CanSIA

CANADIAN SOLAR INDUSTRIES ASSOCIATION | L'ASSOCIATION DES INDUSTRIES SOLAIRES DU CANADA

Avoided Greenhouse Gas Emissions from Solar PV

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Introduction

CanSIA is a national trade association that represents the solar energy industry throughout Canada. CanSIA's vision for Canada's solar energy industry is for solar to be a mainstream energy source and an integral part of Canada's diversified energy mix by 2020.

Throughout the development and release of Ontario's Cap and Trade program and Climate Change Action Plan (CCAP) CanSIA has remained actively engaged with the Ministry of the Environment and Climate Change (MOECC), the Ministry of Energy (MOE), the Ontario Energy Board (OEB) and the Independent Electricity System Operator (IESO) with regards to how solar PV can be transitioned from today's Feed-in Tariff Program to a customer focused net metering industry. CanSIA believes this transition can be executed in order to achieve both the governments and the solar industry's economic development and greenhouse gas (GHG) emission reduction goals. This submission builds on those past engagements and is intended to provide further information on the potential for solar PV to avoid greenhouse gas GHG emissions from electricity generation in Ontario. This information is intended to help inform the MOECC's development of specific programs and incentives under the CCAP.

Solar PV should feature prominently within the programs put in place by the CCAP. By its very modular nature, solar PV is a technology that can be deployed on residential, commercial/industrial, and institutional buildings, making it an ideal solution for deployment on a wide range of building types identified as priorities within the CCAP. Solar PV is also recognized as a central piece of any strategy to develop net-zero buildings, another focus area of the CCAP. Solar PV also generates electricity during peak times of the day, when natural gas generators are used most often. The symmetrical nature of solar and natural gas generation profiles helps ensure that a kWh of solar generation will generally offset a kWh of natural gas generation, thus reducing GHG emissions from Ontario's electricity sector.

Avoided GHG Potential from Solar PV

Estimating Emissions from Ontario's Natural Gas Fleet

As of 2015, the electricity sector accounted for roughly 7% of Ontario's GHG emissions.[1] Since the retirement of coal fired electricity generation in 2014, GHGs from the electricity sector have come primarily from the use of natural gas generation (a small portion is also produced from the transmission and distribution of electricity). While relatively clean compared to other comparable US and Canadian jurisdictions, Ontario's electricity sector GHG emissions are a function of how the natural gas fleet is utilized to meet demand. The more the natural gas fleet is called into service to meet demand, the higher emissions from the electricity sector will be. As such the forecasted emissions from the electricity sector, and actions taken to mitigate those emissions, should account for:

- The GHG emissions per unit of energy generated by the natural gas fleet;
- The current use of the natural gas fleet to meet existing electricity demand; and
- How the use of the natural gas fleet could change over time to meet changing electricity demand.

[1] Ontario's Climate Change Action Plan, pg. 6.

Estimating GHGs per Unit of Energy Generated from Ontario's Natural Gas Fleet

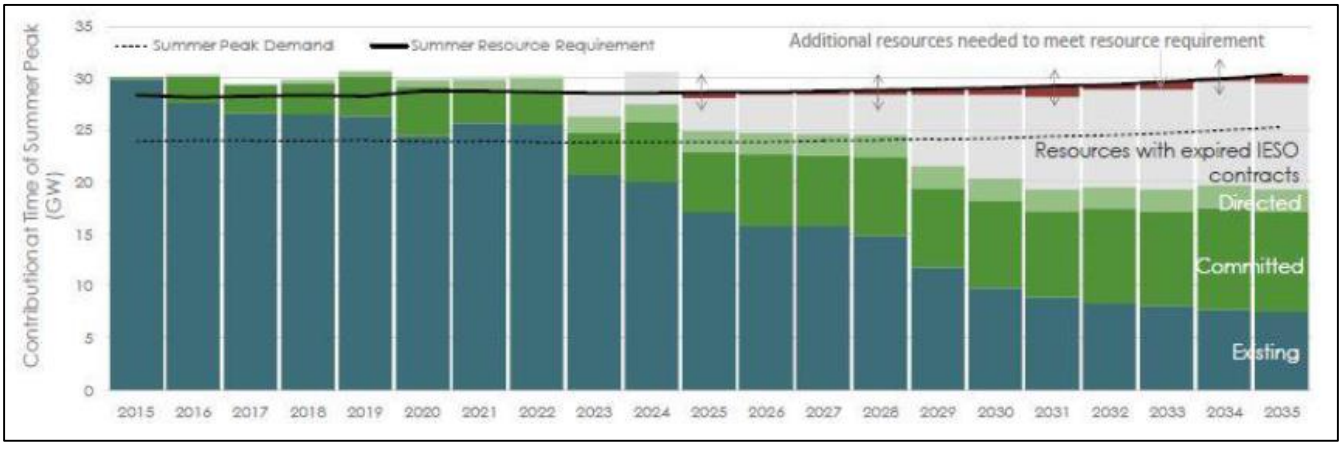
Ontario's natural gas fleet is comprised of a combination of simple cycle and combined cycle generators. For the purposes of this analysis CanSIA has assumed that 85% of energy from natural gas generation is attributable to combined cycle facilities and 15% of energy is attributed to simple cycle facilities. Generally, simple cycle facilities (average heat rate of 7.5 MMBtu/MWh) contribute greater emissions than combined cycle generators (average heat rate of 11 MMBtu/MWh). For the purposes of this analysis CanSIA has excluded both the generation and associated GHG emissions from behind the meter natural gas generation (ex. Combined heat and power generators located behind the meter at industrial facilities), which would increase the overall emissions from natural gas electricity generation in Ontario.

For the purposes of this analysis, emissions due to imports are attributed to Ontario rather than the source, using the same emission factor that is applied to imports and to domestic generation. Emissions due to exports are also attributed to Ontario. Using the assumed split between simple cycle and combined cycle natural gas electricity generators, and the average energy generation from natural gas in Ontario, it is estimated that each kWh of natural gas generation contributes approximately 0.43 kg of GHGs to the province's emissions profile.

Forecasting Overall Emissions from Ontario's Electricity Sector

In order to estimate future GHG emissions from the Ontario electricity sector, a forecast of electricity demand is required. A demand forecast establishes the electrical need that must be met by a resource supply mix over the time period under analysis. The supply mix and demand forecast utilized for this analysis is based on the IESO's Ontario Planning Outlook (OPO).

Figure 1: IESO Ontario Supply/Demand Forecast



The IESO has undertaken an analysis of assumed GHGs from the electricity sector under a baseline flat demand scenario (termed Outlook B in the OPO). Under this scenario the IESO assumes electricity demand in the province will remain relatively stable and only experience minor increases over the planning period of 20 years. In the OPO the

IESO estimates that under a flat demand scenario, that the electricity sector is expected to contribute approximately 80 MT CO2e between 2016 and 2035.[2]

Figure 2: Electricity Sector GHG Emissions under Flat Demand Scenario

MT CO2e	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Electricity Sector GHG Emissions	34.5	29.9	32.9	27.4	14.9	19.8	14.2	14.2	10.9	7.1	7.1

MT CO2e	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Forecast GHG Emissions (Outlook B)	4.6	3.8	3.5	3.1	3.4	3.6	3.7	4.2	3.4	4.7

MT CO2e	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Forecast GHG Emissions (Outlook B)	3.8	3.9	3.7	3.9	3.8	4.5	4.0	4.2	4.6	5.3

The IESO's analysis assumes not only flat demand growth in the province, but also assumes that nuclear units will go down for, and return from, refurbishment on time and on schedule, that Pickering nuclear generating station will continue to operate until 2024, and that the provinces conservation targets will be met (through programs that do not contribute to further GHG emissions such as behind the meter natural gas). CanSIA has conducted analysis testing each of these assumptions to determine a reasonable upper bound for emissions from the electricity sector between 2016 and 2035. Under this alternative scenario CanSIA assumes the following:

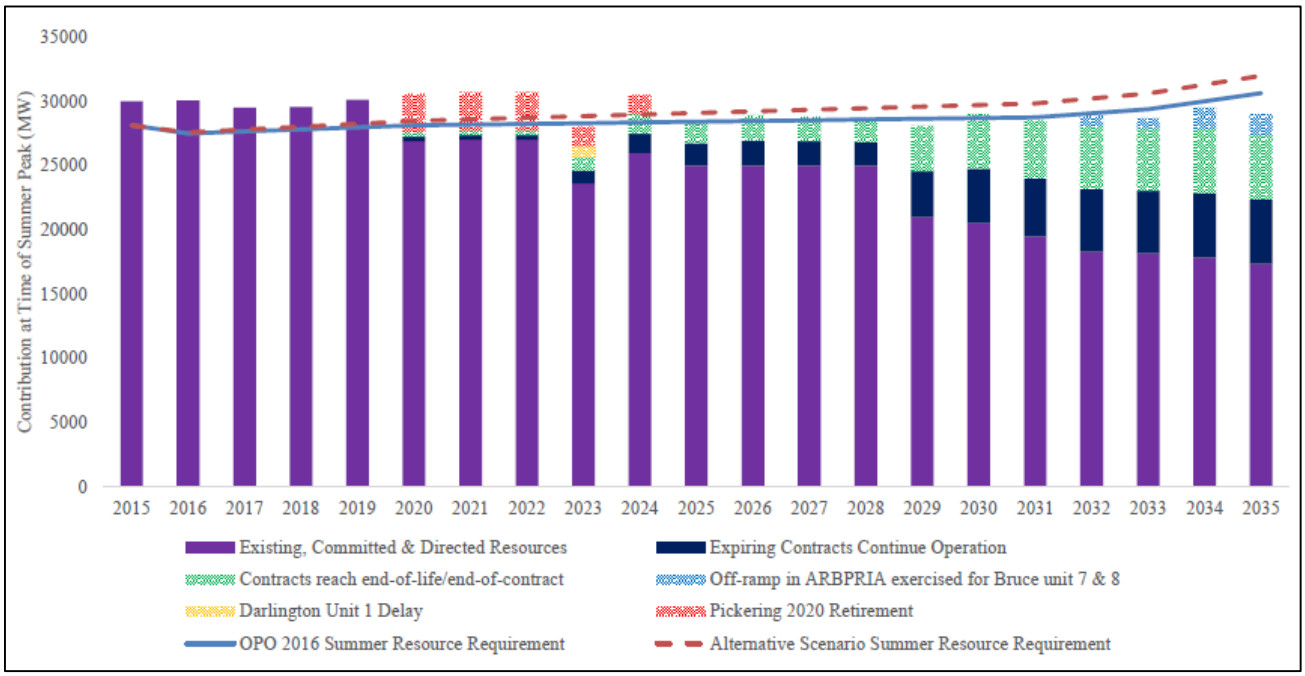
- Gross electricity demand in the province increases due to the success of CCAP initiatives focused on electrification of other sectors of the economy. If 25% of the vehicle fleet were to transition to electric vehicles over the next 15 years, the result would be an extra 6.6 TWh of energy consumption and almost 1 GW increase in peak demand. CanSIA has not assumed any increases in electricity demand from the buildings sector, which if successful, would cause further increases in electricity demand.
- Gross electricity demand in the province increases due to not meeting the full conservation targets. The average between the upper achievable potential and lower achievable potential identified by the IESO's Achievable Potential study is used.
- Pickering generating station reaches the end of its life in 2020, as originally forecast by the IESO and Ministry of Energy in the 2013 LTEP.
- Some of Darlington generating station's reactors come into service later than expected and two Bruce reactors are not refurbished due the Ministry of Energy exercising the off-ramps available to them due to either cost overruns on other refurbished reactors or timeline delays.

If the situation above (or some version of those parameters) were to occur over the planning horizon of the OPO, electricity demand and GHGs from the electricity sector could increase significantly. Figure 3 below illustrates the change to net demand in Ontario that could occur if the conditions outlined above were to occur.

[2] Independent Electricity System Operator, Ontario Planning Outlook, Pg. 38.

Under the alternative scenario, CanSIA estimates that GHGs from the electricity sector could rise as high as 217 MT depending on how the higher net demand is met. CanSIA has assumed that the majority of net demand increases are met using existing natural gas assets and imports from other jurisdictions. GHG increases from the electricity sector could be mitigated if net demand increases are met with imports from other jurisdictions with clean supply.

Figure 3: Summary of Alternative Ontario Supply/Demand Scenario



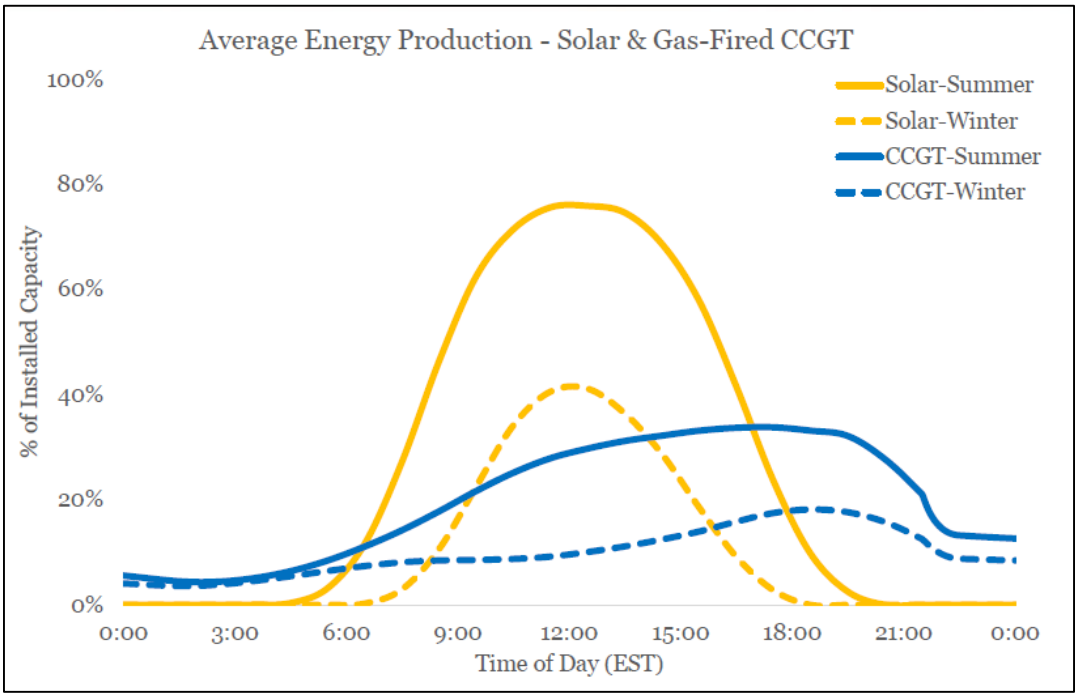
The OPO also lays out additional demand outlooks (Outlooks C and D) which both contemplate large increases in electricity demand due to policies and programs from the CCAP which would increase electricity demand in the province (ex. Additional electrification of the transportation and space heating sectors). Similar to CanSIA's alternative scenario, described above, Outlooks C and D from the OPO could result in increases to GHG emissions from the electricity sector. If risks like nuclear refurbishment schedules/budgets, Pickering life extension, not meeting conservation targets (or meeting them through behind the meter natural gas generation), or increases in net electricity demand from electrification occur, Ontario could jeopardize meeting their GHG emission targets. In order to mitigate this risk, The CCAP should utilize solar PV to further reduce GHG emissions from the electricity sector.

Solar PV vs Natural Gas Generation Profiles

Solar PV's central contribution to emissions reduction in Ontario is through the avoidance of GHGs from natural gas fueled electricity generation. Each kWh generated by solar PV and consumed by electricity customers will generally avoid a kWh generated by natural gas. This is due to both natural gas generation and solar PV generating during peak times, when electricity demand and price are highest. CanSIA's analysis has factored in Ontario's historical demand profile as well as the generation profiles of natural gas and solar in order to determine that a kWh of solar would generally offset a kWh of natural gas, and what the GHG composition of that kWh would be based on the amount of

natural gas being utilized to meet demand. Currently, natural gas generation in Ontario is generally used to meet periods of peak demand on the electricity grid. When possible, the IESO tends not to dispatch natural gas generators for purposes other than meeting peak demand or providing ancillary services as the continued and steady operation of natural gas facilities is expensive and inefficient. The congruence between the generation profiles for solar PV and the natural gas fleet in Ontario are presented in Figure 4, below.

Figure 4: Solar PV vs Natural Gas Generation Profiles



A further contribution to emissions avoidance from solar PV is provided by avoiding the need to generate electricity from centralized natural gas generators and transmit that electricity through the transmission and distribution system. This helps avoid line losses which would otherwise result in additional natural gas generation being required to ensure local demand, often located far away from the source of generation, is met. A small amount of GHGs are also generated from the functioning of transmission and distribution infrastructure which can also be reduced.

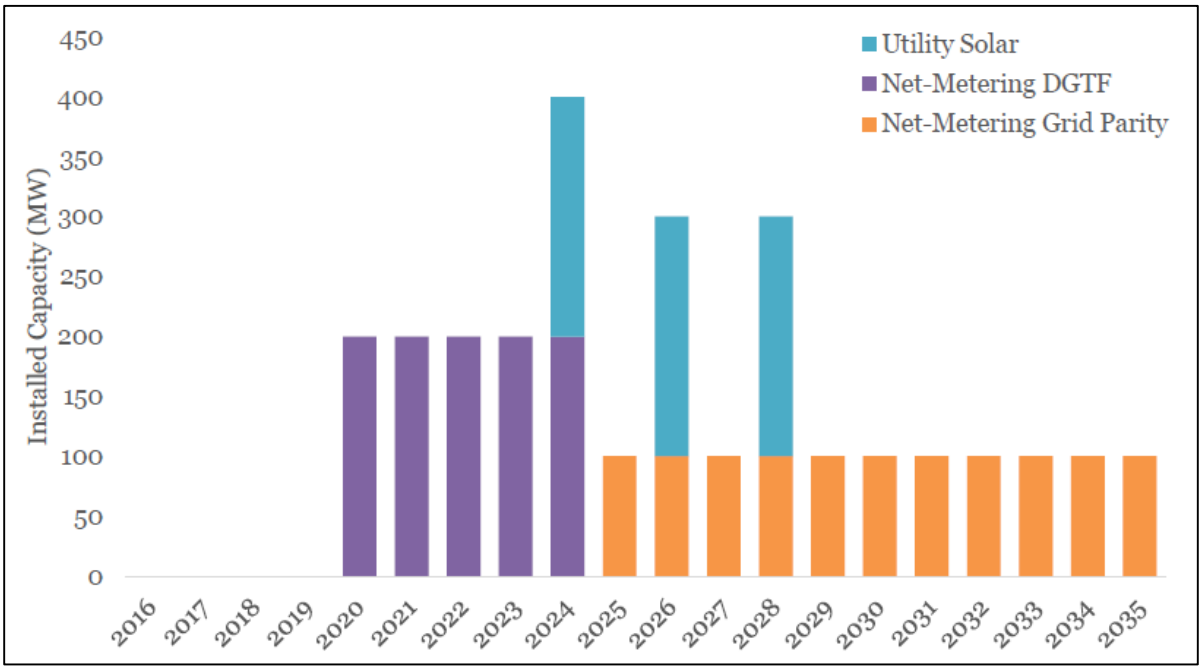
Solar Outlook to 2035

To determine the impact that solar generation could have on GHG emissions from the electricity sector CanSIA has analyzed the impact of different levels of deployment of net metered and grid tied solar to the Ontario electricity grid between 2018 and 2035. This analysis has also determined the specific cost per avoided tonne of GHGs for the deployment of net metered solar that is recommended to be incented within the CCAP by CanSIA's Distributed Generation Task Force (DGTF). These costs have been presented here for consideration by the MOECC with regards to specific programs and incentives offered by the CCAP. CanSIA has conducted additional avoided GHG analysis for larger scale deployments as well as for an assumed level of additional, un-incented, deployment of net metering

projects. This additional analysis has not been included herein, however, as it does not relate directly to program considerations for the CCAP.

CanSIA has assumed for the purposes of this analysis that the DGTF's recommendations are adopted by government and a transitional incentive is offered through the CCAP for net metered solar. A complete description of the DGTF's recommendations are included below. In short, the DGTF has recommended an annually declining transitional incentive be offered for net metered projects over a period of 5 years from 2018 to 2022. This transitional incentive would result in approximately 1 GW of net metered distributed solar generation being constructed in Ontario between 2018 and 2024. Additionally, CanSIA has assumed that the goal of the DGTF's recommendations is achieved and a grid parity situation is achieved for distributed solar resulting in approximately 100 MW being constructed annually in Ontario thereafter without government incentive. Figure 5, below, shows the assumed install schedule for the DGTF's recommended 1 GW of net metered solar as well as the 100 MW of un-incented net metered solar being constructed annually thereafter. While utility scale solar generation has also been included in the chart below, this utility scale generation as well as the un-incented net metered solar has not been included in the calculations for offset GHGs as this deployment would not be directly incented by the CCAP.

Figure 5: Solar Uptake Outlook



The level of deployment of incented net metered solar illustrated in Figure 5 above would result in avoiding approximately 9 MT of GHGs between 2018 and 2035 provided Ontario's peaking electricity demand continues to be served by natural gas generation.

Cost per Avoided Tonne of GHGs

To determine the cost per avoided tonne of GHGs from solar PV CanSIA has assumed that the initial 1 GW of distributed solar generation is incented via the CCAP in-line with the incentive levels and timing recommended by CanSIA's Distributed Generation Task Force. These recommendations are summarized in the next section but begin with a 50 ¢/watt incentive in 2018 declining each year until the end of 2022. The total cost of this program would be approximately $260 million. After the initial 1 GW of incented net metered solar has been deployed, CanSIA has assumed that net metered solar will no longer require direct incentives from government and that deployment will be driven by avoided electricity costs alone and other regulatory supports including the net metering regulation, access to Time of Use rates, the Ontario Building Code, incentives for net zero homes, and simplified connection processes.

The cost per avoided tonne of GHGs from incented net metering (deployed in-line with the DGTF's recommended approach) is 21-22$. This cost is relatively low when compared to other incented programs and initiatives within the CCAP because the majority of revenue for a net metering system is derived from avoided electricity costs of the customer, rather than from government incentives. Importantly, the total GHGs offset by CanSIA's recommended approach to incented net metering could reach as high as 9 MT over the course of the 20 year life of the systems. On an annual basis, CanSIA assumes that the full 1 GW of deployed solar will offset approximately 0.49 MT of GHGs based on the annual energy production (1.138 TWh) compared against the average avoided GHGs from natural gas of 0.43 kg/kWh.

Summary of the Recommendations CanSIA's Distributed Generation Task Force

CanSIA created the Distributed Generation Task Force (DGTF) in early 2015 to consult on and design a transition for the Ontario distributed solar industry to move away from the current Feed-in Tariff (FIT) regime and into a net metering based framework. The recommendations of the DGTF offer a path forward for the government of Ontario to implement a program through the CCAP that will achieve a cost per avoided tonne of GHGs of $21-22 and a total avoided GHG figure of approximately 9 MT over 20 years. The total program cost would be approximately $260 million. This transition from the FIT regime, and the resultant net metering framework, is envisioned to be more responsive to electricity customer demand and to shift investment and performance risk to the market. Making this transition will allow the private sector to design and deliver projects efficiently within a timeline driven by economics and investment decisions rather than centralized procurement cycles.

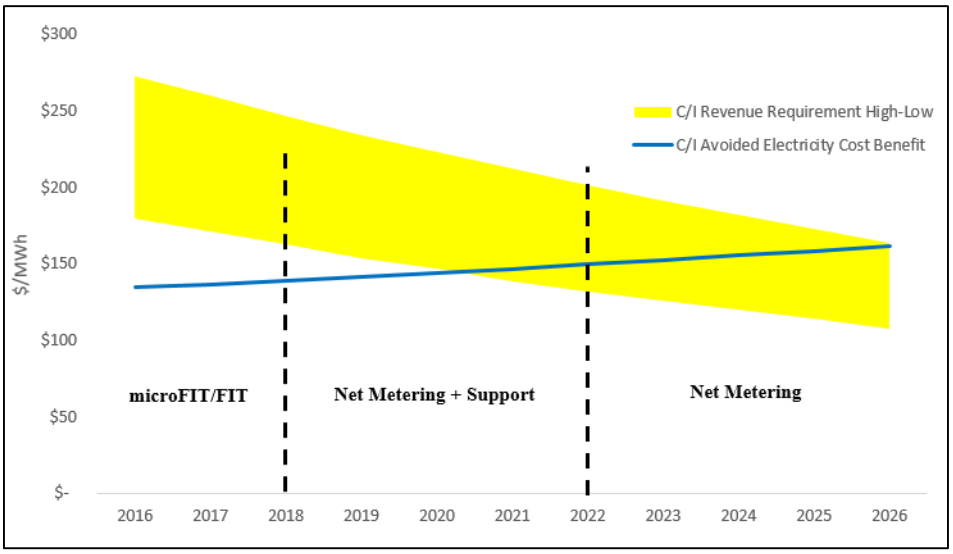
Distributed Solar Generation (DSG) provides the following system value and benefits to Ontario:

- It is a supply mix diversification option that reduces peaking natural gas combustion in support of Ontario's climate change objectives;
- Located behind the meter, it is an effective Conservation and Demand Management (CDM) measure;
- Regional planning and distribution system planning benefit from having DSG as a grid-responsive and flexible resource option to meet power system needs;
- It provides consumers an investment option to hedge against the risk of rising electricity rates and increases resiliency; and

- It leverages strong public support for DSG to engage Ontarians in the electricity sector and its evolution.

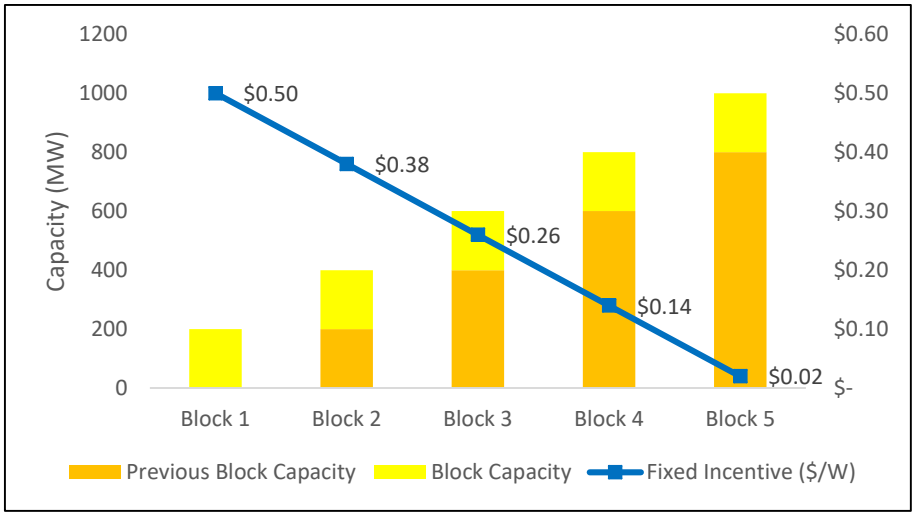
Ontario is currently capturing many of these benefits via the FIT Program. If the program is transitioned effectively to a net metering based framework, all benefits can be captured. The CanSIA has determined that after the conclusion of the FIT program in 2018, modest additional support for net metering projects will be needed for three to five years before net metering is economic without assistance. Figure 6 illustrates the timing of this transition from the conclusion of the FIT Program, through a period of transitionary support, and ending in un-incented net metering. Net metering is the established DSG policy in 46 of 50 United States and most Canadian provinces.

Figure 6: Distributed Solar Generation Cost Curve



The majority of revenue under a net metering regime comes from avoided electricity consumption, so additional support will be significantly lower compared to a FIT program and when compared against the cost per avoided tonne of GHGs for other programs currently outlined within the CCAP. This additional support can decline year over year and is not expected to be required post 2022. CanSIA's DGTF transition strategy balances a number of government and rate-payer priorities. Additional financial support will initially be required when a new net metering program is launched after FIT ends in 2018. This interim support would be provided to net metered projects between 2018 and 2022 to bridge the gap to grid parity. The declining capital cost contribution would be for a capped quantity of 200 MW per year and thus have a finite budget (see Figure 7);

Figure 7: Proposed Capital Cost Incentive Program



The above annual targets represent a cap on DSG eligible for the specified level of capital incentive, and the years are indicative only. If there is a year with under-subscription then the incentive would continue to be available in the subsequent year, and the schedule could be pushed out. It is expected that the capital incentive would be needed until 2022, after which net metering at TOU rates would be an adequate incentive for customer adoption of DSG.

CanSIA's recommendations are an off-ramp from the current centralized FIT and microFIT procurement programs. They seek a reasonable balance between ratepayer protection and continued modest and steadily declining support for solar's participation in the supply mix. They harness a Conservation First approach in order to bend the cost curve for ratepayers. Ontario's evolution from FIT through supported net metering to a customer self-consumption model allows for the Province to capture the full value of being an early champion of renewable energy. This balanced approach ensures that Ontario continues to have the support mechanisms and a regulatory environment necessary to enable enhanced energy services for customers and advance toward a collective smart grid future that manages and seeks to further reduce GHG emissions from the electricity sector.

Conclusion and Summary of Recommendations

The overall impact that solar PV can have on emissions in the electricity sector is tied to both the emissions from the existing sector, as well as how those emissions may change in the future depending on factors including changes in electricity demand and the available supply mix in the Province. Currently, Ontario's electricity sector emissions come primarily from natural gas generation. There are a number of risks to the electricity demand forecast in Ontario that could entail more frequent use of natural gas generation to meet demand which could cause increases to GHG emissions from the electricity sector. These risks include increases to electricity demand as a result of CCAP initiatives, delayed or deferred nuclear refurbishments, Pickering generating station coming off-line in 2020 as originally forecast, or not metering the provinces conservation targets. In order to guard against those risks and reduce emissions from Ontario's electricity sector, the CCAP should incent net metered solar PV in-line with CanSIA's DGTF recommendations by providing a $/watt incentive to customers and developers constructing net metered solar PV systems between 2018 and 2022. The cost per avoided tonne of incented net metered solar PV would be approximately $21-22/tonne and could result in a minimum of 1 GW of net metered solar being deployed by 2022.