Alberta Community Solar Guide

Organizing and owning community solar PV projects

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photo: David Dodge, Green Energy Futures

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Alberta Community Solar Guide

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Contents

Introduction

This guide is for Albertans who want to develop community solar projects. Applicable communities or community facilities may include renters, condominium households, non-profit organizations, housing co-operatives, planned neighbourhoods, property developers, schools, universities, colleges, hospitals, businesses, rural associations, municipal governments or agencies, union groups, business centres, malls, farmers, or Indigenous communities. Renewable energy developers may also use this guide as an awareness tool when working with communities to develop such projects.

Community solar is an ownership model for solar PV systems that enables more community members to have a partial stake in owning, leasing, or accessing electricity from a nearby solar PV array that is not directly connected to their home or facility. Apart from being more financially and physically accessible to more Albertans than traditional rooftop solar PV, community solar projects offer economies of scale and other efficiencies that allow them to compete favourably with retail electricity prices. Section 1 of this guide outlines who may be interested in a community solar project, and offers a brief explanation of community solar and the benefits it can offer.

Section 2 gives context to the reader by explaining the important functions of Alberta's electric grid and electricity market. This will allow proponents to identify the best way their community solar array can be connected to Alberta's grid, and how their project can most effectively earn compensation.

Section 3 offers insight into the economic comparison of solar PV technology compared to other technology options for electrification, along with the key concepts of solar project economics that project proponents need to know. This section also explains the various upfront and ongoing costs and benefits that a community solar project may encounter.

Section 4 explains two regulatory frameworks that currently exist for community solar projects in Alberta. The micro-generation regulatory framework applies for behind-the-meter community solar arrays such as one at a community hall, school, or other facility with a metered electric load. These are governed by Alberta's Micro-Generation Regulation. On the other hand, community solar projects without a discernible electric load that are connected directly to a distribution feeder line fall under the distributed generation framework and are loosely governed by the Alberta Utilities Commission's rules regarding power plant construction. The compensation mechanisms for these frameworks differ significantly, and are explained here.

Section 5 outlines key stakeholders that must be convened in the successful execution of any community solar project, and presents a generalized business model that can be adapted for each project's unique circumstance.

Section 6 proposes a step-by-step process that project proponents should follow in organizing their community solar projects.

The guide concludes with a series of case studies in Section 7 of successful community solar projects around the world. This section is intended to provide project proponents with examples of a diverse set of micro-generation and distributed generation projects. Examples also include non-profit models, for-profit models, municipal-led models, and models led by distribution utility companies.

1. Introduction to community solar

Who is this guide for?

This guide is for Albertans who want to develop community solar PV projects. This could include property owners, renters, businesses, non-profits, and community facilities such as schools, hospitals, universities, and community league or association facilities.

Community solar projects organized or owned by such entities have the potential to take a leading role in clean energy deployment throughout Alberta, in addition to providing the benefits of localized ownership. This goal of this guide is to provide understanding of the options for community solar within the Alberta context and give communities or community organizations the knowledge they need to develop their own solar PV projects in Alberta. This guide may also be used as an educational resource by renewable energy developers to conduct outreach activities among Albertan communities.

Communities or community facilities who can act as proponents of community solar projects may include renters, condominium households, non-profit organizations, housing co-operatives, planned neighbourhoods, property developers, schools, universities, colleges, hospitals, businesses, rural associations, municipal governments or agencies, union groups, business centres, malls, farmers, or Indigenous communities. Such proponents may be responsible for convening relevant stakeholders, developing the business model of the project, gaining community support and subscription, or hosting the community solar array on their facilities or land.

What is community solar?

Community solar is an ownership model for solar PV systems that enables more community members to have a partial stake in owning, leasing, or accessing electricity from a nearby solar PV array. This form of access overcomes many of the barriers of traditional rooftop solar PV, as outlined below. It gives community members the opportunity to share the benefits and revenues of solar PV power without the obligation of owning the roof or land upon which the array is installed or the onus of maintaining the system over its lifetime. Community members can invest smaller amounts than those required for a full rooftop system. Such projects also allow communities to take advantage of economies of scale with larger solar PV arrays than a single rooftop system. Location of the community solar PV array can be optimized based on factors such as the cost and availability of land, shading factors, possibility of members or community institutions leasing their land or roof space at a lower cost, or local feeder line capacity for interconnection.

Benefits of community solar

Flexible community contributions and returns

One of the key benefits of community solar projects is that community members can participate and reap rewards from a project in many different ways, depending on what project design is best suited for the community (See Section 6 for key program design considerations). Community members may contribute by leasing their land, paying membership fees or initial investments, volunteering time to reduce costs of the project or mobilizing other community members, or collectively negotiating with solar PV developers or utilities stakeholders.

Overcoming limitations of traditional rooftop solar PV

Traditional rooftop solar, such as a household installing solar PV modules on their roof, is only accessible to a small portion of Alberta's population. In 2016, 16% of Alberta households lived in a condominium dwelling[1], and 26% of Albertans rented their homes.[2] For renters, landlords generally do not purchase electricity for the residential unit and the renter is likely to occupy the unit only for a short lease term; thus, there is little incentive for either party to install a behind-the-meter solar array onsite. For condominium households, property rights issues may restrict the use of shared roof space for installing private solar PV. In combination, this reveals that roughly only three in five Alberta households meet the bare minimum qualifications for traditional rooftop solar PV.[3] Even within this fraction of Albertans, many encounter barriers when

[1] Statistics Canada, "2016 Census of Population," Statistics Canada Catalogue no. 98-400-X2016226.

[2] "2016 Census of Population."

[3] This number was determined by multiplying the percent of Albertans living in non-condominium dwellings (7 in 8, or 87.5%) by the percent of Albertan homeowners (70%).

trying to install solar PV on their roofs, including rooftop shading, roof insurance premiums, lack of necessary upfront capital, burden of installation and maintenance, or inability to negotiate with the wire service provider for grid connectivity. As a result, traditional rooftop solar PV is only accessible to a select group of Alberta's population.

Similar barriers exist for non-residential rooftop solar PV. This is less available to groups such as businesses using rental facilities, offices in high-rise buildings, organizations in shared spaces, or those with long-term electricity contracts with their utility providers. For example, businesses in downtown Calgary are situated within ENMAX's secondary network systems, where back-feeding electricity into the grid from a solar PV array is not allowed due to safety considerations.[4] This issue might cost as much as $10,000 to resolve. Limiting solar electricity generation to a rooftop-only model significantly impedes the market access of solar PV technology in the province.

Cost effectiveness

Community solar can reduce costs by taking advantage of features of both large-scale and small-scale solar PV. Like large-scale solar PV projects, community solar projects can enjoy economies of scale, investor-backed financing, renewable energy portfolio opportunities from utilities, standardized equipment such as power blocks, and cheap land purchases. Like small-scale projects, community solar can take advantage of features like low connection and transmission costs, already-owned land assets offered by community members, high visibility, and the high alternative price for electricity. Between these two extremes, community solar can also access unique cost reduction features such as accelerated municipal-supported permitting and zoning, equity financing and crowd-funding, lower capital investment per member, and community volunteer labour.

In the United States, community solar projects have been installed at substantially lower costs than behind-the-meter solar PV of similar power output. While current prices have shown community solar to be more expensive than utility-scale solar PV, the cost reduction measures previously mentioned have the potential to together reduce the cost of community solar by up to 40%.[5]

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[4] ENMAX Corporation, "Distributed Generation." https://www.enmax.com/generation-wires/transmission-and-distribution/our-system/distributed-generation

[5] Rocky Mountain Institute, *Community-Scale Solar: Why Developers and Buyers Should Focus on this High-Potential Market Segment* (2016). https://ccednet-rcdec.ca/sites/ccednet-rcdec.ca/files/rmi-shine-report-communityscalesolarmarketpotential-201603-final.pdf

2. Alberta's electricity system

The electric grid

Today's electric grid in Alberta consists mainly of centralized *generating* stations that transmit electricity over long-distance *transmission* lines, such as coal or natural gas power plants. These carry the electricity to local sub-stations, where the voltage is reduced. From these substations, electricity travels over *distribution* lines from substations to neighbourhood transformer boxes. Transformer boxes further reduce the voltage of the electricity to a suitable level for residential and commercial use. Electricity used is measured on a residential or commercial end user's electrical meter, situated at their facility.

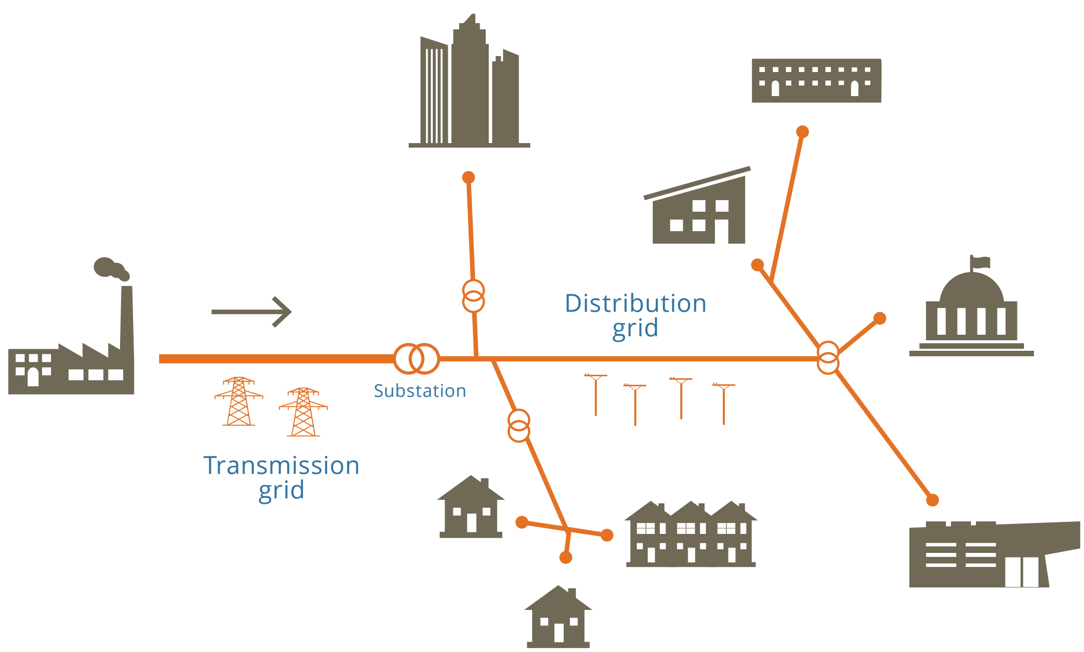

Figure 1. Centralized electric grid

Owners and operators of these distribution feeder lines are called distribution facility owners (DFOs), and they include private companies, municipalities, and rural electrification associations (REAs). A map of the service territories of all DFOs in Alberta is shown in Figure 2.

Municipalities operating DFOs

EPCOR (City of Edmonton)
ENMAX (City of Calgary)
Town of Ponoka
City of Red Deer
City of Lethbridge
Town of Fort MacLeod
Town of Cardston
Municipality of Crowsnest Pass

Rural electrification associations

Armena REA
Battle River REA
Beaver REA
Borradaile REA
Braes REA
Claysmore REA
Delburne West REA
Devonia REA
Drayton Valley REA
Duffield REA
EQUS REA
Ermineskin REA
Fenn REA
Heart River REA
Kingman REA
Kneehill REA
Lakeland REA
Lindale REA
MacKenzie REA
Mayerthorpe and District REA
Montana REA
Myrnam REA
Niton REA
North Parkland Power REA
Peigan Indian REA
Rocky REA
Sterling REA
Stony Plain REA
Stry REA
Tomahawk REA
V.N.M. REA
Warwick REA
West Liberty REA
West Wetaskiwin REA
Wild Rose REA
Willingdon REA
Zawale REA

Figure 2. Alberta's distribution facility owners

Data source: Howell-Mayhew Engineering[6]

Integration of generators

In contrast to these centralized generating stations, solar PV generators have the ability to generate electricity in close proximity to the point of use, connecting directly to the distribution grid at substations without necessarily needing long transmission lines. As more solar PV comes online in Alberta, the grid will undergo a transformation from a centralized grid to one that is distributed and allows for a bidirectional flow of electricity as shown in Figure 3.

[6] Howell-Mayhew Engineering, *Map showing Alberta's Electric Distribution System's Owners.* http://www.hme.ca/connecttothegrid/Map%20showing%20Alberta%27s%20Electric%20Distribution%20System%27s%20Owners.pdf

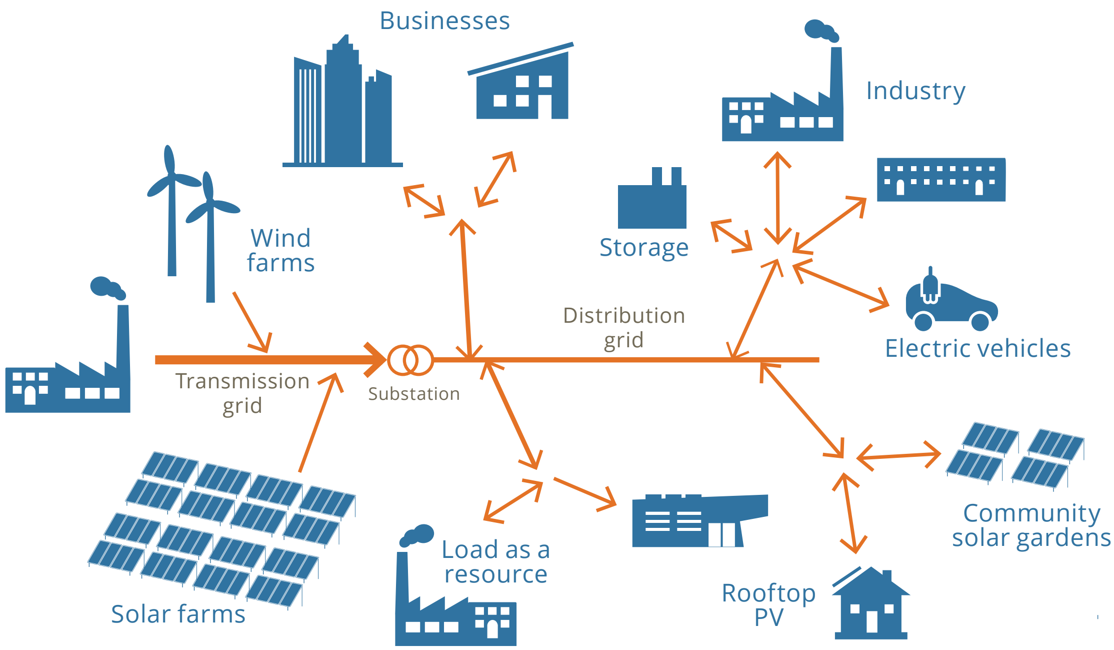

Figure 3. Emerging distributed grid

Solar PV generators can be connected to the electric grid in different ways, as illustrated in Figure 4.

1. Connected behind-the-meter: The energy produced from the small-scale solar panels is directly used by the facility/building, so that less electricity needs to be purchased from the grid. If more electricity is generated than the building needs, the excess is exported to the grid. Behind-the-meter systems are typically in the range of a few kW for homes, going up to hundreds of kW or even a few MW for large buildings.

2. Connected to a distribution line: Medium-scale systems are connected to the local distribution line, not tied to a single load facility. Electricity produced is used by all facilities/buildings on the distribution system. System size is limited by the size of the distribution substation, and can range from a few hundred kW to 10-20 MW.

3. Connected to a transmission line: Similar to the generators on the grid today, large-scale centralized utility-scale solar PV farms can be connected to a high-voltage transmission system.

The first two types of connection, which can be described as non-centralized generation, are generally the form that community-led, shared solar can take.

Centralized, large-scale and transmission-connected projects like utility-scale solar farms are out of scope for this guide.

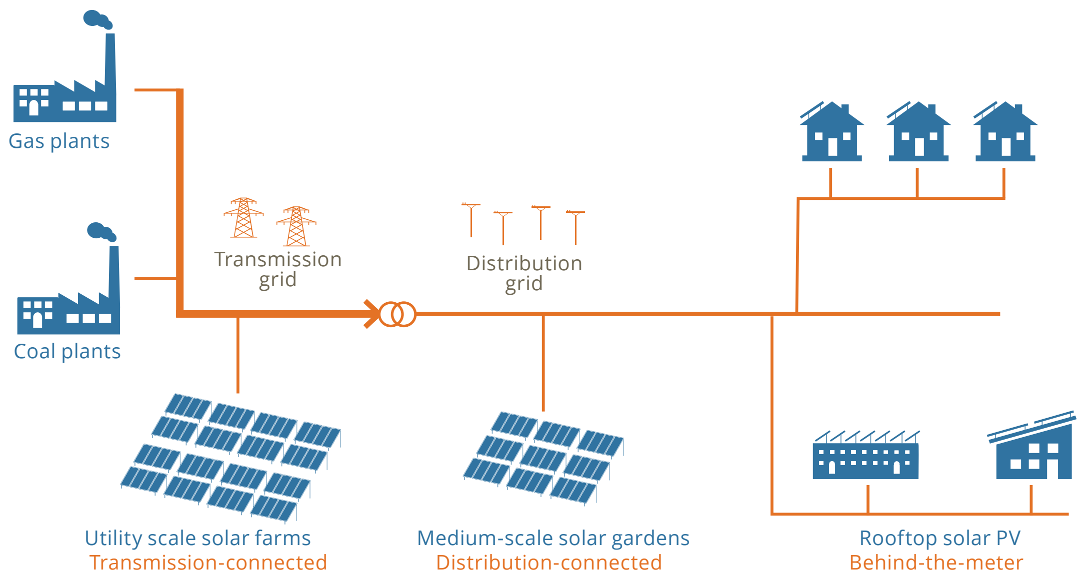

Figure 4. Example of an electric grid featuring behind-the-meter, distribution-connected, and transmission-connected solar PV.

Electricity market

Alberta's electricity market has been fully deregulated since 2001 for power generation (and the wholesale market) and retail suppliers. In the *wholesale market,* any qualified generator can participate in the market where prices are set by hourly supply and demand balance overseen by the Alberta Electric System Operator (AESO). Independent power producers make competitive offers to sell their electricity into the wholesale power pool, and the hourly pool price is set based on supply and demand with the market managed by AESO.[7]

From the wholesale market, electricity retailers purchase bulk electricity at the pool price based on their customers' projected demand. This wholesale electricity is moved from the centralized generation facilities to local substations through the high-voltage transmission lines. Retailers then re-package electricity into their own retail bundles,

[7] AESO, "Guide to understanding Alberta's electricity market." https://www.aeso.ca/aeso/training/guide-to-understanding-albertas-electricity-market/

and sell the *retail* electricity to end-use customers. End-use customers enter contracts with retailers to purchase electricity. These retail rates could be daily average floating rates, flat retail rates, or the regulated rate option (RRO). This market is shown below.

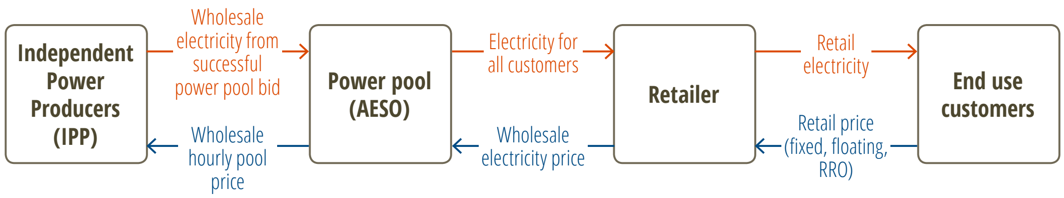

Figure 5. Alberta's electricity market

Benefits of localized electricity generation

Non-centralized generation of electricity (via either behind-the-meter or distribution-connected solar PV systems) enables Albertans to directly participate in power generation and revenue collection that isn't possible with the traditional centralized generation. By producing their own electricity and selling excess to the grid, Albertans can reduce electricity expenses or even produce net positive cash flows or investment returns. Since the majority of costs related to solar PV are upfront, producers are able to hedge themselves against rising future costs of grid electricity. Furthermore, small and community-scale solar PV projects create up to 2.8 times as many jobs and 3.4 times as much local economic impact as large-scale alternatives.[8]

Behind-the-meter and distribution-connected solar PV also benefit the electricity system by reducing transmission losses and the need for peaking generation capacity (which aligns with high solar generation periods). In 2017, some centralized generators lose as much as 12% of their output over long-distance transmission lines[9], and local generation can reduce this by reducing distance that electricity needs to travel. Finally, enhanced visibility of renewable energy within communities poses a learning opportunity for the members of the community.

[8] John Farrell, *Advantage Local: Why Local Energy Ownership Matters* (Institute for Local Self-Reliance, 2014), 2. https://ccednet-rcdec.ca/en/toolbox/advantage-local-why-local-energy-ownership-matters

[9] AESO, "2017 Loss Factors Effective 1 Jan 2017," September 12, 2017. https://www.aeso.ca/assets/Uploads/2017-Loss-Factors-Effective-1-Jan-2017-2017-09-12.pdf

3. Finances and economics of community solar

Underlying economics of solar PV

The costs of solar PV generation have seen a dramatic decline over the past decades compared to other forms of electricity generation, such as natural gas (Figure 6). Currently the average U.S. levelized cost of electricity for community-scale solar is $76-150/MWh, compared to $42-$78 for combined cycle natural gas, $156-$210 for natural gas peaker plants, and $60-$143/MWh for coal.[10] The cost of fuel is a key driver in the cost of natural gas generation, and natural gas prices are currently at an historic low. The long-term outlook shows solar PV prices will continue to fall while natural gas prices potentially rise.

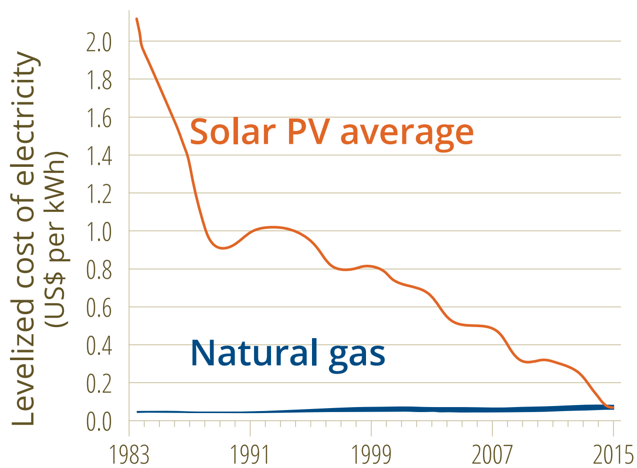

Figure 6. Electricity cost from solar PV compared to a natural gas combined cycle plant

Source: Pembina Institute[11]

[10] Lazard, *Lazard's Levelized Cost of Energy Analysis – Version 11.0* (2017). https://www.lazard.com/perspective/levelized-cost-of-energy-2017/

[11] Barend Dronkers and Sara Hastings-Simon, *Fact sheet: The true price of wind and solar electricity generation* (Pembina Institute, 2016). http://www.pembina.org/reports/true-price-of-wind-and-solar.pdf

Returns from a solar PV system

A community solar PV system delivers the value of electricity and environmental attributes back to the community in four ways.

Revenue from electricity production

The electricity produced by the solar PV system generates a revenue stream over the lifetime of the system. Depending on how the system is connected to the grid and the regulatory structure, this value comes either in the form of reduced cost when electricity from solar PV offsets demand for additional electricity from the grid, as a payment for electricity sold to the grid, or payment for electricity sold to a third party. The electricity market and the regulatory structures under which the electricity is sold set the compensation for electricity produced.

Importing less electricity from the grid

For a behind-the-meter system, during times at which PV production is lower than the load, the PV array produces a portion of the electricity needed by the load. In the load profile for a behind-the-meter solar PV system (Figure 7), this region is referred to as the "solar load offset." Electricity produced by the solar PV replaces a certain amount of electricity that would otherwise be imported from the grid. This saves the user the cost of the electricity purchased as well as the charges for delivery and transmission of that electricity.

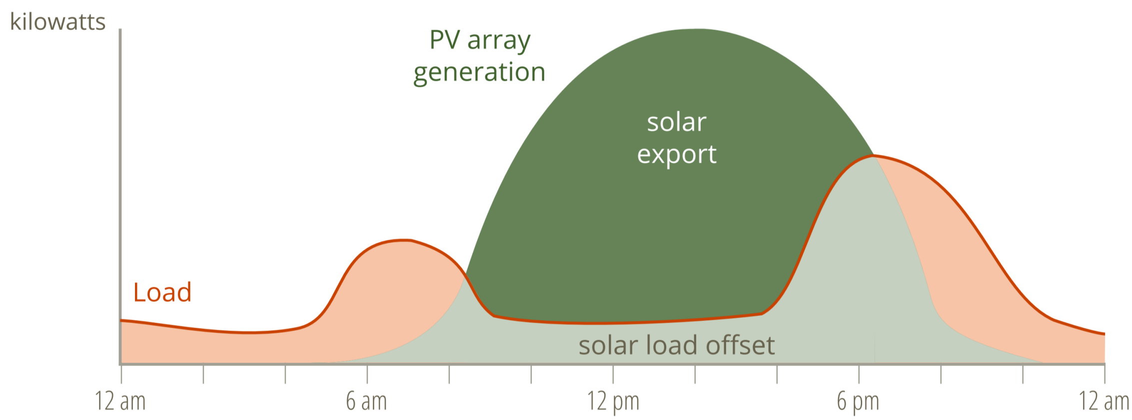

Figure 7. Sample behind-the-meter solar PV daily load profile

Exporting excess electricity into the grid

For a distribution-connected system, all the electricity produced is sold to the grid, since there is no load use (See Figure 8).

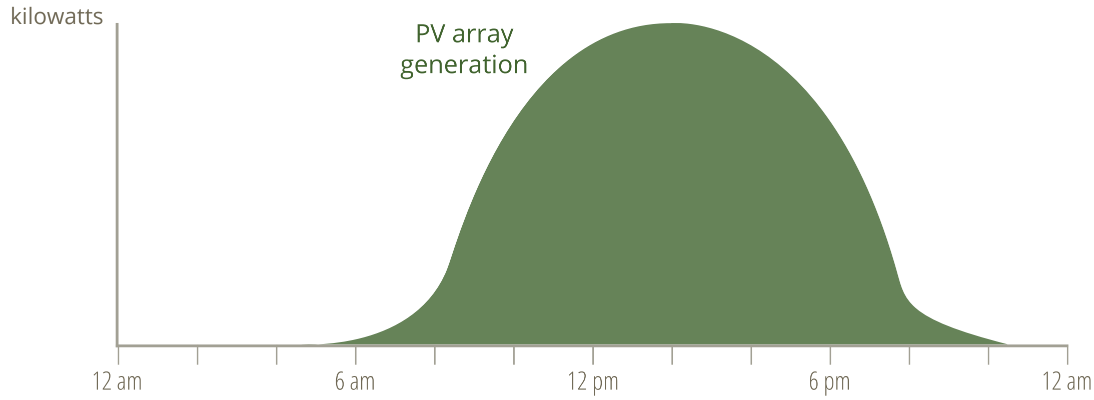

Figure 8. Sample distribution-connected solar PV daily load profile

Similarly, for behind-the-meter systems, during times at which PV production is higher than the load, excess electricity is exported to the grid at that time. In Figure 7, this region is referred to as the "solar export." This excess electricity is exported to the grid, in return for either a retail or wholesale compensation:

> **Retail compensation:** A behind-the-meter solar PV array's exported electricity may be compensated at retail electricity rates. Retail electricity rates are reported on an electricity customer's electricity bill.[12] The rate could be the regulated rate option, a competitive floating retail rate, or a competitive fixed rate, depending on the retailer. The rate may also depend on if the facility is classified as residential, a small business, or a farm.[13] Note that compensation does not include fixed transmission or distribution fees.
>
> **Wholesale compensation:** A distribution-connected PV array's exported electricity is compensated relative to wholesale power pool prices, where prices vary by the hour. This option is also available to large behind-the-meter systems (>150 kW). Wholesale power pool prices are set by the Alberta Electric Systems

[12] Utilities Consumer Advocate, "Understanding Your Bill." https://ucahelps.alberta.ca/understanding-your-bill.aspx

[13] Utilities Consumer Advocate, "Historic Rates." https://ucahelps.alberta.ca/historic-rates.aspx

Operator and are reported on the AESO website.[14] Hourly pricing may allow solar arrays to benefit from higher compensation since solar generation aligns well with hours of high power pool prices; however, the current oversupply of electricity generation assets in Alberta has made power pool prices low and unprofitable for solar PV arrays.

Power purchase agreements

As an alternative to selling electricity to the wholesale market, a project can sign a long-term contract to sell electricity to a customer at a favourable fixed cents-per-kilowatt-hour rate under a power purchase agreement (PPA). This can apply to either customers with the solar PV array connected behind-the-meter, or to a solar PV system that is distribution-connected — in which case the electricity is sold to the wholesale market and the contract is setup as a virtual PPA.[15]

Offsetting transmission and distribution costs

Besides revenue from electricity sales, a distribution-connected PV array can generate a second revenue stream from part of the value it provides to the distribution lines. This value is called the demand transmission service (DTS) credit, and is set by the local distribution facility owner based on a rate structure defined by the regulator. In simple terms, each DFO pays AESO a certain fee called the DTS charge, which reflects the amount of electricity it is drawing from the power pool. When a generator interconnects with a DFO's wires, it reduces the amount of electricity the DFO needs to draw from the power pool. As a result, the DFO sees a difference in DTS charges, which it must credit to the generator. Each DFO has its own name for the DTS charges, but they are in essence similar:

- ATCO Electric: D32 price schedule[16]
- Fortis Alberta: Option M credit[17]
- ENMAX: D600 tariff[18]

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[14] AESO, "Energy Trading System." http://ets.aeso.ca/

[15] Solar Energy Industries Association, "Solar Power Purchase Agreements." http://www.seia.org/research-resources/solar-power-purchase-agreements

[16] ATCO Electric, "Price Schedule D32: Generator Interconnection and Standby Power." http://www.atcoelectric.com/Rates/Documents/D32.pdf

[17] Fortis Alberta, "Rates, Options and Riders Schedules," October 1, 2017. http://www.fortisalberta.com/docs/default-source/default-document-library/2017-oct-rates-options-and-riders.pdf?sfvrsn=8

Value of long-term price hedge

A solar PV system provides a long-term electricity price hedge which itself is a return. Because the costs of the system are primarily upfront, the variation in long-term costs is quite small, and as a result the cost of electricity is mostly stable. This is in contrast to other forms of electricity such as natural gas generation, where future prices depend on the fuel price. This certainty has a value equal to the cost of procuring a hedge on future electricity or natural gas prices.

Environmental attributes

The environmental attributes of solar PV generation include both monetary or regulated and non-monetary benefits. The monetary benefits can be monetized in different ways depending on the regulatory structure. The non-monetary intrinsic benefit is less well defined and can include elements such as the benefit an individual gets from participating in enabling additional renewable energy generation, or the example that a municipality sets in using renewable energy to power its operations. Regardless, two forms of monetary compensation for the environmental attributes generated from solar PV are described below:

Renewable energy certificates

Renewable energy certificates (RECs) are market-based instruments used in certain states in the U.S. to represent the value of environmental, social and other attributes of renewable sources of electricity. In states with REC markets, utilities might be required to meet state-mandated renewable portfolio standards, which are measured by their procurement of RECs (either from projects built independently, or projects sourced from distributed generation or third-party developers). RECs are usually measured in dollars per megawatt-hour of electricity. RECs are often tracked by institutional brokers, who use project characteristics to assign REC values and keep track of sales or retirement.[19] While Alberta does not have a market for RECs, projects in the province may be able to sell RECs to utilities elsewhere and earn extra compensation for their electricity. Alberta

[18] ENMAX Power Corporation, “Distribution Tariff Rate Schedule,” April 1, 2017. https://www.enmax.com/ForYourBusinessSite/Documents/2017-04-01-DT-Rate-Schedule.pdf

[19] United States Environmental Protection Agency, “Renewable Energy Certificates (RECs).” https://www.epa.gov/greenpower/renewable-energy-certificates-recs

Co-operative Energy (ACE) offers an incentive for behind-the-meter solar PV projects similar to a solar REC.[20]

Alberta's GHG Offsets Market Registry

Under Alberta's Specific Gas Emitters Regulation (SGER), a market exists to sell CO_2-equivalent emission offsets (one credit per tonne of emissions) to large industrial facilities in Alberta, who must reduce their emissions intensity from a preapproved baseline as per law.[21] Solar project developers or proponents can participate in this market by quantifying the offsets established by their environmental attributes.[22] This approach may change in coming years depending on how renewable energy offsets are transitioned into the new Output-Based Allocation legislation that is replacing SGER on January 1, 2018.

Key concepts in project economics

Two metrics are typically used to understand the project economics: payback periods and return on investment. Depending on project proponents' the goals and motivations, one may be more appropriate than the other.

Payback period

A community solar PV project acts like a financial asset with an upfront cost and ongoing monetary returns. The payback period is a simple measurement for calculating the period of time taken for a solar array to become profitable. The payback period, in years, is calculated by dividing the combined cost of a solar PV project by the annual financial benefits. In this calculation, the combined cost of the PV project consists of the gross cost of the solar panel and interconnection system minus any upfront incentives that may have been secured by the proponent. The annual financial benefit includes the compensation for exported electricity, the foregone cost of importing some

[20] Alberta Co-operative Energy, "SPARK Green Offset Program." https://www.acenergy.ca/green-offset-program/

[21] Government of Alberta, *Technical Guidance for Offset Project Developers* (2013). http://aep.alberta.ca/climate-change/guidelines-legislation/specified-gas-emitters-regulation/documents/TechnicalGuideOffsetProject-Feb2013.pdf

[22] Alberta Environment, *Specified Gas Emitters Regulation Quantification Protocol for Solar Electricity Generation* (2008). http://aep.alberta.ca/climate-change/guidelines-legislation/specified-gas-emitters-regulation/documents/ProtocolSolarEnergy-May2008.pdf; Project proponents can quantify their offsets and register to sell them on the SGER registry by contacting AEP.GHG@gov.ab.ca.

electricity, and the value of any renewable energy certificates that may be secured. Details on these various components follow.

Note that solar PV arrays generally have an expected useful life of 25 to 30 years[23]. To ensure a project is profitable, the project's payback period needs to be shorter than the system's expected useful life. The payback period can be minimized by ensuring large annual financial benefits.

Solar return on investment (ROI)

A solar PV project's return on investment (ROI) is the net benefit of the project to the owner or subscriber, and is accrued between the payback period and the end of life of the project. Project proponents may have different expectations for ROI. Depending on the degree of certainty of the revenue stream this ROI may be more or less certain upfront. Typically, higher levels of certainty are linked to lower ROI.

Alberta Solar Calculator

The Municipal Climate Change Action Centre (MCCAC) has prepared a calculator to assist solar PV project proponents in evaluating the financial implications of their micro-generation projects. In particular, it allows planners to compare the value of their project to purchasing electricity from the Alberta grid. This unique, Alberta-specific tool can be found on MCCAC's website.[24] Note that this tool is only designed for generators attached behind the meter to a load.

Options for government project support

The largest cost for solar PV is in the upfront installation and hardware costs. The installation includes the labour as well as other associated costs such as design and permitting. Hardware includes all the system components such as the solar panels, inverters and racking. A variety of options can support upfront costs:

[23] National Renewable Energy Lab, *PV FAQs* (2004) http://www.nrel.gov/docs/fy04osti/35489.pdf

[24] Municipal Climate Change Action Centre, "Alberta Solar Calculator". www.mccac.ca/solar-calculator#pv

Provincial subsidies

Several upfront subsidies are available to solar PV projects in Alberta, offered on a dollar-per-watt-installed basis. These include the Alberta Municipal Solar Program (available to municipalities and community-related organizations)[25], the Residential and Commercial Solar Program (available to homeowners, businesses, and non-profit organizations for micro-generation systems)[26], and the Alberta Indigenous Community Energy Program (available to Indigenous-led organizations).[27]

Federal subsidies

Federal upfront incentives include the Canadian Renewable and Conservation Expenses, which offers subsidies for transmission interconnection to the purchaser of electricity,[28] as well as business income tax incentives.[29]

Municipal and county subsidies

Some municipalities and counties in Alberta offer their own grants and incentives that may be applicable for community solar PV projects. These include the City of Edmonton EcoCity Environmental Grants[30], the City of Medicine Hat's HAT Smart Program with an upfront incentive of $1/W[31], as well as the Town of Banff's Solar PV production incentive which offers $0.75/W.[32] Additionally, municipalities can access funding from

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[25] Municipal Climate Change Action Centre, "AMSP." http://www.mccac.ca/programs/AMSP

[26] Energy Efficiency Alberta, "Residential and Commercial Solar Program." https://www.efficiencyalberta.ca/solar/

[27] Alberta Indigenous Relations, "Alberta Indigenous Community Energy Program." http://indigenous.alberta.ca/AICEP.cfm

[28] Natural Resources Canada, *Technical Guide to Canadian Renewable and Conservation Expenses* (2012) https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CRCE%20Technical%20Guide%202014_en.pdf

[29] Natural Resources Canada, "Tax Savings for Industry." http://www.nrcan.gc.ca/energy/efficiency/industry/financial-assistance/5147

[30] Alberta Ecotrust, "Ecocity Edmonton." http://www.albertaecotrust.com/ecocityedmonton/

[31] City of Medicine Hat, "HAT Smart." https://www.medicinehat.ca/government/departments/utility-sustainability/hat-smart

[32] Town of Banff, "Solar Photovoltaic (PV) Production Incentive." https://banff.ca/solar

the Municipalities for Climate Innovation Program (MCIP) for solar PV arrays installed on municipal facilities.[33]

Alberta Investor Tax Credit

In addition to these upfront subsidies available explicitly to solar projects, another possible financing mechanism that might benefit community solar PV projects is the Alberta Investor Tax Credit.[34] This program offers a 30% tax credit to investors, eligible business corporations or eligible small businesses.

Bridge financing options

Solar PV projects might be able to benefit from low-interest loans offered by some banks. For example, the Royal Bank of Canada offers specific loans for renewable energy projects. These include floating-rate term loans during the construction phase, and financing options for equipment during installation. Other Canadian banks may provide similar offerings to help provide the start-up capital for a community solar project.[35] Experienced developers in Alberta can also offer their own bridge financing sources, especially for projects smaller than 20 MW.

Standard offer programs or feed-in tariffs

Standard offer programs (SOPs) or feed-in tariffs (FITs) are energy supply policies that have been used to promote deployment of renewable energy sources by governments worldwide, including California, Hawaii, Ontario and Washington.[36] They offer a guaranteed price for electricity produced from renewable energy projects for the electricity, and could be used for community solar projects. However, no SOP or FIT policy currently exists in Alberta.

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[33] Federation of Canadian Municipalities, "Climate change capital project grants." https://fcm.ca/home/programs/municipalities-for-climate-innovation-program/climate-change-capital-project-grants.htm

[34] Government of Alberta, *Alberta Investor Tax Credit* (2017). http://economic.alberta.ca/documents/AITC-program-guidelines.pdf

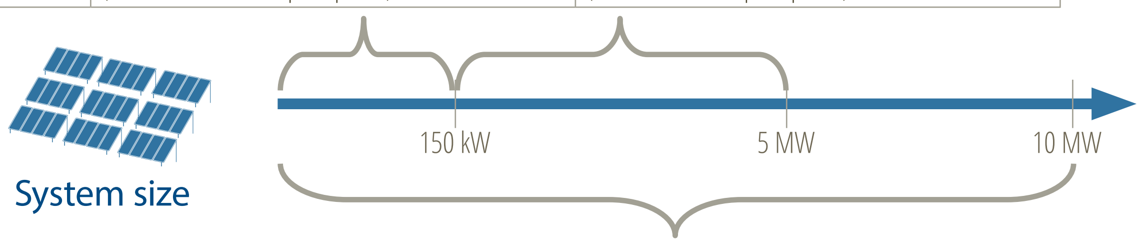
[35] RBC, "Solar Panel Financing." http://www.rbcroyalbank.com/business/financing/solar-panel-financing.html)

[36] NREL, "Feed-In Tariffs." https://www.nrel.gov/technical-assistance/basics-tariffs.html

4. Regulatory context for community solar

The regulatory context for community solar depends on how it is connected to the grid. As described in Section 2 this can be either behind-the-meter where the Micro-Generation framework applies, or distribution-connected where the Distributed Generation framework applies. Both have unique regulatory contexts discussed here:

Micro-generator		
	Small micro-generator	**Large micro-generator**
Load limitation	Array can supply 100% of aggregated load's yearly demand (maximum)	Array can supply 100% of aggregated load's yearly demand (maximum)
Relevant regulation	Micro-Generation Regulation	Micro-Generation Regulation
Application process	Micro-generation notice to distribution facility owner Conflict resolution through AUC	Micro-generation notice to distribution facility owner Conflict resolution through AUC
Compensation	Net billing of retailer's rate minus T&D – Not hourly (Cannot benefit from peak prices)	Hourly pool price from AESO (Can benefit from peak prices)



Distributed generator	
Load limitation	No load required, array size not dependent on load
Relevant regulation	Alberta Utilities Commission: Rule 007 Application for Power Plants
Application process	Notify/ apply to the AUC Complete interconnection agreement with DFO Register as a power pool participant with AESO
Compensation	Combination of distributed generation credits and energy credits

Figure 9. Summary of micro-generation and distributed generation frameworks

Micro-generation projects

Micro-generation refers to electricity production using renewable or alternative energy resources (e.g., solar) on a small scale to meet a metered load's own energy needs. Metered loads may include individual homes, residential or commercial buildings, community centres, schools, or malls. In Alberta, the Micro-Generation Regulation governs this practice.[37] Maximum generation from a micro-generation array is set as the connected load's total demand from the grid during the preceding year, up to 5 MW capacity. This limit used to be 1 MW but was amended on December 1, 2016.[38] Also, the 2016 amendment allowed aggregation in limited cases, which means a micro-generation array can now be larger than its connected load. Aggregation is well suited for universities, hospitals, government facilities, or planned neighbourhood residential communities. However, aggregated loads must meet the following conditions:

- They are owned by the same customer,
- are customers of the same distribution company, and
- are located along the same distribution line.

A facility that wants to install its own solar PV array and become a micro-generator to offset its electricity costs must follow the rules outlined by the Alberta Utilities Commission (AUC)'s Rule 024 (Rules Respecting Micro-Generation).[39] Reading this document is highly advised; however, the flow-chart below summarizes the process for applying to become a micro-generator:

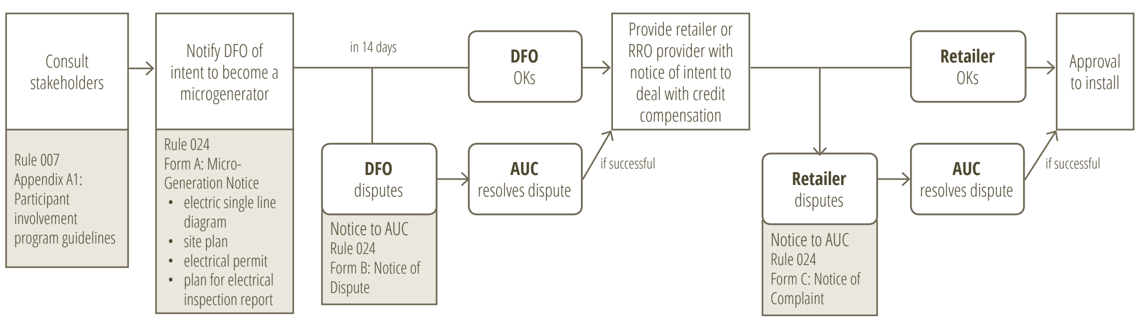


Figure 10. General application process for micro-generating community solar PV arrays

Two types of micro-generators are covered under the Micro-Generation Regulation: small micro-generators (under 150 kW) and large micro-generators (between 150 kW and 5 MW). Small micro-generators are compensated on a monthly basis at daily average retail rates, which does not allow access to peak hourly prices. Large micro-

[37] Government of Alberta, *Micro-Generation Regulation*, http://www.qp.alberta.ca/documents/Regs/2008_027.pdf

[38] Alberta Energy, "What is Micro-generation?" http://www.energy.alberta.ca/Electricity/microgen.asp

[39] AUC, "Rule 024: Rules Respecting Micro-Generation," (July 4, 2017). http://www.auc.ab.ca/regulatory_documents/Consultations/Rule024.pdf

generators are compensated at hourly wholesale prices of the power pool, which flow through from the AESO, to the retailer, to the micro-generating customer. Because wholesale power pool prices peak during the middle of the day, this aligns well with hours of maximum solar power production, and hence could provide a more profitable option compared to flat retail prices. However, the current oversupply of generation on the wholesale market means these peak events are rare, but this will likely change as the supply/demand balance returns in the market over the medium and long term. Small micro-generators have the option of asking their DFO to install a bi-directional interval meter (instead of the default cumulative meter for small micro-generators), in which case they can receive wholesale power pool compensation.

Distributed generation projects

A distributed generator refers to a standalone, distribution-connected solar PV array that has minimal load, primarily built for the purpose of exporting electricity directly into the local distribution grid. This guide does not cover large solar PV projects connected to the transmission grid, such as utility-scale solar farm projects.

There are three regulatory steps involved in building a distribution-connected solar project: notification or application to the AUC, interconnection agreement with the DFO, and registration in the AESO wholesale power pool.[40] Under this regulatory framework, the electricity exported by the distributed generator is compensated by AESO at the hourly wholesale pool price. A DTS tariff unique to the distribution facilities owner also applies to distributed generators.

The steps of the regulatory process regarding distributed solar generators is outlined in Figure 11 and described in more detail below.

[40] AESO, *Guide for Distribution Connected Generation*.
https://www.aeso.ca/downloads/Guide_for_Distribution_Generation_Fact_Sheet_020311.pdf

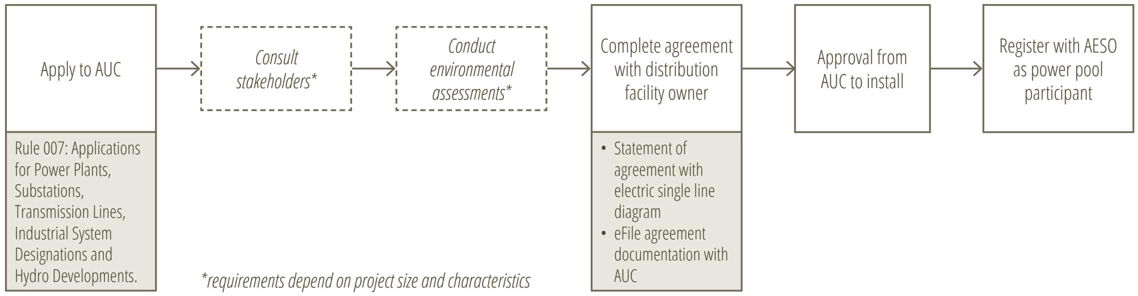


Figure 11. General application process for distributed generation solar PV arrays

Notification/application

The first step in a distributed generation solar PV project is to notify and apply to construct and interconnect the array to the grid. This is governed by the AUC's Rule 007 (Application for Power Plants, Transmission Lines, Industrial System Designations and Hydro Developments).[41] Project proponents or developers should notify the AUC about their intentions to develop a distributed solar generator, and seek clarification on the application procedure from them depending on the capacity of the project. As well, construction of distributed solar arrays must also comply with the Wildlife Directive for Alberta Solar Energy Projects, under Rule 007.[42]

Interconnection

Following notification/application to the AUC, the project proponent must also determine which distribution facility owner is operating in their area, and contact them to determine how to connect to the local distribution grid. Depending on the location within Alberta, this could be ENMAX Power Corporation, EPCOR Distribution Inc., ATCO Electric, or Fortis Alberta. See Figure 2 for further details. The DFO is responsible for administering power contracts, connecting the array to their distribution network, and facilitating the exchange of electricity. Conflicts regarding cost sharing can be reported and resolved by the AUC through an independent hearing. Contact information for distributed generation interconnection queries for each of these DFOs is included in Figure 12.

[41] AUC, *Rule 007: Applications for Power Plants, Substations, Transmission Lines, Industrial System Designations and Hydro Developments.* http://www.auc.ab.ca/regulatory_documents/Consultations/Rule007.pdf

[42] AEP, *Wildlife Directive for Alberta Solar Energy Projects*, October 4, 2017. http://aep.alberta.ca/fish-wildlife/wildlife-land-use-guidelines/documents/Directive-SolarEnergyProjects-Oct04-2017.pdf

Distribution Facility Owner (DFO)	Region served	Contact information
ENMAX Power Corporation	Serves Calgary, Red Deer, Lethbridge, Cardston, Fort Macleod, and Crowsnest Pass	Call 403-310-2010 in Alberta and follow prompts to reach the metering department
EPCOR Distribution Inc.	Edmonton and Ponoka	Call 780-310-4300
ATCO Electric	Northern and east central Alberta	1-800-668-2248
FortisAlberta	Remainder of Alberta	Call the customer assistance centre at 310-WIRE (9473)

Figure 12. Contact information for Alberta DFOs

Source: AESO

Registration

The final regulatory step for distributed generation arrays is to register with the AESO as a pool participant, so that electricity can be sold to the wholesale power pool. AESO recommends that power pool participants notify AESO two to three months prior to the in-service date, and is responsible for following up with project proponents regarding further paperwork.

5. Project roles

Despite their broad adaptability, all community solar projects must fulfill certain functions. Other roles are optional based on the nature of the project. Below are the definitions of those roles, along with examples of whom they could be filled by.

Generator

The generator is the entity that owns and manages the community solar array and the electricity produced from it. The generator could be the same entity as the host (for micro-generation projects) or landowner (for distributed power plant projects). If it is a third-party owner, then it may consider compensating the host or landowner for using their roof space or land. The generator could also play a leading role in aggregating community demand by entering into community subscription agreements for the electricity. The generator may benefit from government incentives or leveraged financing options, and from the services of a renewable energy developer for establishing a solar array.

In a micro-generation project, the generator sells a portion of the electricity to the host and exports excess electricity to the distribution facility owner. In a distributed power plant project with no host load, the generator sells all electricity to the distribution facility owner. Upon receiving compensation for the exported electricity, the generator will distribute the returns to the rest of the community.

The generator's role could be played by a third-party company, a home or business owner, a farmer, an independent power producer, municipally owned facilities like fire stations, large private facilities such as malls, or community facilities such as a schools, churches or community leagues.

Electric utilities

The electric utilities involved in a community solar project include the distribution facility owner, which is physically interconnected with the community solar array, and the retailer, which compensates the exported electricity from the array.

The DFO determines if the power lines are adequate to allow for the generation. The DFO also supplies and installs the interconnection electricity line and meter. They are required to accept the energy onto their electricity lines, and send the retailer and generator the data. The DFO may also charge a demand transmission service tariff to interconnected generators.

In the case of micro-generation, the retailer gets involved in the community solar project by providing micro-generation credits on the host's monthly electric utility bill. The retailer could also participate in community demand aggregation by advertising the project to their customers, and could optionally even offer direct community micro-generation credits to all subscribers as line items on their own utility bills (assuming that eligible subscribers all have the same retailer). However, retailer involvement is not mandatory, and community solar projects can work without such involvement (for example, by offering cheque-based repayments between the community participants and the generator).

In special cases where the DFO also acts as a retailer within its service territory (e.g. ENMAX, EPCOR), then it may also take on the role of the community aggregator, the generator, the host or the landowner.

Community participants

Apart from the generator, other members of a community solar project include residents, businesses, institutions, or government who join the generator in sharing the costs and benefits of the project under a shared agreement. Eligibility criteria for participation could include customers of a particular electricity retailer, residents and businesses within the entire service territory of a particular DFO, electricity customers along a particular distribution feeder line of a DFO, or facilities that reside within a certain neighbourhood or community. In order to maximize the number of subscribers, eligibility criteria should remain as broad as possible.

Depending on the nature of the community solar project, members may pay an initial service fee, help fundraise, lease access to their own roofs or land upon which to install the solar array, or (in the case of grassroots projects) may help aggregate demand themselves through community mobilization. In return, they may benefit from the community energy project by directly offsetting their electric utility bill with solar credits (value of the electricity that was produced from the community array and sold), or in the form of a recurring third-party cheque if the retailer isn't involved.

Renewable energy developers

A community generator may use the technical services of a reputable renewable energy developer to site, install and interconnect its community solar array, often taking on the role of the construction manager.

Financial institutions

A financing body such as a bank or a government agency can work with community solar generators to provide expedited financing such as low-interest loans and repayment options. While this might be very helpful to small projects with little disposable capital, the involvement of such a financial institution is not mandatory. Often, financial institutions will already have agreements in place with renewable energy developers to leverage their equity investment.

Government

Municipal governments and the Government of Alberta can play important roles in enabling community solar projects. They may provide incentives to projects that make solar PV accessible to low-income or Indigenous communities through a standard offer program, upfront solar incentives, or a fixed long-term power purchase agreement. Furthermore, government-owned facilities themselves can play the role of the generator, electricity user or community participant.

Interaction between stakeholders

The business model in Figure 13 shows how the various players involved in a community project might interact.

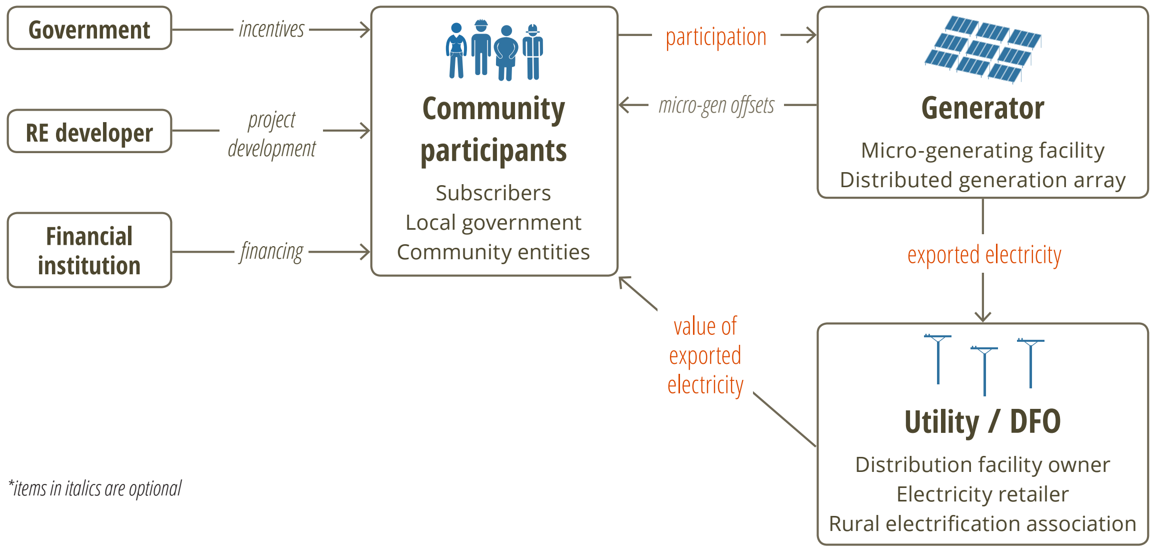


Figure 13. Business model blueprint for community solar PV projects

6. Project development process

Outlined below is a step-by-step process for a developing a community solar project in Alberta. A *project proponent* is the entity or person who convenes the relevant stakeholders to execute the project.

Step 1: Project design

Before proceeding, a community solar project proponent should answer the following questions about the intended project design. This will help them realize their version of the business model.

How does the community participate?

Community members have various options for participating in the project. Do they own a solar panel that is part of the array and are they entitled to electricity produced from it? Do they physically receive the electricity themselves, or is the electricity sold to the distribution facility owners and the money passed on to community members (virtual PPA)? Can they lease the panel and pay lease payments back to the community generator?

In any of these setups, what will be initial membership fees and return payments? What is the minimum and maximum commitment required from each community participant? What is the contract length between the generator and the community members?

In the case that a community member changes addresses, does the purchased contract they have made transfer ownership to the new address adopter, or go with the original owner?

What are the community subscription targets? Are any social goals such as low-income and Indigenous participation included in project design? What are other geographic, demographic, or technical limitations on who can participate (e.g. only those on a particular feeder line, those within the municipality, anyone in Alberta, etc.)?

How is the community's demand aggregated?

Who is responsible for aggregating community demand for the total installed capacity of the project? This could be done by a retailer, a municipality, the generator itself, a government agency, or a third party. How does the aggregating body engage and mobilize the community or market the project? What happens to any unsubscribed portions of the project? Can demand be physical electricity aggregated from a large third party instead of only individual community members, and if so how can the rest of the community benefit from this?

How is value returned to community participants?

Is the value of the exported electricity from the generator returned directly to the subscribed community members through their retail utility bills in the form of a solar credit (in which case collaboration with their electricity retailer is required)? Or is it done with third-party cheques independent of subscribers' utility bills? Is a constant amount returned regularly, or do payments fluctuate?

What is the long-term value to community participants?

Based on contract length, what is the long-term projected financial gain to a participating community member? If electricity is being physically offset, how does the new rate compare to their current electricity retail option and projected electricity prices? If the choice to participate is framed as an investment option, how does it compare to standard mutual funds or interest rates?

Step 2: Stakeholder consultation

Once the above questions have been answered by the project proponent, they should engage relevant stakeholders and community members to answer the rest of the questions, validate assumptions, and garner collaborators. Stakeholder consultations could include:

- The regional distribution facility owner to find out the capacity of the local distribution feeder line for distributed generation.
- Nearby community/municipal/government facilities or private facilities/landowners to identify interest in becoming a micro-generation or distributed generation host.
- Potential community participants (including residents, businesses, or community-based organizations) to identify large-scale aggregated community interest.

- [Optional] A reliable renewable energy developer that can provide the project proponent with guidance at every step of the process for the technical development and interconnection of the community array to the local distribution grid.
- [Optional] A financial institution that may be able to offer low-interest project development loans, and similar other community-based philanthropic organizations that may be able to offer no-interest loans or grants to benefit the community.
- [Optional] Government organizations that are offering grants, production or installation incentives, or capacity-building support.

Step 3: Site selection and interim project design

Once the consultation has been hosted and a few potential facilities/landowners have expressed interest in becoming the community generator, more steps need to be taken to verify their interest and quantify possible project economics based on their site. Using the help of a solar technician, vendor or developer, a site inspection can be conducted to determine the total surface area of land or roof space that can be covered by the PV array. Consider tilt and azimuth (orientation) combinations, as well as shading. In the case of a micro-generating community generator, the maximum PV array size will be limited by the previous year's maximum load of the facility (unless the site is being aggregated as per the Micro-Generation Regulation). This value should be compared against the local distribution feeder line capacity to see which of the two values is the upper limit. Once the maximum size of the PV array is known, project economics can be calculated by estimating the total energy the site could generate, minus any host load in the case of a micro-generating facility. Factoring this along with expected installation costs and projected future electricity costs will provide an estimate of the payback period for the project. This information will help the project proponent rank the potential community generators in order of preference.

Step 4: Partnership agreements

Following site prospecting and comparison of project economics, the community generator (host facility) and the project proponent can strike an agreement. The terms of use of the agreement consider possible change in property tax, payment for use, and allocation/ownership of electricity produced from the community generator. In particular, a differentiation should be made between the electricity being used to offset the host's load (in micro-generating cases) and that being exported.

Finally, following the site inspection and consultation, the project proponent should seek at least three quotes from solar developers. Based on the best quote and external reviews of the developer, the proponent should select a developer to help the project navigate future technical development and set up an agreement with them. The developer might at this point offer to lead all technical development and even provide bridge financing.

If the proponent intends to offer community members monetary returns through their retailer electricity bill, an additional agreement for this is needed between the retailer(s) of choice and the project proponent. This may also involve the distribution facility owner if this is a different entity than the retailer.

Step 5: Business and financial plan

Now that all the initial details of the project design have been established, it is highly advisable for the project proponent to write a business and marketing plan to outline these details. Such a business plan should also include a financial assessment of the project, based on the size of the proposed community PV array. This business plan should use the help of the project developer, and should be used to assess financial assistance based on the most competitive quote offered by the developer.

Step 6: Outreach

Using the marketing plan, the project proponent can proceed to offer subscriptions through contracts. This could involve a membership fee from community participants. It is advised that a minimum percentage of the project be subscribed before proceeding in order to reduce risk and ensure the project is meeting its goals for community participation.

Step 7: Finalize project design

Following the outreach, the interim project design can be adjusted to match the subscribed capacity. During the adjustment the technical aspects of the project can be finalized with the help of the renewable developer.

Step 8: Fundraising

With the completed financial plan, the proponent can begin fundraising, with goals based on the capacity available. Fundraising includes crowd-funding, applying for upfront incentives and grants, and applying for loans. Often, financial institutions that offer debt financing will have prearranged options associated with the choice of renewable developer or their own special renewable energy low-interest loans.

Step 9: Regulatory approvals and permitting

The project proposal must be approved as per the guidelines provided by AUC's Rule 007 (for power plants) or Rule 021 (for micro-generation). See Section 4 for details on the application process for each regulatory framework. In addition, depending on the land use bylaws of the municipality that the project is located within, the project will also have to obtain permits. The contracted developer should be well-versed in the permitting processes:

- Development (land use) permit: Used to confirm that any land use changes adhere to the intentions and rules of local zoning bylaws (residential, commercial, industrial, etc.)
- Building (structural) permit: Used to confirm that PV systems are securely attached/mounted to buildings or ground, abiding to the building and fire safety codes
- Electrical permit: Used to confirm safe installation and operation of solar PV systems. This will include a single-line diagram and list of components of the proposed project.
- Interconnection study: Used by the wire owner to determine if there is availability capacity on a distribution line to handle the interconnection of a solar array.
- Wildlife permit: Used by Alberta Environment and Parks to ensure that a distribution-connected array does not cause harm to the local ecosystem.

Step 10: Procurement

Once design is confirmed, the renewable energy developer can purchase the solar PV system components.

Step 11: Construction and installation: Following the receipt of approvals and permits, the contracted developer can install the array.

Step 12: Grid interconnection

Once installation is complete, the developer should apply for a cut-and-connect procedure with the distribution facility owner. A master electrician will disconnect the facility from the grid, electrically connect the solar PV system to the facility electrical system, and then re-establish the grid connection. Optionally, the meter may also be replaced during this procedure following the “cut.”

Step 13: Community activation

Once the system has been brought online and electricity is being exported from the community generator to the local grid, the project proponent should ensure that the community members involved are received their contracted value. This may be from the retailer as credits on their retail utility bill, or coordinated through the proponent as third-party cheques or a similar process. The proponent may also have to coordinate this process with the community generator to track meter data.

Step 14: Maintenance

To the project proponent, the primary metric of a successful solar PV project is that the life cycle financial benefits exceed the initial costs. At the planning stage, this means that the project should have a payback period shorter than the expected lifetime of the system (25 years on average). However, after installation, technical and non-technical maintenance of all aspects of a community solar project are required to ensure that this criterion is met. The developer should inform the community generator about maintenance and safety best practices before exiting the project. Some of these topics include isolation troubleshooting, emergency shutdown, and diagnosing low power production. Only qualified personnel should operate upon systems. System warranties must also be taken into account. The project also requires ongoing non-technical maintenance including transfer of payments, transfer of stake in case some community members become ineligible, and maintaining ongoing relationships with the community generator and wire owner.

Step 15: Decommissioning

The project proponent should have a decommissioning plan established with the project developer, ensuring that the PV modules are recycled properly at the end of their life and all electronic components either recycled or responsibly disposed of.

7. Community solar case studies

Alberta-based project

Alberta Solar Co-operative

In 2015, a group of Calgarians launched a community energy co-operative called the Alberta Solar Co-op (ASC). As Alberta's first renewable energy co-operative, ASC brought together solar developers and co-operative experts to create a blueprint for the future of Alberta's community energy. ASC is registered as a legal entity (co-operative) as of May 2017. Other major milestones include successfully running a fundraising campaign through the online crowd-funding platform Indiegogo. Figure 14 illustrates milestones ASC has accomplished so far:

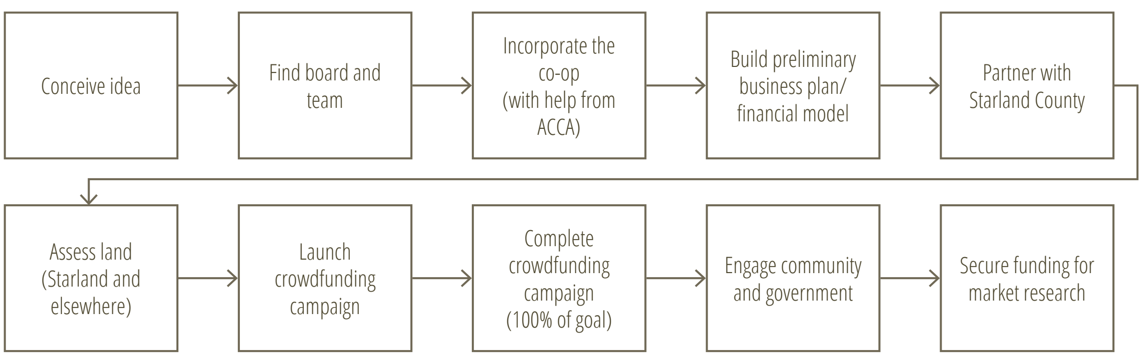


Figure 14. Project milestones for Alberta Solar Co-op

ASC envisions an equity-financed co-operative model in which members pay a principal payment to own a certain number of panels on the array. The total of all principal payments would act as startup capital with which to develop the solar PV array. The project will be designed as a distributed generation project, with a standalone solar PV array meant to export electricity into the local distribution grid in return for money. Members would receive periodic dividends from the profits generated when electricity generated by the array is sold. Distribution-connected systems were chosen since load-side connected systems would be unable to take advantage of economies of scale, and transmission-connected systems are too expensive.

Being a community-led project, ASC has no paid staff as of May 2017, but hopes to work collaboratively with for-profit solar developers who would own 51% of assets and would drive the initial project development. Community members who opt to buy in after the project is under development would own the remaining 49%. ASC is working closely with SkyFire Energy, an experienced Alberta-based solar developer.

As of May 2017, ASC has no online solar capacity but plans on installing roughly 20 MW by 2025 through numerous community-owned arrays.

Barriers the project has faced include a lack of a regulatory framework suited for community solar.[43] For example, AUC Rule 007 requires the same diligence in interconnection assessment studies for a 1 MW distribution-connected solar array as for a 300 MW project.[44] This results in a higher startup cost per megawatt of power for the community solar array. A simpler process for interconnection studies and environmental assessments for smaller (sub-5 MW) distribution-connected solar arrays would make them more competitive with larger distribution-connected generators. Another regulatory barrier for micro-generation projects is the requirement that all interconnected solar arrays, no matter the size, be in an aggregated site configuration; that is, on the same site as the load even if the location isn't ideal for solar (either due to land cost or shading issues). This means that energy offsets to the grid from offsite community solar arrays cannot be credited through consumer electricity bills.

Another barrier is a lack of a targeted funding source for community-scale renewables and a lack of applicable tax credits to improve cost-effectiveness.[45]

Non-profit third-party project

University Park Community Solar[46]

Location: Church of Brethren, University Park, Maryland

Year initiated: 2010

Capacity: 23 kW

[43] Tim Schulhauser, Alberta Solar Co-op member and president of SkyFire Energy, personal communication, May 19, 2017

[44] *Rule 007: Applications for Power Plants, Substations, Transmission Lines, Industrial System Designations and Hydro Developments.*

[45] Tim Schulhauser, personal communication, May 19, 2017.

[46] University Park Solar, "A great opportunity for individuals to make a difference by becoming a member in future projects." http://www.universityparksolar.com/index.htm

University Park Community Solar LLC was created specifically for this project by members of a Maryland church. The LLC acts as an aggregator, to represent the collective demand of the community members and to administer and negotiate the project with other stakeholders. Interested members (participants) of the church invested various amounts into the LLC, who then acted as the system owner and used the capital and the help of a solar developer to install a 22.8 kW array on the roof of the church (site owner). The church then signed a power purchase agreement to the LLC and paid them monthly in return for the electricity from the array. The church itself received net metering credits from its utility company when the system was producing more electricity than the church needed (exporting electricity to the grid). The LLC received revenue from the PPA, from the U.S. federal tax incentive for solar producers, and from the auction of solar renewable energy credits. The LLC passed on these revenues in the form of dividends to the invested church members.

Volunteer church members agreed to provide two years of their time to execute the project, and the project received free legal assistance from a local business bureau. However, the project committee found that a "a social benefit like carbon reduction did not preclude a possible return on an individual's contribution to the project." Figure 15 describes the various stakeholders and transfer of assets between the stakeholders.

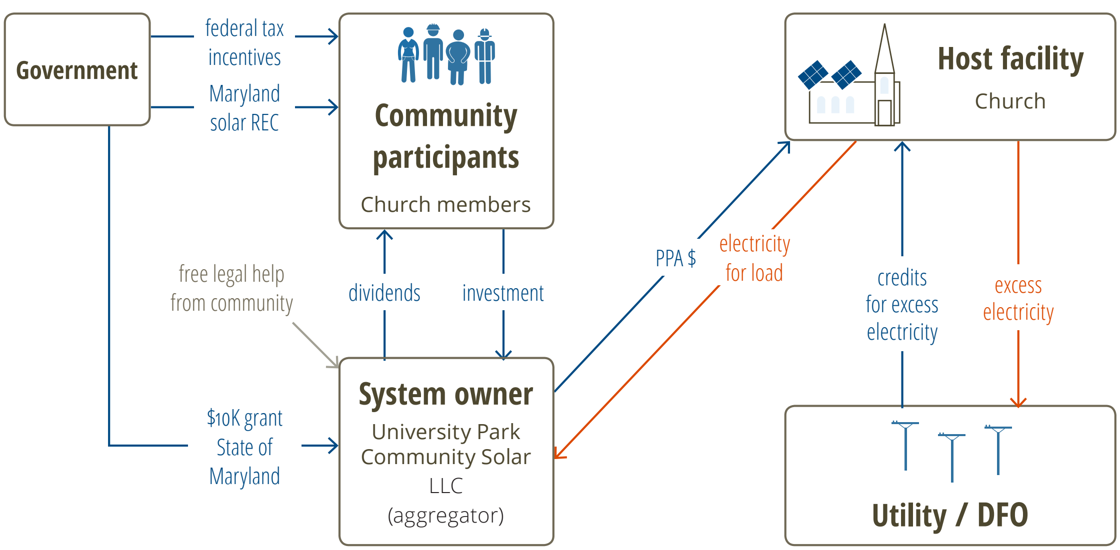


Figure 15. Business model used by the University Park Community Solar project

This example can be readily replicated in Alberta as of August 2017, since it does not require a net energy metering policy or virtual net metering policy. Replacement revenue may need to be found for the federal tax incentive and Maryland's renewable energy credits market.

For-profit third-party project

Clean Energy Collective Pilot Project[47]

Location: El Jebel, Colorado

Year initiated: 2010

Capacity: 51 MW installed, 349 MW under development

Clean Energy Collective (CEC) is an equity-financed company that built a business around its proprietary community solar model, first implemented in the El Jebel community of Colorado. Here, CEC raised equity capital from tax equity investors who would benefit from the 30% federal tax credit for solar in the United States. CEC used this startup capital, along with a bridge loan and a federal 1603 grant for solar developers, to work with a developer to build a 78 kW solar farm on a plot of land leased for a low price from Mid Valley Metropolitan District (site owner). CEC acted as the aggregator and host customer of the solar farm, but sold individual panels to 20 remote participants who paid CEC for ownership of the panel. CEC then entered a 50-year solar power purchase agreement (PPA) with the local utility company, who needed to purchase renewable energy certificates (RECs) in order to meet portfolio renewable standards. This PPA provided a cost benefit to CEC. The net metering credits from the utility company, as well as the SRECs, were passed on to the 20 signed-up participants/ tax equity investors.

CEC has since replicated this proprietary business model, dubbed "Roofless Solar," 56 times in 15 different states in the U.S. CEC currently has 51 MW of online solar capacity, with another 349 MW under development.[48]

[47] CPS Energy, "RooflessSolar™." www.cpsenergyrooflesssolar.com/docs/Aspen_Times_04222010.pdf

[48] Clean Energy Collective, "About CEC." http://www.easycleanenergy.com/

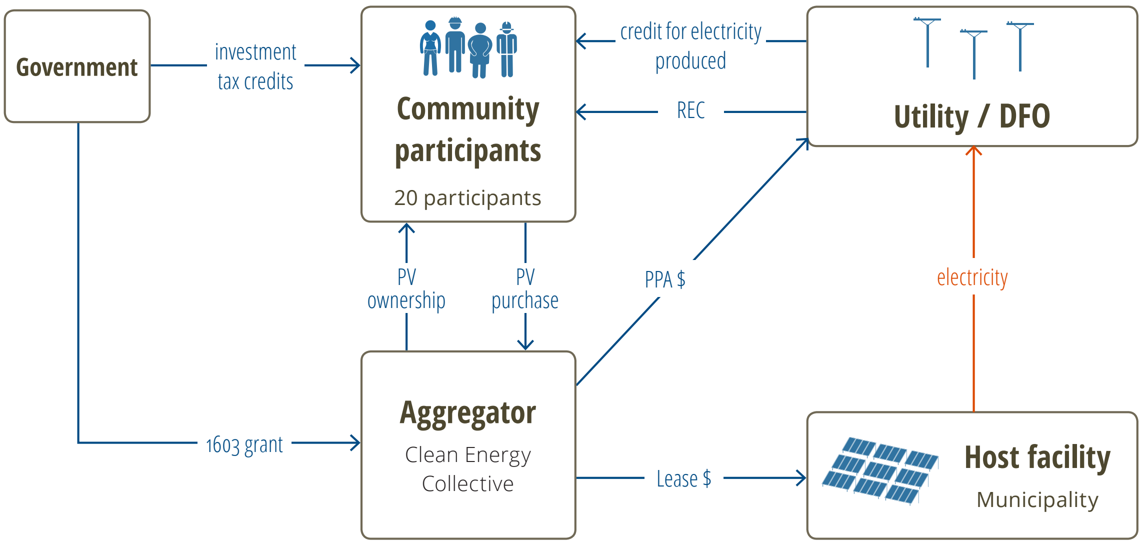


Figure 16. Business model used by Clean Energy Collective's pilot project in Colorado

Utility-led project (U.S.)

Xcel Energy Solar Rewards Program

Xcel Energy Inc. is an investor-owned utility holdings company that serves over 3.3 million electric customers in various mid-western states. Xcel's Solar Rewards Community program is an example of a utility-sponsored community solar program that helps Xcel meet the goals of its 2014 Renewable Energy Standard Compliance Plan while simultaneously allowing third-party solar garden developers to access the electricity market.[49] Through this program, a community solar garden operator may sell or lease a portion of the energy output directly to the subscribers. Xcel's role is to facilitate the selection process for community solar gardens, procure the electricity and RECs produced from these gardens, and pass on the benefits to their subscribed customers through credits on their electricity bills. An overview of this model is shown in Figure 17.

[49] Colorado's Public Utilities Commission mandated a Renewable Portfolio Standard requirement for utilities like Xcel, and whether or not this mandate was met was determined through RECs procured by the utility. According to the mandate, Xcel was also incentivized to procure RECs from community-owned projects, which were allowed to count as 1.5 times that of a utility-scale REC.

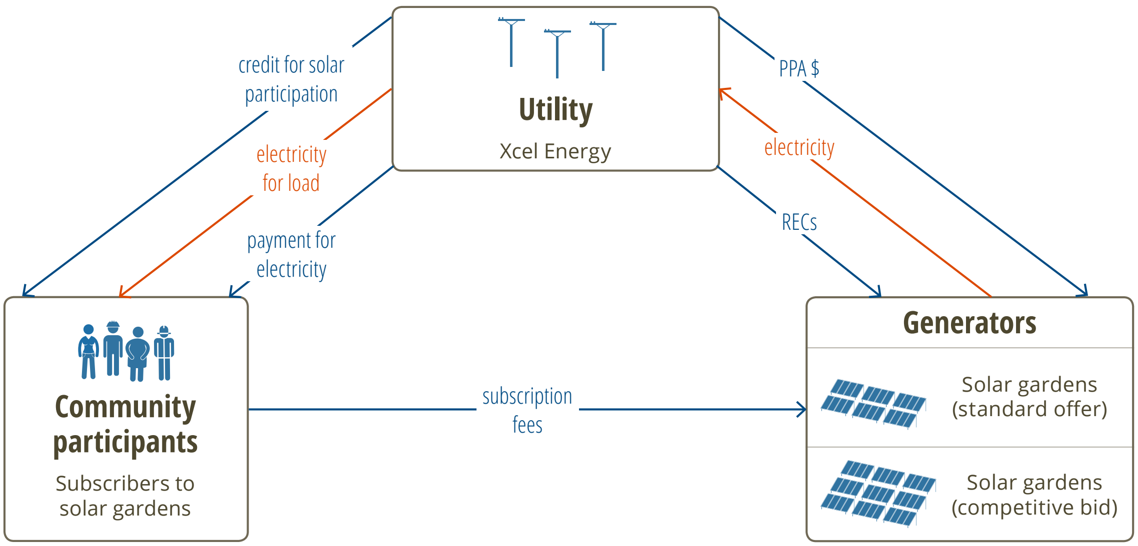


Figure 17. Business model used by Xcel Energy's Solar Rewards program for community solar

Xcel's program had a goal of procuring 59 MW of solar gardens from third-party community solar developers.[50] Xcel selected third-party developers through an initial standing offer program (SOP), and began by accepting applications for 10.1–100 kW community solar gardens. The total available capacity of this SOP was 500 kW, and the renewable energy credit incentive price was $0.05/kWh.[51] Xcel followed this by soliciting competitive bids through a request for proposal (RFP) for projects in the 10.1 kW–2 MW range. Common requirement criteria for SOP and RFP projects included having at least 10 subscribers, having at least 5% allocation to low-income-qualified subscribers, no single subscriber with more than 40% of the total garden allocation, and limiting subscriptions to no more than 120% of the subscribers' annual electric energy usage. Prospective developers in the SOP were required to provide an application deposit and escrow of $100/kW. Following that, they were given an additional 30 days to provide a list of at least 10 valid subscribers with statements of interest, and required engineering documents and site plans. They were also required to provide a Small Generator Interconnection Application, synonymous with Alberta's Distributed Generation

[50] Xcel Energy, *2016 Request for Proposals: Energy and Renewable Energy Credits from Qualified Community Solar Gardens* (September 13, 2016) https://www.xcelenergy.com/staticfiles/xe-responsive/Working%20With%20Us/Renewable%20Developers/CO-SRC-2016-RFP-Bid-Form.pdf

[51] Xcel Energy, *Solar* Rewards Community Standard offer launch notification* (October 10, 2016) https://www.xcelenergy.com/staticfiles/xe-responsive/Working%20With%20Us/Renewable%20Developers/Solar-rewards-comm-developer-october-2016-standard-offer-launch-notice.pdf

Application process under Alberta Utilities Commission, and required interconnection study fees.

Once these steps were completed and the community solar garden developers were selected, the developers were required to have their gardens operational within 18 months of assignment. This SOP resulted in three third-party community solar gardens receiving capacity allocations up to 100 kW each: 303 Solar (LLC), Microgrid Energy, and SET Ventures Group (LLC). RFP winners were chosen based on REC price offered, developer experience, detailed permitting, operations and maintenance plans, and levelized energy costs.[52]

Municipal-led project

City of Ashland's Solar Pioneer II[53]

Location: Ashland, Oregon

Year initiated: 2008

Capacity: 63 kW

In Ashland, Oregon, the city council decided to leverage their governance of the municipal-owned utility to increase PV access while matching or beating the financial returns of state and federal incentives for individual PV projects through a community ownership model. The City of Ashland financed the installation of a 63 kW solar array on a well-sited city-owned facility (parking lot) at a total installed cost of ~$7/W in 2008. Since the project was developed by a non-profit municipality (which does not pay taxes), it was ineligible for direct federal state tax credits but was still able to access the pass-through option for the Oregon Business Energy Tax Credit (BETC). Additionally, Ashland's request to use Clean Renewable Energy Bonds was approved by the Internal Revenue Service; the Bank of America bought the bonds at 1.25% interest and also received the tax credits. As well, the Bank of the Cascades became Ashland's BETC pass-through partner, purchasing 35% tax credit over five years in exchange for an upfront payment of 25.5% of the system cost.

[52] *2016 Request for Proposals: Energy and Renewable Energy Credits from Qualified Community Solar Gardens.*

[53] Bonnyville Energy Foundation, *The Northwest Community Solar Guide,* 13. http://sparknorthwest.org/wp-content/uploads/2013/05/NW-Community-Solar-Guide.pdf

Once the installation was complete, the City of Ashland opened access to purchasing or leasing parts of the community array to all members of the community, so long as they were ratepayers with the municipal utility. The members of Solar Pioneer II were able to either make upfront payments or monthly zero interest loans for a full, half, or quarter panel. In return, the members would receive credits from the utility for the electricity produced from that panel (or portion thereof) for the next 20 years, at a pre-established retail rate of $0.06/kWh. Once the tax credit pass-through and CREB benefits were included, members were being charged a rate of $4.71/W for the electricity being produced from their portion of the array. Credits were returned to the members through annual payments on the electricity bill. Any unsold panels were absorbed by the utility. In either case, the utility that developed the project would itself retire the RECs to meet renewable portfolio standards. Figure 18 explains the flow of financial levers and electricity between the various involved parties in this project.

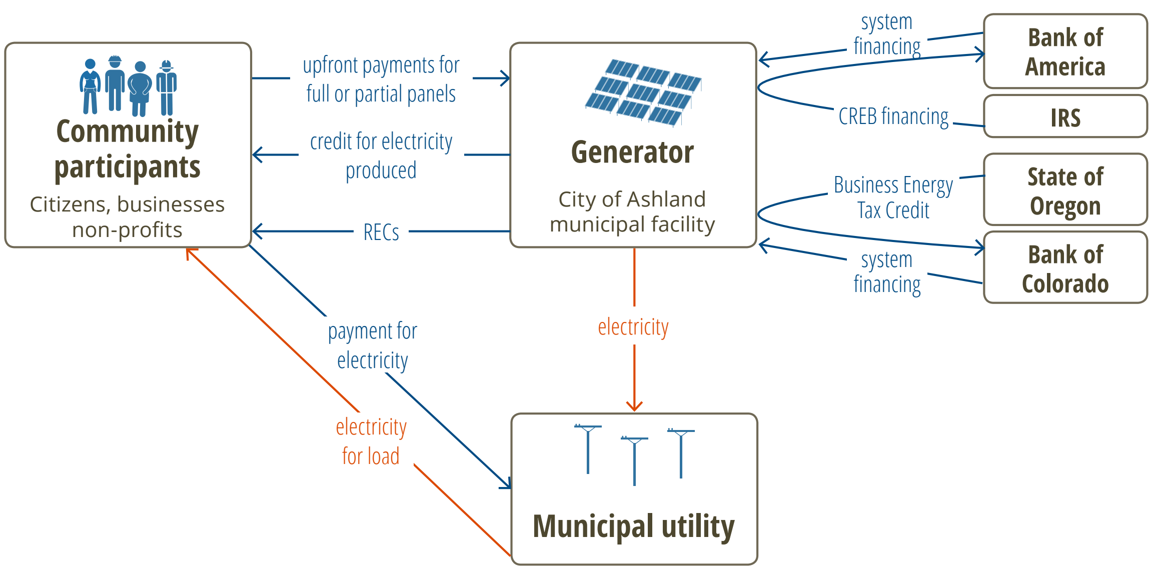


Figure 18. Business model used by the City of Ashland's community solar PV project

Investment model project

SolarShare (Toronto Renewable Energy Co-op)[54]

Location: Ontario

Year initiated: 2010

Capacity: 600 kW (18 projects in total)

In January 2010, the Toronto Renewable Energy Co-operative created SolarShare, a non-profit co-operative with the mandate "to grow community-based solar electricity generation in Ontario by engaging citizens in projects that offer tangible financial, social and environmental returns". After a one-time membership fee of $40, members of the co-operative can purchase $1,000 community solar bonds, with five-year terms and 5% annual returns. The principal is also returned after five years.

These bonds are backed by several solar power projects, including solar farms hosted on institutional and commercial rooftops and rural fields. All projects are supported by a 20-year power purchase agreement with the Ontario Power Authority, which is financed through the Ontario Feed-in Tariff. This stable revenue stream makes the investment financially predictable for community members. In addition, all projects are developed with bridge loans so that SolarShare bondholders are not exposed to pre-development risks.

SolarShare Community Solar Bonds offer a captivating investment vehicle for Ontarians at a time when returns from ordinary securities markets are low and when individuals are keen to invest in social and environmental initiatives. Through its unique investment model, SolarShare has generated over $13 million in revenues for its community investors, with over 22,000 MWh in solar energy sent into Ontario's electric grid.

[54] SolarShare, "About Us." https://www.solarbonds.ca/about/about-us

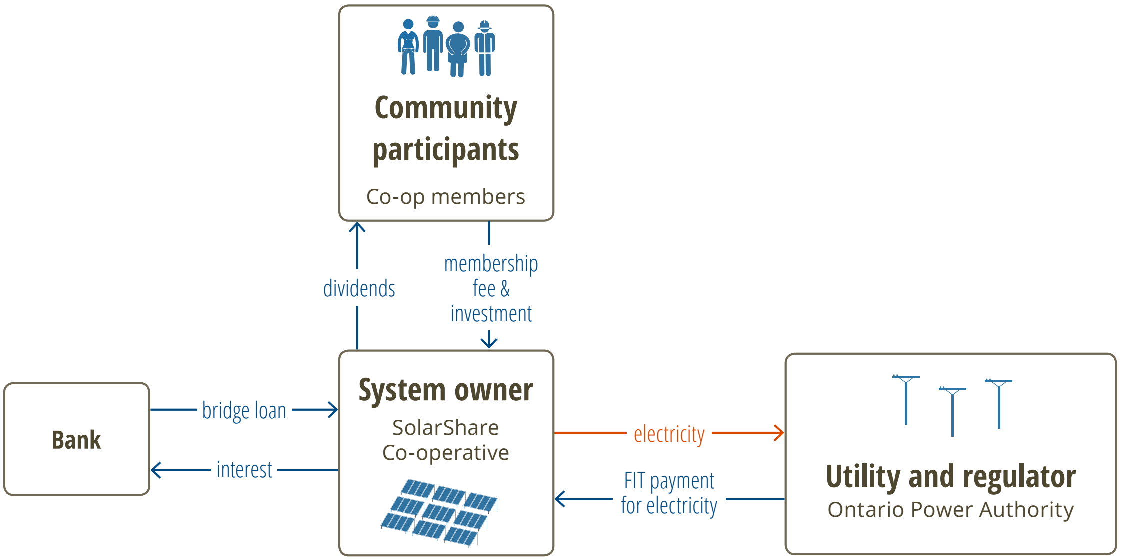


Figure 19. Business model used by the SolarShare's community solar PV projects

Community solar plus demand response management project

Steele-Waseca Cooperative Electric[55]

Location: Minnesota

Year initiated: 2015

Capacity: 102 kW

Steele-Waseca Cooperative Electric (SWCE) is a small electricity provider based in Minnesota, which operates as a member-owned cooperative organization with fewer than 10,000 consumer-members. Its member base exhibited a strong desire towards owning their own community-based solar array within the service region, as opposed to simply purchasing renewable energy from their wholesale electricity provider. SWCE responded by introducing a unique program that allows the cooperative members to benefit from both a community solar array as well as demand-response management. In 2015, SWCE built a distribution-connected community solar array consisting of 250

[55] National Rural Electric Cooperative Association, *The 51st State: The Consumer-Centric Utility Future* (2016), 14. https://www.cooperative.com/public/51st-state/Documents/51st-State-Report_FINAL.pdf

410-W solar panels. It allowed members to purchase individual solar panels at $170 each, in return for solar credits on their monthly electricity bills. Each panel produced roughly 510 kWh per year. Over 20% of the community array's panels were sold before the farm was even operational.

Each member who purchased a part of the community array was also required to install a grid-enabled electric water heater. This 105-gallon water heater used 400 kWh of electricity per month, and heated water overnight instead of during daylight hours in order to eliminate peak electricity costs for the co-operative membership base. Thus, the heater acted as a local energy storage element for the co-operative, and allowed the entire co-operative member base to benefit from the community solar array. In fact, SWCE found these heaters so valuable that they gave them to its member base for free. This program gave members access to solar PV at 90% lower cost than average solar PV. The demand response function controlled an estimated 20% of the co-operative's peak load, and allowed an additional 4500 kWh in electricity sales per year. Figure 20 provides a summary of this innovative program's mechanisms.

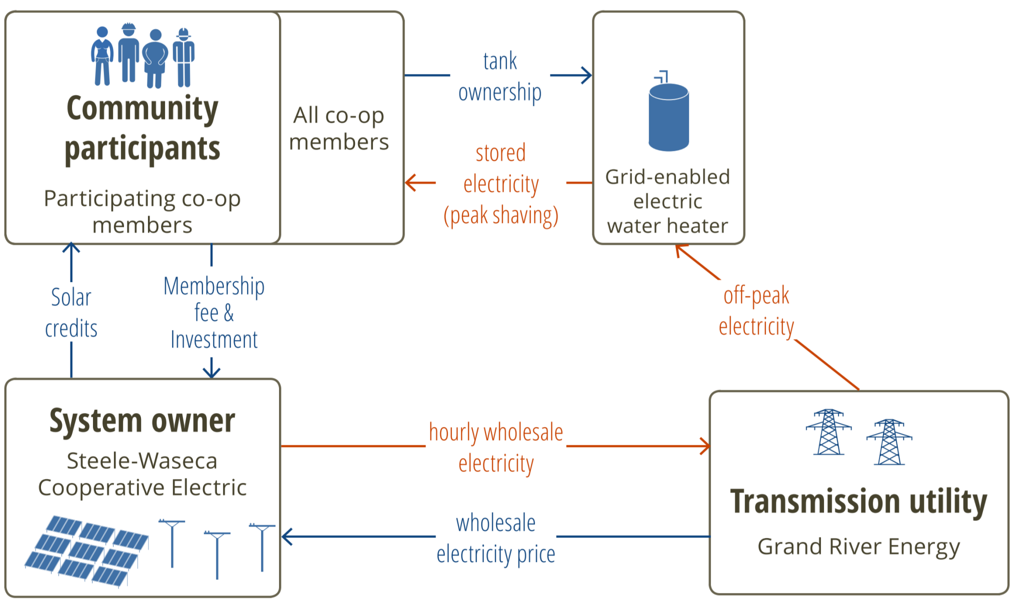


Figure 20. Business model used by SWCE's community solar plus electric water heater project

Appendix A. Glossary

Aggregated sites

"Two or more sites that are located on property that is owned or leased by the same customer, connected to a single electric distribution system feeder owned by one electric distribution facility owner, and either enrolled with the same retailer or enrolled with the same regulated rate provider."[56] Under the Micro-Generation Regulation, aggregated sites can share a micro-generating solar PV array.

Alberta Electric System Operator (AESO)

The Alberta Electric System Operator "plans and operates Alberta's electricity grid and wholesale electricity market safely, reliably and in the public interest of all Albertans."[57]

Alberta Utilities Commission (AUC)

The Alberta Utilities Commission is an independent, quasi-judicial agency of the province of Alberta, responsible for ensuring "that the delivery of Alberta's utility service takes place in a manner that is fair, responsible and in the public interest."[58] The AUC regulates investor-owned electric utilities and certain municipally owned electric utilities to ensure that customers receive safe and reliable service at just and reasonable rates.

Behind-the-meter generator

A small-scale electricity generating system uniquely designed and built for a single building or facility. It generates electricity locally for the facility, and offsets the amount of electricity being imported from the grid.

[56] Alberta Queen's Printer, *Micro-Generation Regulation*, 2008. http://www.qp.alberta.ca/documents/Regs/2008_027.pdf

[57] AESO, "About the AESO." https://www.aeso.ca/aeso/about-the-aeso/

[58] AUC, "Who We Are." http://www.auc.ab.ca/about-the-auc/who-we-are/Pages/default.aspx

Centralized generation

Large-scale electricity generating facilities usually located away from end users and connected to a network of high-voltage transmission lines. Includes coal-fired power plants, gas plants, hydroelectric plants, etc.[59]

Clean Renewable Energy Bonds (CREBs)

A financing tool available in the public sector in the United States to finance renewable energy projects.[60]

Co-operative

"An autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise."[61]

Distribution-connected generator

A medium-scale electricity generating system connected to local electric distribution lines. It generates electricity locally for the connected facilities, and offsets the amount of electricity that the distribution line imports from the transmission system.

Distribution facility owner (DFO)

"Entities that own and operate distribution lines, the portion of the Alberta electrical system operating at 25 kilovolts (25,000 volts) or less."[62] Also known as a wires owner.

Distributed generation

Small- or medium-scale electricity generating facilities usually located at or near the point of consumption. Distributed generation can consist of both behind-the-meter and distribution-connected generators.

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[59] EPA, "Centralized Generation of Electricity and its Impacts on the Environment". https://www.epa.gov/energy/centralized-generation-electricity-and-its-impacts-environment

[60] Energy.gov, "Clean Renewable Energy Bonds (CREBs)." https://energy.gov/savings/clean-renewable-energy-bonds-crebs

[61] International Cooperative Alliance, "Co-operative identity, values & principles." https://ica.coop/en/whats-co-op/co-operative-identity-values-principles

[62] AESO, "Glossary of terms."

Distribution generation framework

The regulatory framework that governs distribution-connected renewable energy generators, allowing them to export electricity into a local distribution grid.

Distribution line

A medium- or low-voltage power line that moves electricity from the transmission system to individual customers.

Electricity retailer

Entities that sell electricity to end-use customers. A retailer may or may not also be a distribution facility owner, and the service area of a single distribution facility owner may include several retailers. Retailers can offer electricity retail sales at either the regulated rate option, competitive floating rates, or competitive fixed rates.[63]

Hourly pool price

The average of 60 one-minute system marginal prices in the wholesale power pool accumulated over an hour.

Inverter

A PV power inverter converts the variable direct current (DC) output of a PV solar panel into a standardized alternating current (AC). The inverter makes the electricity compatible with either the local distribution grid, or with the behind-the-meter facility's electrical network.

Levelized cost of energy (LCOE)

An economic assessment of a power-generating asset, calculated as the average total cost to build and operate over the asset's lifetime divided by its total energy output over that lifetime.[64]

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[63] Utilities Consumer Advocate, "Retailers and Distributors." https://ucahelps.alberta.ca/retailers.aspx

[64] DOE Office of Indian Energy, "Levelized Cost of Energy (LCOE)." https://www.energy.gov/sites/prod/files/2015/08/f25/LCOE.pdf

Micro-generation framework

The regulatory framework that governs behind-the-meter renewable energy generators, allowing homes and facilities to meet their own electricity needs or receive credits for the electricity that they produce but do not consume.

Micro-Generation Regulation

Established in 2008, this regulation allows Albertans to meet their own electricity needs by generating electricity from renewable or alternative energy sources.[65]

Payback period

The period of time taken by a PV system to recover the cost that went into installing the system. A solar PV project that is profitable in the long term must have a payback period that is shorter than the expected lifetime of the project (20-30 years).

Pool participant

"Companies or organizations that trade electricity in the wholesale energy market through the AESO. They include power generators, consumers and marketers."[66]

Regulated rate option (RRO)

The consumer electricity rate in Alberta regulated by the Alberta Utilities Commission. It can change from month to month. This is the default rate option for residential customers who do not buy their electricity through a contract with a competitive retailer.

Renewable Portfolio Standards (RPS)

A state-level regulation used in the United States to mandate that utilities generate a certain amount of energy from renewable sources such as wind, solar and biomass.

Rooftop solar PV

A photovoltaic system that has its electricity generating solar panels mounted on the roof of a residential or commercial building or structure.

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[65] Alberta Energy, "What is Micro-generation?" http://www.energy.alberta.ca/Electricity/microgen.asp

[66] AESO, "Pool participant list." https://www.aeso.ca/market/market-and-system-reporting/pool-participant-lists/

Rural Electrification Associations (REAs)

Co-operative non-profit utilities that provide rural communities with support for their electricity needs and services. REAs were formed to serve the needs of communities that were not served by distribution facility owners.[67]

Secondary network systems

A special type of distribution network designed with multiple distribution lines providing electricity to a single load, and with automatic protective devices intended to isolate faulted individual distribution lines and other components. Distribution facility owners in big cities such as ENMAX (Calgary) and EPCOR (Edmonton) use secondary networks in downtown cores to reduce the chances of power outages. Neither DFO allows behind-the-meter or distribution-connected generators to interconnect with their secondary network systems for safety and reliability reasons.[68]

Solar photovoltaic (PV)

Solar photovoltaic (PV) cells convert sunlight directly into electric current. Solar cells are connected together into a larger array of PV modules, also called "solar panels"

Solar return on investment (ROI)

A percentage used to compare the profitability of solar PV project to the initial upfront investment.

Substation

Part of an electrical generation, transmission and distribution system that transforms voltage from high to low, or the reverse. Distribution line substations will connect a low-voltage distribution network to a high-voltage transmission line. Distribution facility owners own substations in Alberta.

Transmission-connected generator

A large-scale, centralized electricity generating facility connected to the high-voltage transmission lines. It generates electricity far away from end users, and this electricity serves the demand from several individual loads.

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[67] AFREA, "Who We Are." http://www.afrea.ab.ca/who-we-are

[68] NREL, *Secondary Network Distribution Systems Background and Issues Related to the Interconnection of Distributed Resources* (2005). https://www.nrel.gov/docs/fy05osti/38079.pdf

Transmission line

A high-voltage power line that moves electricity between centralized generation points to substations that transform the current for delivery over the distribution lines to customers.

Wholesale electricity market (power pool)

The spot market for bulk wholesale electrical energy in Alberta, governed by the Alberta Electric System Operator. The price is set in real time as generating units are dispatched on demand to balance total load with supply.[69]

[69] Market Surveillance Administrator, *Alberta Wholesale Electricity Market* (2010). http://albertamsa.ca/uploads/pdf/Reports/Reports/Alberta%20Wholesale%20Electricity%20Market%20Report%20092910.pdf