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T 613-736-9077 • TF 1-866-522-6742
F 613-736-8938 • E info@cansia.ca • www.cansia.ca

Maria Baitoiu
Lead Application Officer, Market Oversight and Enforcement
Uploaded electronically to the Alberta Utilities Commission (AUC) eFiling System

May 30, 2017

Dear Ms Baitoiu,

RE: Evidence Submission (1/4) on "Outlook & Status" to AUC DCG Review (22534)

The Canadian Solar Industries Association (CanSIA) is the national trade association that represents the solar energy industry throughout Canada. We applaud the Government of Alberta's decision to undertake a review of Distribution Connected Generation (DCG) in Alberta and welcome the opportunity to participate as an Intervenor therein.

Our vision for electricity in Alberta in 2030 is one with the following four characteristics: i) more energy efficiency, demand-side management and local electricity generation; ii) delivered by a cleaner and smarter grid; with iii) greater choice for consumers; and iv) more resilience to the impacts of climate change.

This Evidence Submission provides our response to the questions posed by the Alberta Utilities Commission (AUC) to registered participants in the Distribution Generation Review (Proceeding 22534) in Appendix B of the Process Letter relevant to the "Status & Outlook" of Solar Distribution Connected Generation (SDCG) in the province.

Answers are provided in the context that Alberta's electricity market is changing rapidly and that many policies, regulations and rules are inter-dependent. CanSIA appreciates the opportunity to continue to participate as a stakeholder in the on-going consultations as decisions are made and directions evolve.

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The questions responded to herein are listed as follows in the order that they are answered:

> ***3. Please describe the current state of SDCG in Alberta, and how it is evolving over time including, if applicable, the technologies and devices that could be deployed on the distribution system to monitor and control SDCG.***
>
> ***36. How will the design and operation of the Alberta capacity market affect the deployment of SDCG, and how will any increase in SDCG affect the design and operation of the Alberta capacity market?***
>
> ***7. How will the design, operation and outcome of the Alberta renewable electricity program (REP) affect the deployment of SDCG? How will future rounds of REP auctions be affected by any increase in SDCG?***

Evidence Submissions detailing our responses to the questions relevant to Community Solar (2/4), Retail & Rate Design (3/4), Wires & Wires Owners (4/4) have also been submitted in parallel.

3. Please describe the current state of SDCG in Alberta, and how it is evolving over time including, if applicable, the technologies and devices that could be deployed on the distribution system to monitor and control SDCG.

CanSIA's response to question 3 is presented in four parts: i) definitions; ii) status and outlook; iii) integration and control; and iv) cost and value.

3.1 Definitions: CanSIA classifies SDCG as either: i) "Behind-the-Meter" in which generation primarily serves a load directly; or ii) "Direct-Connect" in which all generation is exported to the grid. The key defining characteristics of these two approaches are described in Table 1 overleaf.

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Table 1. Categories of Approaches to Solar Distribution-Connected Generation (SDCG)

	Behind-the-Meter SDCG	**Direct Connect SDCG**
Regulatory Framework	Micro-generation Regulation	Merchant or Shared Solar (proposed)[1]
Description	Directly serves a single electricity customer's load.	All output exported to grid. Serves load of single or multiple electricity customers indirectly.
Siting Requirements	On-site or adjacent to load.	Siting not dependent on load.
Sizing Requirements	0 ≤ 5,000 kW. System sized so annual output equivalent to annual on-site demand.	0 kW ≤ ~20,000 kW[2].
Facility Ownership	Not Restricted[3]	

Table 2: Comparison of Merchant and Proposed Shared Solar Direct-Connect SDCG

	Merchant	**Shared**
Regulatory Framework	Distributed Generation	Closely aligned with existing retail market structure.
Sizing Requirements	0 ≤ ~20,000 kW	150 kW[4] ≤ ~20,000 kW.

[1] A full description of "Shared Solar" is presented in CanSIA's Evidence Submission (2/4).

[2] The upper limit is defined by that which can be safely and reliably integrated at the point of interconnection: typically no more than 20,000 kW; but frequently significantly less. The upper limit of ~20,000 kW is explained as follows. The standard distribution voltage in Alberta is 25 KV. A typical substation has a 600 amp breaker. In a simplification, this combination results in sizing of lines to accommodate a load of 15 MW (25kV x 600 A= 15 MW). A double circuit system can also be used (2 overhead lines and 2 breakers) to effectively accommodate up to 30 MW. A direct connection in to a distribution substation can also be accommodated at industry standard collection system voltages of 35kV. With a standard 600 amp breaker, a 21 MW project can easily be accommodated (P= V x C) with a single overhead line. This voltage can then be stepped down to 25 kV at the substation and into two parallel breakers. There are also other considerations on Dx transmission lines such as continuous loads that can offset the generation on the feeders to accommodate a generation of over 15 MW with a transfer trip arrangement so no over-voltage scenarios occur).

[3] Ownership can be structured in a variety of ways i.e. sole proprietorship, partnership, corporation or co-operative and can include combinations of full, partial or no ownership by Community or Communities.

[4] The lower limit of 150 kW was selected to align with the current division between small (<150 kW) and large (≥150 kW) Micro-generation. The rationale for this proposed minimum threshold is to enable DCG facilities to be developed in the absence of an on-site or adjacent load.

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Compensation	Hourly Pool Price for electricity, Distributed Generation Credits for system benefits and value and mechanism for Environmental Attributes to be determined under Output Based Allocation (OBA).	Off-take agreement for electricity, Distributed Generation Credits for system benefits and a Solar Renewable Energy Certificate (SREC) proposed by CanSIA for Environmental Attributes.
Facility Ownership	Not Restricted	

3.2 Status and Outlook: As of May 2017, there were more than 1,800 SDCG facilities[5,6] with a total installed capacity of approximately 17.5 MW[7] in Alberta producing approximately 23,000 MWh per year[8]. This is equivalent to less than 0.2% (i.e. two thousandths) of grid-connected peak demand, less than 0.03% (i.e. three ten thousandths) of annual electricity demand and less than 4 watts per capita[9]. In contrast to other jurisdictions, this is not a significant penetration. For example, in 2016: Arizona, California, Germany and Ontario have between approximately 190 to 500 watts per capita.

In consideration of the level of new renewable electricity generation capacity that will be required to meet the province's legislated 30% by 2030 target[10] and the current status of solar electricity in jurisdictions globally, analysis undertaken for CanSIA[11] shows that meeting 3 – 6 % of annual electricity demand in 2030 from solar energy (representing 1,768 -3,536 MW_{AC} of installed capacity) would be a reasonable outcome to expect.

[5] All SDCG in Alberta today are Behind-the-Meter (i.e. there is no Direct-Connect). Alberta's first Direct-Connect SDCG to be brought in-service is expected to be the Brooks 1 Solar Facility (15 MW) before the end of 2018. The first round of the Alberta Electric System Operator (AESO) Renewable Electricity Program (REP) that will contract 400 MW of utility-scale renewable electricity generation facilities in December 2017 and the Alberta Infrastructure competitive procurement for 135,000 MWh of solar electricity per year (i.e. equivalent to <100 MW) that will contract with facilities in March 2018 may give rise to Direct-Connect SDCG in the coming years.

[6] Some qualify as Community Solar including those developed with support from the Alberta Municipal Solar Program (AMSP) and Alberta Indigenous Solar Program (AISP). Notable facilities include the Green Acres Solar Farm in Bassano (2 MW) and the Leduc Recreation Centre (>1.1 MW)

[7] AESO (May, 2017) "Micro-generation Reporting"

[8] Assumes 1,300 MWh/MW_{AC}. Average yield from solar fleet will increase as generating fleet uses higher performance technologies and as proportion of roof-mounted to ground-mounted decreases.

[9] In 2016, Alberta's total Alberta Internal Load (AIL) was 79,560 GWh and maximum AIL was 11,458 MW (ref: AESO) and population was 4,252,900 (ref: Statistics Canada).

[10] Renewable Electricity Act (2016) "*a target is established that at least 30% of the electric energy produced in Alberta, measured on an annual basis, will be produced from renewable energy resources*".

[11] Solas Energy Consulting Inc. (May, 2017) "Alberta Solar Market Outlook"

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The degree to which this installed capacity is SDCG or Transmission-Connected Generation (STCG) would be largely dependant upon policy and regulatory framework design. With respect to SDCG, the major limiting factor for growth in the: residential, commercial, industrial and farm SDCG market segments would be a requirement that Behind-the-Meter generation is sized so that the annual output from individual systems is equivalent to annual on-site demand; and in the utility-scale market segment will be the extent to which SDCG is competitive with STCG and all other utility-scale renewable electricity generation facilities. The policy and regulatory framework for Community Solar which is currently under development with formal stakeholder engagement in June and July 2017 will have a major bearing on the outlook for SDCG.

3.3 Integration and Control: There are three phases of increasing solar penetration on an electricity system[12]:

- Phase 1 (Low Penetration):
  - Low solar penetration in a few distribution grids.
  - Solar electricity plays a passive role in the electricity system.
  - Local consumption exceeds local generation (uni-directional distribution grids).
  - TFO not monitoring variable generation (just load variability).
  - DFO may need to manage new over-voltage or over-loading issues (especially in rural grids).

- Phase 2 (Medium Penetration):
  - High solar penetration in a few distribution grids.
  - Local generation exceeds local consumption (bi-directional distribution grids).
  - Need for a focus on increasing the “hosting capacity”.
  - Reverse power flows may begin to be experienced by TFO.
  - TFO may increasingly need to re-dispatch and manage congestion.
  - DFO may experience heightened over-voltage and over-loading issues and also changes in reactive power balance.

- Phase 3 (High Penetration):
  - High PV penetration in many distribution grids.
  - Solar as a major electricity source and integral part of system operation.
  - Low and medium penetration issues continue as before.

[12] As defined by the International Energy Agency’s (IEA) Photovoltaic Power Systems Task 14 (http://www.iea-pvps.org/index.php?id=58)

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- Increased need for TFO to re-coordinate protection settings and to manage potential reliability issues (e.g. constraint operations, voltage and frequency stability impacts, black start issues etc).

Today, Alberta is firmly in Phase 1. It could be expected that Alberta enters Phase 2 during the 2020 – 2025 time-frame and Phase 3 during the 2025 – 2030 time-frame.

There are a several activities that can be taken by various stakeholders (i.e., DFO, TFO, AESO, AUC, government, etc.) to prepare Alberta for Phase 2 and beyond. Maintaining a reliable and efficient grid requires thoughtful planning to determine the optimal approach to integrating new elements. The grid that exists today was designed and constructed to delivery electricity for consumption and emphasized strong grid connection where consumption was the highest (e.g., urban centers). SDCG and other Distributed Energy Resources (DER) can be located where load density is low and therefore where the grid connection is weak. Wire Service Providers (WSP) and TFOs will need to assess the production potential for solar generation and gauge the investment interest in developing solar generation to determine how the grid may need to evolve. By including distributed renewable generation as part of the system planning process, DFOs/TFOs can ensure that expansion and re-enforcement of grid is optimized and that each new connection supports a broader progressive evolution of the power system.

To support the new planning framework, DFOs will need to increase the visibility into the real-time operation of the grid including updated outage management systems, major asset (i.e., transformers) health monitors and remote operation through SCADA. DFOs, TFOs and The AESO will need to increase communication and cooperation with respect to the impact of new distributed generation on the grid. Increased visibility into the grid should provide DFOs with the ability to inform solar generation developers where connection capability exists and where the grid needs investment. Information sharing with solar generation developers can help ensure that new connections can be sited to provide maximum grid benefits and minimal grid stress.

More SDCG will increase the amount of variable generation within the Alberta electricity system and will increase the need for more ancillary services products to maintain system reliability and stability. In particular, regulating reserve (i.e., the component of operating reserve that is responsive to automatic generation control and frequency responsive) will be needed to balance the system demand and supply between dispatch intervals. In addition to regulating reserve, more variable generation will increase the need for ramping and load-following in the supply mix. New energy storage technologies, such as batteries or fly-wheels, are beginning to be able to

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offer cost-effective Ancillary Services in addition to conventional options. Solar generation using advanced inverter functionality can offer dynamic compensation to the grid to support stability and voltage control. Finally, Demand Response services can be used to reduce consumption when solar generation is unable to produce at full capacity for periods of time.

Overall, there are a variety of actions that should be taken to prepare the grid for higher penetration of distributed solar generation. Including potential and interest in solar generation as part of the system planning process through technical analysis and stakeholder consultation will maximize the benefits of distributed solar generation and reduce the potential negative implications. DFOs and TFOs should work with solar generation proponents to guide development to the best parts of the grid to delay additional grid investments. New ancillary service products and technical can be leveraged to maintain reliability and stability of the Alberta power grid.

3.4 Cost and Value: Numerous sources document the rapidly declining cost of solar electricity[13]. The Alberta Electric System Operator (AESO) has estimated the Levelized Unit Energy Cost (LUEC) of utility-scale solar electricity to be $200 – 400 per MWh in 2012[14], $176 per MWh in 2014[15] and $150/MWh in 2016[16]. This represents a decrease of between 25 and 63% in the period of four years from 2012 to 2016. Price discovery may demonstrate that the LUEC for STCG (i.e. ~50 MW) is similar to what would be expected for the largest DCG (e.g. 20 – 25 MW) as the economies-of-scale associated with larger projects can be offset by less complex and costly interconnection.

It is expected that price-discovery for utility-scale solar electricity will be realized in Alberta in the coming year. In October 2017, submissions to the AESO's Renewable Electricity Program (REP) Request for Proposals (RFP) will be made by qualified proponents. In March 2018, the Alberta Infrastructure Negotiable Request for Proposals (NRFP) for 135,000 MWh of solar electricity will be contracted with the successful proponent. In addition, SaskPower's utility-scale solar (10 MW) competitive procurement is expected to contract with the successful proponent in December 2017 which will reveal price discovery representative of that which could be expected

[13] For example, "*Lazard (December, 2016) Levelized Cost of Energy Analysis 10.0*" estimates solar electricity's Levelized Cost of Energy (LCOE) to be $138 - 222 (USD) per MWh for residential, $88 - 193 for commercial, $78 – 135 for community and $46 – 61 for utility-scale. This represents a decrease in cost of 48 -68% for utility-scale and 27-32% for commercial in the 4.5 years since "*Lazard (June, 2012) Levelized Cost of Energy Analysis 6.0*".
[14] *AESO (2012) "Long-term Outlook"*
[15] *AESO (2014) "Long-term Outlook"*
[16] *AESO (2016) "Long-term Outlook"* noted a LUEC of "well above $100 per MWh". *AESO (2016) "Renewable Electricity Program Recommendations"* stated $150 as an average of the range $120 to $215.

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in Alberta. CanSIA expects that these price discoveries will set a new national record with pricing potentially hitting double digits (i.e. <$99 per MWh) for the first time in Canada. The cost of smaller-scale SDCG is higher than that of larger scales.

Analysis of the potential price capture of solar electricity's generation curve by the Market Surveillance Administrator[17] reveals that its price capture would have been on average 47% above the average pool price from 2010 to 2015 (but only 9% in 2016).

In addition to having a generation profile that aligns with higher-than-average pricing in the wholesale electricity market, the other attributes that contribute to SDCG's value stack in Alberta are as follows:

- "Environmental Attributes": GHG emission displacement (e.g. Offsets).
- "System Benefits": Infrastructure investment deferral and line loss avoidance (e.g. DTS Credit, Option M).
- "Forward Price Hedge": near-zero marginal costs guarantee fixed long-term costs.

36. How will the design and operation of the Alberta capacity market affect the deployment of SDCG, and how will any increase in SDCG affect the design and operation of the Alberta capacity market?

The Alberta capacity market is expected to potentially result in a fundamental change to the framework of the Alberta electricity market. During the time of the adoption of a capacity market, the Alberta supply mix will evolve from primarily a thermal based one (i.e., coal-fired and gas-fired generation) to a mixture of renewable generation and thermal. How each generation type receives investment signals from market prices and compensation for energy production along with other electricity products must consider the different attributes, benefits, and drawbacks of those generation types.

The deployment design and operation of the Alberta capacity market will affect the deployment of SDCG in Alberta with respect to two key factors:

[17] Matt Ayres, CEO, Market Surveillance Administrator presentation at Solar West 2017 conference "Implications of Alberta's Evolving Electricity Market for Solar"

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- Wholesale electricity pricing: Build signals for Behind-the-Meter and Merchant solar electricity generators or consumer demand for solar electricity with Bi-Lateral Power Purchase Agreements (PPA) or participation in Shared Solar programs are driven by forward retail pricing i.e. the scale and pace of investments are relative to the savings an electricity customer expects to make. The degree to which the capacity market decreases wholesale electricity pricing during the hours that solar electricity is generated (or uncertainty with respect to future impacts in this regard) could have a major impact on the deployment on SDCG.
- Definition of "Peak": Capacity eligible for payment in Capacity Markets is typically determined by production at "peak" times. The definition of "peak" varies from jurisdiction to jurisdiction. Solar electricity generation (whether SDCG or STCG) can provide significant support to reliability in Summer but less so at night or in Winter. Should the design and operation of the capacity market value the contribution of SDCG to reliability, this would be likely to increase the scale and pace of deployment of SDCG. It may also support the business case for generators to aggregate SDCG as "virtual power plants" so that they may participate in the capacity market at scale.

7. How will the design, operation and outcome of the Alberta renewable electricity program (REP) affect the deployment of SDCG? How will future rounds of REP auctions be affected by any increase in SDCG?

The Renewable Electricity Program (REP) states a lower threshold of 5 MW facility size for participation. SDCG and STCG can therefore participate in the REP. The first round of the REP ("REP 1") is structured to contract with the facilities that have the lowest bid price, regardless of the facilities value in the wholesale electricity market (i.e. how the generation profile corresponds to pool price). For this reason, it is not expected that solar will be contracted in REP 1.

Whether solar is contracted in future rounds of the REP as part of the commitment to support 5,000 MW will be dependent upon three factors: i) procurement design (i.e. fuel-neutrality or approaches to valuing differences in generation profiles); ii) the competitiveness of SDCG vis a vis STCG and other utility-scale renewable generation options; and iii) whether the policy and regulatory framework or market-based opportunities send alternate build signals for SDCG greater than 5 MW that are deemed preferable by developers than the REP.

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We look forward to participating in the oral proceedings and to responding to additional questions that you may have throughout this process. Thank you for your consideration.

Best regards,

Patrick Bateman

Patrick Bateman

Director of Policy & Market Development

Canadian Solar Industries Association (CanSIA)