario was Alberta's 15 MW_{AC} Brooks Solar array. Canada's decentralized (or distributed) capacity was the sum of all other provinces and territories added to the Ontario distributed total. Ontario's distributed capacity was the sum of all microFIT, small-scale FIT contracts, and net metering.

Table 2: Annual PV power installed during calendar year 2019

		Installed PV capacity in 2019 [MW]	AC or DC
PV capacity	Off-grid	Data not tracked	Not Applicable
	Decentralized	90,96	DC
	Centralized	140,77	DC
	Total	231,73	DC

Among the Canadian provinces and territories, there is no standardized collection of PV capacity figures or distinction between ground-mounted and rooftop, commercial versus residential, or BIPV and BAPV systems. The closest estimates for ground-mounted and rooftop PV are from the Ontario IESO's quarterly reports. The IESO distinguishes between ground-mounted and rooftop in their FIT, GEIA, and LRP projects. Thus, the cumulative capacity for rooftop and ground-mounted systems in Ontario as of March 31, 2020, was approximately 565 MW_{DC} and 1,68 GW_{DC}, respectively.

The data collection process is described in **Table 3**. Ontario, Alberta, Nova Scotia, and Newfoundland and Labrador report their PV capacities in AC, while the rest report in DC. The Ontario PV capacity data in this report were limited to systems contracted through the IESO, and the Ontario Energy Board (OEB). These data do not include contracts with non-utility generators, or contracts with Ontario Power Generation or the Ontario Electricity Financial Corporation. Net metering data for Ontario, reported by the OEB, refers to embedded generators that do not participate in the IESO-administered market.

Table 3: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Unless stated otherwise, PV capacity data in this report are in DC. To convert from AC to DC, a conversion coefficient of 0,85 was assumed.
Is the collection process done by an official body or a private company/Association?	Data were collected by Natural Resources Canada (NRCan) through the Renewable Energy Integration program.
Link to official statistics (if this exists)	See works cited
Estimated accuracy of data:	Approximately ±3%

Table 4 summarizes the centralized versus distributed PV power capacity increase between 1992 and 2019. Centralized PV systems are typically ground-mounted, provide bulk power, are on the supply side of electricity meters, and perform the function of a centralized power station. For the purposes of this report, centralized PV systems are defined as having power capacity greater than 0,5 MW_{AC} and may be connected to either the distribution grid or transmission grid. By contrast, distributed PV systems have a power capacity equal to or less than 0,5 MW_{AC}, are connected to the distribution network, and are on the demand side of the electricity meter. Distributed systems are often located on residential or commercial buildings and can be further categorized as building integrated (BIPV) or building applied (BAPV) depending on whether the modules replace conventional building materials. Since a breakdown of PV power capacity for each project is available only for Ontario, it is assumed that all of the PV capacity in the other provinces is distributed (with the exception of Alberta's Brooks solar array).

Table 4: The cumulative installed PV power in 3 sub-markets

Year	Off-grid [MW_{DC}] (including large hybrids)	Grid-connected distributed [MW_{DC}] (BAPV, BIPV)	Grid-connected centralized [MW_{DC}] (Ground, floating, agricultural…)	Total [MW_{DC}]
1995	1,64	0,21	0,01	1,86
1996	2,31	0,24	0,01	2,56
1997	3,12	0,25	0,01	3,38
1998	4,2	0,26	0,01	4,47
1999	5,53	0,29	0,01	5,83
2000	6,84	0,30	0,01	7,15
2001	8,48	0,34	0,01	8,83
2002	9,63	0,37	0,00	10,00
2003	11,43	0,40	0,00	11,83
2004	13,37	0,47	0,04	13,88
2005	15,62	1,07	0,06	16,75
2006	18,98	1,44	0,06	20,48
2007	22,86	2,85	0,06	25,77
2008	27,48	5,17	0,06	32,72
2009	35,2	12,25	47,12	94,57
2010	60,1	27,74	193,29	281,13
2011	61,05	131,16	366,11	558,29
2012	NA	218,68	547,29	765,97
2013	NA	273,19	937,29	1 210,48
2014	NA	540,85	1 302,23	1 843,08
2015	NA	735,81	1 782,50	2 518,31
2016	NA	792,66	1 871,65	2 664,31
2017	NA	906,91	2 006,29	2 913,20
2018	NA	1 059,20	2 009,29	3 093,67
2019	NA	1 178,61	2 148,12	3 326,73

Figure 3 shows the installed capacity by province and territory for grid-connected PV power and the number of utility interconnected PV systems as of December 31, 2019.

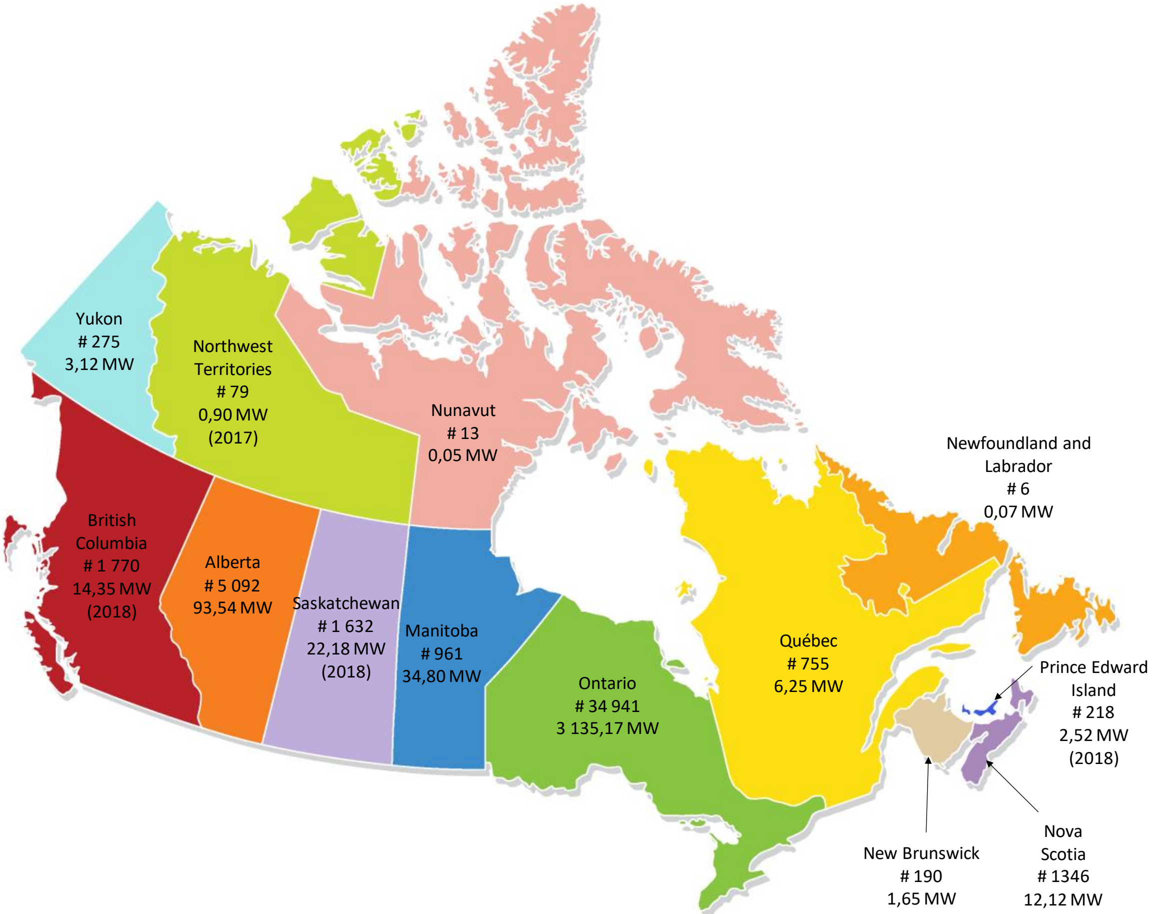

Figure 3: Map showing the Canadian provinces and territories PV power capacity (MW_{DC}). This map is for illustrative purposes only and sizes or distance scales are approximate. Note: PV data for the Northwest Territories, British Columbia, and Saskatchewan were not available in 2019, and so values from previous years were reported.

Figure 4 gives an overview of Ontario's net metering, which is under the jurisdiction of the OEB. The program has two principal requirements: power generated must be from renewable sources (wind, water, solar, or biomass), and the energy generated must be for the customer's own use or be paired with a storage facility. Alterations to Ontario's net metering program came into force on July 1, 2017, which expanded net metering equipment to systems larger than 500 kW. The PV capacity data collected by the IESO and the OEB were added together to obtain the total capacity for the province. The OEB also collects data on energy storage facilities linked to PV arrays. As of December 31, 2018, the total capacity of installed storage facilities (distributed among four solar projects) was 509 kW_{AC} [4]. Data on PV electrical storage sites in other provinces and territories are not currently collected for this report.

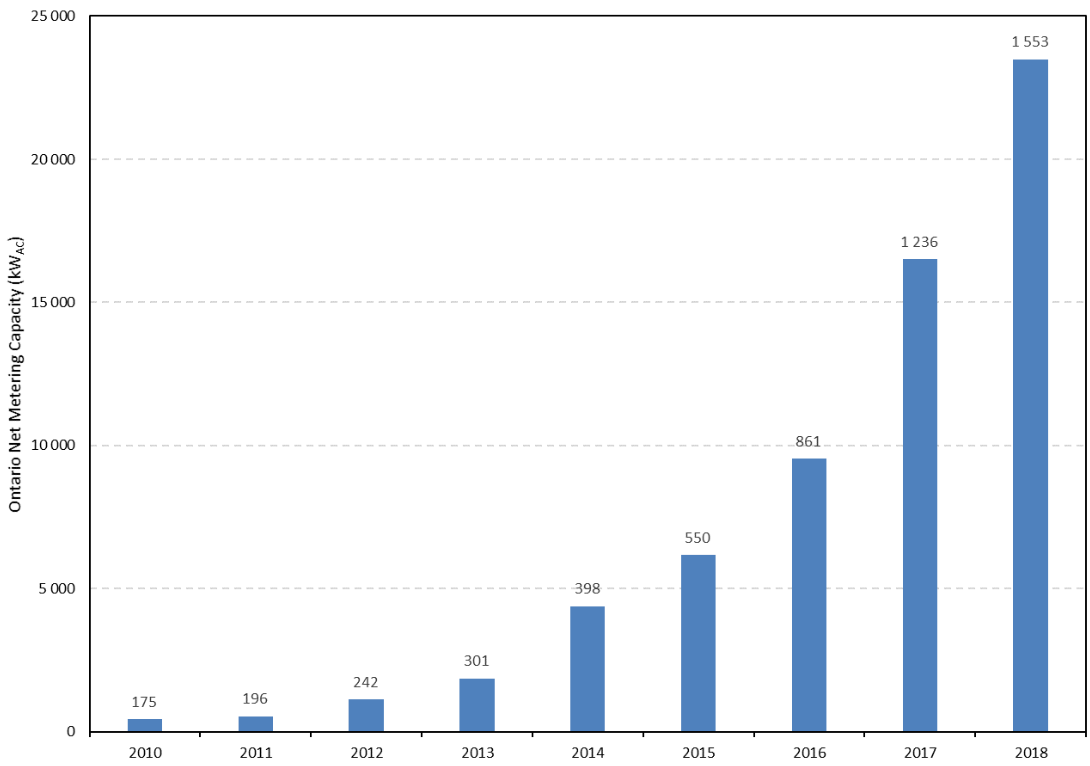

Figure 4: Ontario net metering capacity timeline. The corresponding number of PV system installations are shown above each year. Data were not available for 2019.

Table 5 provides detail on the total PV capacity connected to the distribution and transmission grids. Capacity connected to the low-voltage distribution grid was the sum of Ontario's distribution grid-connected capacity plus the capacity of all other provinces and territories. Total capacity connected to the high-voltage transmission grid was composed only of Ontario's transmission-connected PV systems.

Table 5: Other PV market information

	2019
Number of PV systems in operation in Canada	47 278 (during 2019, there were 3 442 new systems)
Decommissioned PV systems during the year [MW]	Not tracked
Repowered PV systems during the year [MW]	Not tracked
Total capacity connected to the low voltage distribution grid [MW]	2 764,37 MW_{DC}
Total capacity connected to the medium voltage distribution grid [MW]	Not tracked

Total capacity connected to the high voltage transmission grid [MW]	562,35 MW_{DC}

Table 6 provides national figures on power generation and electricity demand as well as an estimate of total PV energy production. Total power generation capacity for 2019 was calculated using the Statistics Canada data for 2017 **[5]** for all energy sources and NSR PV capacity data for 2019. To derive the 2019 total power generation capacity, a 1% annual growth rate was assumed **[6]**. Total renewable power generation capacities were calculated in a similar manner except using technology specific growth rates derived from the previous year (0,4% growth for hydro, and 3,6% growth for wind) **[5]**. Total electricity demand was estimated from Statistics Canada's supply and demand for primary and secondary energy **[7]**. New power generation and renewable power generation capacities installed in 2019 were estimated using Statistics Canada data for wind, tidal and hydro **[5]**, with NSR data used for PV capacity. To estimate PV energy production, the total nameplate power was multiplied by the average yearly Canadian PV potential which was assumed to be 1 150 kWh/kW_p. The average PV potential was determined using satellite-based insolation data and assuming a typical performance ratio of 0,75 **[8]**. Photovoltaic electricity production was calculated as a percentage of total generation based on Statistics Canada annual electricity generation estimates (including energy imports and excluding energy exports) **[9]**.

Table 6: PV power and the broader national energy market

	2018	2019
Total electrical power generation capacities (all technologies) [GW] [5] [6]	146,59	148,05
Total renewable power generation capacities (including hydropower) [GW] [5]	96,77	97,53
Total electricity demand [TWh] [6]	530,74	540,33
Total energy demand [TWh] [7]	2 464,24	2 488,89
New power generation capacities installed during the year [GW] [5]	1,87	1,47
New renewable power generation capacities installed during the year (including hydropower) [GW] [5]	0,89	0,76
Estimated total PV electricity production (including self-consumed PV electricity) [TWh] [8]	3,56	3,83
PV electricity production as a % of total electricity generation	0,60	0,64

1.3 Key enablers of PV development

Whether connected to PV or not, enabling technologies such as decentralized storage and electric cars, buses, and trucks can increase the grid's hosting capacity and/or directly provide storage capacity. Technologies, such as heat pumps, provide a capacity for heating and cooling which may require electricity produced by a PV array. Table 7 provides information on these technology categories. No official data at a federal level are currently available on the number of decentralized energy storage systems in Canada.

Heat pump capacity provides several opportunities for energy savings and greenhouse gas reductions in the residential heating and cooling market. Space heating and water heating accounts for around 81% of the Canadian residential building sector, which in turn emits 16% of Canada's total greenhouse gas emissions. A study comparing air-source and ground-source heat pumps in five Canadian provinces (Nova Scotia, Québec, Ontario, Alberta, and British Columbia) showed that heat pumps could provide up to 66% secondary energy savings and up to 84% greenhouse gas reduction. One of the main challenges to making heat pump technology widely available is competition with the low cost of natural gas and electrical baseboard heating prices. Natural Resources Canada research into heat pump technology focuses on the use of ejectors with air-source heat pumps, and the use of CO_2 refrigerant to reduce borehole size in ground-source heat pumps **[10]**. The two provinces with the largest number of residential heat pumps are Québec and Ontario which, in 2015, accounted for approximately three quarters of the Canadian total.

As of December 2019, the combined sales of both plug-in hybrid (PHEV) and battery electric vehicles (BEV) in Canada reached 55 793. Provincial incentives in Ontario for EVs were discontinued in June 2018, and while sales of EVs predictably peaked at that time to take advantage of program benefits, EV sales showed robust recovery and monthly growth in the aftermath of program cancellation. Provincially, that largest adopters of EV technology remain Québec, Ontario, and British Columbia **[11].**

Electric bus adoption in Canada is growing and pilot projects are underway in Montreal, Vancouver, and Toronto. Domestic electric bus production is centred in Quebec (Nova Bus) and Manitoba (New Flyer Industries). Electric bus operation in Canada is almost entirely hybrid buses. By contrast, battery all-electric buses are more expensive than their hybrid counterparts but have lower life-cycle cost and simpler powertrain. The federal government has set a target of 5 000 electric buses in the country-wide fleet by 2025 **[12]**.

Table 7: Information on key enablers

	Description	2019 Volume	Total Volume	Source
Decentralized storage systems	No provincial or federal programs	NA	NA	NA
Residential Heat Pumps [#]	Air-source and ground-source	21 200	817 800	[13]
Electric cars [#]	Deployment highest in Quebec and British Columbia	55 793	148 884	[11]
Electric buses and trucks [#]	Pilot projects underway in Montreal, Toronto and Vancouver	Not tracked	1 250	[14]

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Crystalline silicon module prices vary by manufacturer and module type (monocrystalline and multicrystalline). However, the trend for decrease in module spot prices remains similar in all markets. In the Canadian market in 2019, there was a significant transition from 60-cell to 72-cell modules in residential installation, from traditional mono to mono PERC, and from regular cells to split cells. Table 8 shows whole-sale price estimates applied to high efficiency monocrystalline modules for modules of 290 W and above (such as PERC, HIT, n-type, or back-contact cell types).

Table 8: Typical module prices [$/W]

Year	Lowest price of a standard module crystalline silicon	Highest price of a standard module crystalline silicon	Typical price of a standard module crystalline silicon
2005	----	----	4,31
2006	----	----	5,36
2007	----	----	4,47
2008	----	----	3,91
2009	----	----	3,31
2010	----	----	2,27
2011	----	----	1,52
2012	0,85	----	1,15
2013	0,80	----	0,95
2014	0,82	----	0,85
2015	0,75	----	0,80
2016	0,66	0,90	0,78
2017	0,75	0,81	0,80
2018	0,61	0,65	0,63
2019	0,50	0,74	0,62

2.2 System prices

Photovoltaic system prices, shown in Table 9, take into account hardware costs such as mounting materials and inverters, as well installation and development.

Table 9: Turnkey PV system prices of different typical PV systems

Category/Size	Typical applications and brief details	Current prices [$/W]
Off-grid 1-5 kW	A stand-alone PV system is a system that is installed to generate electricity to a device or a household that is not connected to the public grid. Such applications include, for example, rooftop or ground-mounted systems in remote communities.	----
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	2,50 - 2,75
Residential BIPV 5-10 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected households. Typically, on villas and single-family homes.	----
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	2,00 - 2,50
Small commercial BIPV 10-100 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	----
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1,80 - 2,50
Large commercial BIPV 100-250 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	----
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	1,80 - 2,00
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	1,25

Large centralized PV >20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	1,25

Table 10: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW [$/W]	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW [$/W]	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW [$/W]	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW [$/W]
2005	10,00	10,00	10,00	----
2006	8,50	12,60	12,60	----
2007	8,50	10,00	10,00	----
2008	6,50	----	----	----
2009	8,50	6,00 - 8,00	6,00 - 8,00	----
2010	6,50 - 8,00	6,00	6,00	4,00
2011	6,79	5,27	5,27	3,50
2012	3,00 - 5,00	4,00	4,00	2,80
2013	3,44	3,27	3,27	2,88
2014	3,00 - 4,00	2,20 - 2,90	2,20 - 2,90	2,00 - 2,60
2015	2,80 - 6,00	2,20 - 2,90	2,20 - 2,90	2,00 - 2,60
2016	3,00 - 3,50	2,00 - 3,00	2,00 - 3,00	< 2,00
2017	2,50 - 3,20	1,80 - 2,50	1,80 - 2,50	< 1,80
2018	2,93	1,80 - 2,50	1,80 - 2,50	1,46
2019	2,50 - 2,75	1,80 - 2,50	1,80 - 2,00	1,25

2.3 Cost breakdown of PV installations

The cost breakdown of a typical 5-10 kW roof-mounted, grid-connected, distributed PV system on a residential single-family house at the end of 2019 is presented in Table 11. The cost structure presented is from the customer's point of view and does not reflect the installer companies' overall costs and revenues. The "average" category in Table 11 represents the average cost for each cost category. It takes the whole system into account and summarizes the average end price to the customer. The "low" and "high" categories are the lowest and highest cost that has been reported within each segment. These costs are individual posts, i.e. summarizing these costs may not give an accurate system price. Cost data were collected by soliciting input from HESPV, a PV consulting, installation, and training company with links to industry. Additional data were sourced from the Canada Energy Regulator [15].

Table 11: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of 5-10 kW

Cost category	Average [$/W]	Low [$/W]	High [$/W]
Hardware			
Module	0,62	0,50	0,74
Inverter	0,45	0,30	0,60
Mounting material	0,40	0,33	0,46
Other electronics (cables, etc.)	----	----	----
Subtotal Hardware	**1,47**		
Soft costs			
Planning	0,10	----	----
Installation work	0,65	----	----
Shipping and travel expenses to customer	----	----	----
Permits and commissioning (i.e. cost for electrician, etc.)	0,175	----	----
Project margin	0,20	----	----
Subtotal Soft costs	**1,125**		
Total (including VAT)	**2,60**		

2.4 Financial parameters and specific financing programs

In Canada, financing from institutional lenders is available for projects, or portfolios of projects, that meet certain financial thresholds. There are fewer financing options for residential and small commercial projects, but the number of options for low cost capital is growing. The Canadian Infrastructure Bank, a federal government crown corporation, was established in June 2017 and uses federal financing to attract private and institutional partners. It is investing $35 billion into infrastructure projects, of which $5 billion is devoted to renewable energy initiatives such as photovoltaics [20].

2.5 Specific investments programs

As outlined in Section 3.2, there are a variety of investment mechanisms across the country. In Ontario, the IESO operates the vast majority of investment programs supporting PV, as described in Section 1. Programs that led to growth in other provinces can be found, for example, in Alberta. In 2017, Alberta implemented the “Residential & Commercial Solar Program”, the “Municipal Solar Program” and the “Indigenous Solar Program”, which helped make it the first province aside from Ontario to install more than 5 MW of PV in a single year. The “Residential & Commercial Solar Program” was cancelled in 2019. At the federal level, the Government of Canada continues to offer tax incentives for commercial solar PV systems including accelerated depreciation as Class 43.2 Accelerated Capital Cost Allowance (ACCA) and the Canadian Renewable and Conservation Expense (CRCE) [21]. Additional details are provided in Table 12.

Table 12: Summary of existing investment schemes

Investment Schemes	Additional Information
Third party ownership (no investment)	Several companies offer third party ownership and leasing services. The residential market in Ontario has been dominated by this approach to date.
Renting	A number of companies offered rented systems in Canada in 2019. However, it is more common that after a specified term the system becomes the property of the renter (i.e. leasing).
Leasing	A number of companies offered leased systems in Canada in 2019.
Financing through utilities	No utilities are yet to offer on-bill financing specifically for PV as of the end of 2019.
Investment in PV plants against free electricity	A number of “Solar Gardens” are under development or in operation in Canada including in the City of Nelson, British Columbia.
Crowd funding (investment in PV plants)	Several solar energy co-operatives have been incorporated to facilitate investment in, and ownership of, PV systems.
Community solar	There are several approaches to "Community Solar" being trialled and tested throughout Canada.
International organization financing	The Green Energy Investment Agreement (GEIA), initiated in 2010, mandated investment and cooperation between the Government of Ontario and Samsung and the Korea Electric Power Corporation.

2.6 Additional country information

Canada's electricity sector is regulated provincially and is comprised primarily of a mixture of wholesale open markets and vertically integrated crown corporations. Electricity generation in Canada was estimated to be 653,3 TWh in 2019 with the largest producers of electricity being the provinces of Quebec, Ontario, British Columbia, and Alberta. As shown in Table 13, the population of Canada was around 37,8 million inhabitants at the end of 2019.

Table 13: Country information (electricity prices vary by province and territory and figures quoted in this table represent an average rate across selected cities)

Retail electricity prices for a household [¢/kWh]	18,06
Retail electricity prices for a commercial company [¢/kWh]	15,87
Retail electricity prices for an industrial company [¢/kWh]	11,08
Population at the end of 2019	37 797 496
Country size [km^2]	9 985 000
Average PV yield in [kWh / kW_p]	1 150

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies influence PV by incentivizing or simplifying the process. Indirect support policies change the regulatory environment in a way that can push PV development. Table 14 provides a summary of key measures.

Table 14: Summary of PV support measures

Category	Residential		Commercial + Industrial		Centralized	
Measures in 2019	**On-going**	**New**	**On-going**	**New**	**On-going**	**New**
Feed-in tariffs	yes	----	yes	----	yes	----
Feed-in premium (above market price)	----	----	----	----	----	----
Capital subsidies	yes	----	yes	----	----	----
Green certificates	yes	----	----	----	----	----
Renewable portfolio standards with/without PV requirements	----	----	----	----	----	----
Income tax credits	----	----	----	----	----	----
Self-consumption	yes	----	yes	----	----	----
Net-metering	yes	----	yes	----	----	----
Net-billing	----	----	----	----	----	----
Collective self-consumption and virtual net-metering	yes	----	----	----	----	----
Commercial bank activities e.g. green mortgages promoting PV	yes	----	----	----	----	----
Activities of electricity utility businesses	----	----	----	----	----	----
Sustainable building requirements	yes	----	----	----	----	----
BIPV incentives	----	----	----	----	----	----

3.1 National targets for PV

There is no specific target for PV set by the federal, provincial or territorial governments. However, the federal government has committed to 90% of Canada’s electricity coming from non-emitting sources by 2030.

3.2 Direct support policies for PV installations

3.2.1 New, existing or phased out measures in 2018

Climate Change commitments

Canada’s current target for reducing greenhouse gas emissions is 30% below 2005 levels by 2030. Canada is committed to the 2015 Paris Agreement and specifically the global transition towards a low carbon economy in order to keep the rise in global average temperature below 1,5°C. A first step towards Canada’s commitment to meet these goals was made by enacting the Pan-Canadian Framework on Clean Growth and Climate Change [25] to address Canada's international obligations under the United Nations Framework Convention on Climate Change. The Pan-Canadian Framework has four parts: (1) pricing carbon, (2) complementary climate actions to reduce emissions, (3) adaptation measures to mitigate the damage of global warming, and (4) supporting low carbon technologies. There is also a degree of flexibility allocated to the provinces to pursue their own emissions reductions strategies at the local level.

The Federal Government implemented country-wide carbon pricing in fall 2018. The price began at $20 per CO_2 equivalent tonne in 2019 and increases by $10 each year to reach $50 per tonne in 2022. The program does not apply to provinces that implement their own carbon pricing schemes so long as they impose an equivalent price on carbon.

Description of Solar PV support measures by province and territory

Alberta: EQUS, a Rural Electrification Association, provides electrical distribution services throughout 26 municipal districts. EQUS offers up to $15 000 in loans to its members to finance PV installation. The Clean Energy Improvement Program provides financing for residential and commercial property owners with long-term financing to cover renewable energy projects which are repaid through property taxes. This program is part of several Property Assessed Clean Energy (PACE) programs being implemented by various provincial and municipal governments. Alberta's solar incentive program was cancelled on June 11, 2020. However, the cities of Banff, Canmore, Edmonton, and Medicine Hat offer rebates on PV installations ranging from 0,40 - 1,00 $/W.

British Columbia: The cities of Nelson, Penticton, and Vancouver offer loans for home energy projects, many of which are paid back through electric utility bills. There are two renewable energy incentive programs: a 7% provincial sales tax exemption for PV installations (which also includes micro-hydro), and a Renewable Energy System Program in the districts of Nanaimo and Lantzville which offer incentives for PV, solar thermal, and geothermal.

Manitoba: Manitoba Hydro offers support for PV upgrades for homeowners through its Home Energy Efficiency Loan and Energy Finance Plan programs. The cost of the system is repaid through the electric utility bill with the full amount being due if the home is sold before the loan is fully repaid.

New Brunswick: The New Brunswick Credit Union offers renewable energy loans through its Greener Home Loans program, which provides financing for PV projects. The provincial utility NB Power offers a 0,20 - 0,30 $/W rebate on PV systems through its Total Home Energy Savings Program.

Newfoundland and Labrador: Although the province offers two clean energy incentive programs and 16 energy efficiency rebates, there are no support measures targeted specifically to PV.

Northwest Territories: The Alternative Energy Technologies Program is managed through the Artic Energy Alliance and offers homeowners a 50% rebate on the cost of renewable energy generation projects, including PV. The Northwest Territories are also implementing the regulatory framework for a PACE program similar to what is already in place in Alberta.

Nova Scotia: The province has two separate PACE programs. One is administered through the Clean Energy Financing Program to the cities of Bridgewater, Lunenburg, Digby, Barrington, Yarmouth, Amherst, and Cumberland. The second is administered through Solar City and applies exclusively to the city of Halifax, offering a 10 year 4,75% fixed interest loan attached to the home owner’s property. Should the original tenant sell the property, the loan is automatically transferred to the new owners. The province also has a Solar Homes program offering a 0,60 $/W rebate on the purchase of PV systems.

Nunavut: Although Nunavut offers energy efficiency loans for heating, electrical, and other home upgrades, no specific PV financing or incentives are offered.

Ontario: Much of Ontario’s installed capacity is contracted with long-term power purchase agreements through the IESO. Financing from institutional lenders has been available for projects, or portfolios of projects, that meet certain financial thresholds. Residential and small commercial projects have been less well served but the number of options for low cost capital is growing. Structured around the popular PACE framework, the city of Toronto uses a Home Energy Loan Program to provide loans for renewable energy projects that are paid back through property tax billing.

Prince Edward Island: The province’s Solar Electric Rebate Program, Efficiency-PEI, offers a 1,00 $/W incentive for PV systems. Through its Energy Efficiency Loan Program, PEI offers a 7-year loan at a fixed interest rate of 5%.

Quebec: The province has eight clean energy incentive programs and 27 types of energy efficiency rebates. Beyond net metering, there are currently no support policies directly targeted to PV.

Saskatchewan: Beyond net metering, there are no support policies specifically targeted to PV.

Yukon Territory: Through its Good Energy Renewable Energy Rebate, the Yukon Government offers a rebate of 800 $/kW for off-grid residents installing PV, or other renewables such as wind, hydro, and geothermal. The Yukon's version of the PACE program is the Rural Electrification and Telecommunications Program and is used to fund PV projects for off-grid homeowners.

3.2.2 BIPV development measures

There are currently no policies to support BIPV either provincially or federally. However, several voluntary green building programs have resulted in demonstration projects.

3.3 Self-consumption measures

Table 15: Summary of self-consumption regulations for small private PV systems in 2019

PV self-consumption	1	Right to self-consume	Throughout Canada
	2	Revenues from self-consumed PV	Applied as credits or monetarily depending on the jurisdiction
	3	Charges to finance transmission, distribution grids & renewable levies	Offset in some instances, paid in others depending on the jurisdiction
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Applied as credits or monetarily depending on the jurisdiction
	5	Maximum timeframe for compensation of fluxes	Most typically one year
	6	Geographical compensation (virtual self-consumption or metering)	Typically uniform within a jurisdiction
Other characteristics	7	Regulatory scheme duration	Various, depending on jurisdiction
	8	Third party ownership accepted	Various, depending on jurisdiction
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Various, depending on jurisdiction
	10	Regulations on enablers of self-consumption (storage, DSM…)	Various, depending on jurisdiction
	11	PV system size limitations	Various, depending on jurisdiction
	12	Electricity system limitations	Various, depending on jurisdiction
	13	Additional features	None

3.4 Collective self-consumption, community solar and similar measures

Measures for collective self-consumption (e.g. PV systems for several apartments in the same building), virtual net-metering (allowing consumption and production in different places), and community solar (investment by private or public organizations) have begun in several Canadian jurisdictions with the potential for implementation in 2019.

3.5 Tenders, auctions & similar schemes

Ontario's IESO has used three procurement methodologies: standard offer, bilateral negotiations, and competitive bid, as described in Section 1. Bilateral-negotiation and competitive bid processes are rare. The vast majority of contracts in Ontario for PV have been awarded by standard offer. Solar PV contract periods are generally awarded for a period of 20 years. The ways in which incentives are paid in Canada varies from region to region. Ontario's feed-in tariff is funded by electricity consumers. Other programs are funded through revenues from carbon pricing programs or provincial and municipal taxes.

3.6 Social policies

In terms of PV policy, support measures are largely left to the provinces and territories to define. However, as stated previously, PV will be eligible for several national support programs announced by the Federal Government in 2017, including the $500 million Low Carbon Economy Challenge Fund, the $220 million Clean Energy for Rural and Remote Communities program, and the $100 million Smart Grid Program. As discussed in Section 1, 2017 was the last year for Ontario's microFIT and FIT programs. Ontario's net-metering regulation now forms the basis for future project development. There is also the Federal tax provision for clean energy equipment. Clean energy equipment, such as PV, qualifies for an accelerated Capital Cost Allowance rate (a deductible portion of the capital cost of a depreciable property). This rate is between 30% and 50% for equipment purchased after 1994 and 2005 respectively [28].

Other sub-national measures of importance launched in 2017 include the province of Alberta's $36 million Residential and Commercial Solar Program implemented by Energy Efficiency Alberta. This consists of a subsidy providing a $0,90 per watt incentive to residential systems. The maximum allowable grant is the lesser of 10% of the system cost or $10 000. In addition to homeowners and small businesses, all publicly funded institutions and non-profit organizations are eligible. Commercial and non-profit groups receive incentives of $0,75 and $1,00 per watt respectively. The program is fully subscribed and no longer accepting new applications [29].

3.7 Retrospective measures applied to PV

On July 5, 2018, 758 solar PV and wind energy project were cancelled in Ontario. The solar projects cancelled were in the FIT5 (small community project) and LRP1 (competitive bid market price) contracts. The cancellations negatively affected local ownership among small communities and First Nations, as well as impacting local distributors and installers.

3.8 Indirect policy issues

3.8.1 Rural electrification measures

Canada has approximately 300 off-grid communities with a total population of around 200 000 people. There is an ongoing transition in these communities from diesel fuel to cleaner sources of energy including solar. In particular, the Federal Government initiative studying PV system performance, cost, and durability north of the 60th parallel provides funding for the monitoring of PV arrays in remote communities.

3.8.2 Support for electricity storage and demand response measures

Several innovation funds have given rise to solar projects with electricity storage including the province of Ontario's Smart Grid Fund. The Federal Government's Smart Grid program, announced in 2017, is also expected to result in support for combined solar and storage projects across Canada.

3.8.3 Support for electric vehicles (and VIPV)

The support measures for electric vehicles (EVs) are mainly situated in Quebec, Ontario, and British Columbia. However, support policies for EVs in Ontario were discontinued in June 2018 when the cap and trade program that funded these incentives was discontinued. Together, Quebec, British Columbia, and Ontario account for approximately 95% of all electric vehicles sold in Canada [16]. Electric vehicle support measures in these provinces are not explicitly linked to the storage opportunity they provide for PV, but are offered in the context of reducing greenhouse gas emissions from the transport sector and improving air quality.

3.8.4 Other support measures

In 2016, Canada's Federal Government announced a price on carbon throughout Canada starting at a minimum of $10 per tonne in 2018, and rising by $10 per year to $50 per tonne in 2022. This measure puts a price on pollution and created new revenue streams for re-investment in technologies that displace greenhouse gas emissions. In 2016, the Federal Government launched the Pan-Canadian Framework on Clean Growth and Climate Change which presented a strategy for Canada to meet its nationally determined contributions to the Paris Agreement.

3.9 Financing and cost of support measures

As has been discussed previously, the ways in which incentives are paid in Canada varies from region to region. Over the past few years, governments in several countries have faced both financial and political pressures due to the high cost of feed-in-tariff programs. To control the rising costs of subsidies like FIT, there has been a shift towards "winner take all" methods of competitive bidding and auctions. However, the competitive bidding process tends to favour large suppliers while shutting out smaller companies, community groups, and cooperatives.

Although the cost of PV systems continues to fall, a distinction must be drawn between construction costs and auction prices. Construction costs continue to decline, driven by technological improvements and economies of scale. Nevertheless, the competitive pressures of auction-based purchasing strategies drive down auction costs faster than construction costs. This has resulted in shrinking profit margins for investors and declining investor interest, as shown in Ontario's reduced PV capacity growth after 2015. Auction-based competition has, in some countries, resulted in the emergence of dive bidding and what has been termed the "winner's curse" whereby a successful bidder underbids in order to win the contract and then cannot deliver power at the agreed-upon price. Such practices were, for example, reported by the International Renewable Energy Agency (IRENA) [34], for PV projects in India and Brazil.

4 INDUSTRY

4.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Canada continues to produce feedstock for the global solar industry through 5N Plus (Table 16). 5N Plus is a Canadian company with 14 manufacturing facilities located throughout Canada, US, Malaysia, England, China, Belgium, and Laos. They have 18 sales offices in Asia, Europe, North America, and South America. First Solar is their primary customer and is the largest thin film PV module producer worldwide. There are currently no producers of polysilicon, silicon ingots, or silicon wafers in Canada. However, pilot production of polysilicon in Sarnia by Ubiquity Solar may be a contributor in the coming years.

Table 16: Silicon feedstock, ingot and wafer producer's production information for 2019

Manufacturers	Process & technology	Total Production	Product destination	Price
5N Plus	CdTe & CIGS high purity compounds	350 tonnes (2010 est.)	First Solar and other thin film PV manufacturers	

4.2 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country. Table 17 presents data from four companies in Canada producing PV modules all of which have their facilities located either in Ontario and Quebec and are involved in contract manufacturing of modules for other multi-national companies. Together, these companies produced an estimated 390 MW/year of crystalline silicon modules. Notably, Stace also manufactures CPV modules. Total PV cell and module manufacturing together with production capacity information are summarised in table 17.

4.3 Manufacturers and suppliers of other components

The balance of system technology market in Canada is mainly served by foreign companies with operations in Canada or production through contract manufacturing. The companies that have Canadian development and manufacturing facilities include Eaton and Sungrow Canada. Typical balance of system components manufactured or supplied in Canada are inverters (central/string, microinverter, power optimizer), racking and mounting (rooftop, ground-mount, dual/single axis trackers), and wiring (cabling and combiner box). Among these components, the manufacturing of central inverters has experienced the largest growth and is primarily used for commercial rooftop and utility-scale systems. Companies providing Canada-made inverters include: Schneider Electric, Siemens, Emerson, SMA/Samsung, ABB, Advanced Energy, Power One, and Satcon.

Table 17: PV cell and module production and production capacity information for 2019

<table>
<tr><th rowspan="2">Cell/Module manufacturer (or total national production)</th><th rowspan="2">Technology (sc-Si, mc-Si, a-Si, CdTe, CIGS)</th><th colspan="2">Total Production [MW]</th><th colspan="2">Maximum production capacity [MW/yr]</th></tr>
<tr><th>Cell</th><th>Module</th><th>Cell</th><th>Module</th></tr>
<tr><td colspan="6">Wafer-based PV manufactures</td></tr>
<tr><td>Canadian Solar</td><td>sc-Si, mc-Si</td><td>----</td><td rowspan="4">475</td><td>----</td><td rowspan="4">1 050</td></tr>
<tr><td>Heliene</td><td>mc-Si</td><td>----</td><td>----</td></tr>
<tr><td>Silfab</td><td>sc-Si, mc-Si</td><td>----</td><td>----</td></tr>
<tr><td>Stace</td><td>sc-Si, mc-Si, CPV</td><td></td><td></td></tr>
<tr><td>**Totals**</td><td colspan="2">----</td><td>**475**</td><td>----</td><td>**1 050**</td></tr>
</table>

5 PV IN THE ECONOMY

5.1 Labour places

The number of labour places was calculated using the model for Jobs and Economic Development Impact (JEDI) developed by NREL [17]. The JEDI model was customized for Canada using Canadian national multipliers, local costs, and local content percentages. These data were provided by Natural Resources Canada and Compass Renewable Energy Consulting Inc. [18]. The amount of PV-related employment by category is given in Table 18.

Table 18: Estimated PV-related full-time labour places in 2019

<table>
<tr><th>Market category</th><th>Number of full-time labour places</th></tr>
<tr><td>Research and development (not including companies)</td><td>105</td></tr>
<tr><td>Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D</td><td rowspan="3">4 301</td></tr>
<tr><td>Distributors of PV products</td></tr>
<tr><td>System and installation companies</td></tr>
<tr><td>Electricity utility businesses and government</td><td>----</td></tr>
<tr><td>Other</td><td>1 103</td></tr>
<tr><td>Total</td><td>5 509</td></tr>
</table>

5.2 Business value

The value of PV business in Canada as it relates to the solar PV capacity installations in 2019 is estimated in Table 19.

Table 19: Estimate of the value of the PV business in 2019 (VAT is excluded)

<table>
<tr><th>Sub-market</th><th>Capacity installed [MW]</th><th>Average price [$/W]</th><th>$ Amount in Million</th><th>Sub-market</th></tr>
<tr><td>Off-grid</td><td>----</td><td>----</td><td>----</td><td>----</td></tr>
<tr><td>Grid-connected distributed</td><td>90,96</td><td>2,5</td><td>227,4</td><td>227,4</td></tr>
<tr><td>Grid-connected centralized</td><td>140,77</td><td>1,25</td><td>175,9</td><td>175,9</td></tr>
<tr><td colspan="4">Value of PV business in 2019 ($ amount in million)</td><td>403,4</td></tr>
</table>

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

Each Canadian province and territory has jurisdiction over its electricity sector. As a result, the market structure and regulations in each jurisdiction is unique (although several inter-ties do join the systems). For example, Quebec, British Columbia, Manitoba, and Newfoundland and Labrador are hydropower-dominated provinces characterized by low production costs, a dynamic export orientation and public ownership. Alberta and New Brunswick moved away from the centrally managed model through the creation of independent system operators and wholesale markets. Saskatchewan, Nova Scotia, and Prince Edward Island are structured along vertically integrated utilities and highly dependent on fossil fuels leading to higher prices.

6.2 Interest from electricity utility businesses

Given the diversity in market structures across Canada, the interest from electricity utility businesses is equally variable. In Ontario, several utilities have established unregulated subsidiaries to act as generators and participate in Ontario's Feed-In Tariff program while others simply interconnect projects and handle the settlement of payments. In other jurisdictions, utilities offer rebates, manage net-metering, and are considering offering solar financing products such as lease-to-own. Given the renewed focus on global warming mitigation policies and the rapidly declining costs in solar electricity, many utilities have been exploring PV seriously and continue to do so in 2019.

6.3 Interest from municipalities and local governments

There are over 3 500 urban and rural municipalities in Canada. Many are interested in economic and environmental sustainability and continued to explore PV opportunities throughout 2019.

7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

Canada's PV sector has reached 3,3 GW_{DC} installed capacity, 94% of which is located in Ontario. The PV market in Ontario is experiencing a slowdown due to the closing of the Large Renewable Procurement, Feed-In-Tariff (FIT), and microFIT programs. Across the country, there is strong growth in small-scale PV systems connected to local electricity distribution systems particularly in Alberta, Saskatchewan, Nova Scotia, and British Columbia.

7.2 Prospects

Achieving Canada's commitment to greenhouse gas emissions reductions of 30% below 2005 levels by 2030 represents a significant opportunity for Canadian PV industry development. A combination of falling costs, climate change mitigation policies, and consumer demand point to an increasing amount of solar PV generation. According to the Canada Energy Regulator, Canada's future renewable energy capacity is expected to grow significantly with wind capacity doubling and solar capacity more than tripling by 2040 [38]. However, to meet emission reduction targets, a large and rapid increase in investment in photovoltaics (and other renewable technologies) in Canada is required. As outlined in section 3.9, relying on capricious market-driven forces to gradually increase PV investment can result in minimal growth. Outside-of-market mechanisms may be needed to push renewable technology deployment levels to their full potential.

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