Acting on Climate Change:

# Extending the Dialogue Among Canadians

A collection of texts in response to

***Acting on Climate Change: Solutions from Canadian Scholars***,

a consensus document released in March 2015

Sustainable Canada Dialogues

Trottier ISPP — Institute for Science and Public Policy

United Nations Educational, Scientific and Cultural Organization — UNESCO Chair for Dialogues on Sustainability — McGill

United Nations Educational, Scientific and Cultural Organization — Canadian Commission for UNESCO

McGill — Faculty of Science

SOLAR GLOBAL SOLUTIONS

ABOUT THE ORGANIZATION

# SOLAR GLOBAL SOLUTIONS

ADAM DAY AND SEAN FLEMING

Solar Global Solutions (SGS) is a manufacturer of micro-grid systems specializing in the design, supply, and construction of high quality solar photovoltaics (PV), combined heat and power generators, and battery-based energy storage. The team at SGS delivers turnkey Engineering, Procurement, and Construction (EPC) services for both grid-tied and off-grid projects. SGS is a privately held corporation founded in 1988 in Halifax, Nova Scotia, Canada, and has over 25 years of experience successfully developing projects for residential, commercial, government and utility clients. To date, SGS has supplied over 500 solar systems globally including projects throughout North America, the Caribbean, and the Middle East.

FOR MORE INFORMATION, PLEASE CONTACT
sfleming@solarglobalsolutions.com

OFFICIAL WEBSITE
solarglobalsolutions.com

A 12.2 KW COMMERCIAL SOLAR PHOTOVOLTAIC SYSTEM DESIGNED AND INSTALLED BY SOLAR GLOBAL SOLUTIONS FOR THE CITY OF HALIFAX, AS PART OF THEIR CORPORATE EFFORTS TO ADOPT SOLAR AND REDUCE THE CARBON FOOTPRINT OF THEIR FACILITIES

Contributed by

**SOLAR GLOBAL SOLUTIONS**

# Distributed Generation Micro-Grid Systems:

## Advancing Renewable Energy Adoption and the Evolution of Our Electrical Grid

SGS values the importance of environmental sustainability in Canada's Atlantic region, and across the country. As a solar energy and micro-grid company, SGS promotes, designs, and installs solutions that minimize the use of fossil fuels and reduce the carbon footprint of its clients around the world. SGS is proud to support the work of Sustainable Canada Dialogues in developing its *Acting on Climate Change: Solutions from Canadian Scholars* paper and renewable energy map for Canada. Multi-stakeholder planning, like that being implemented by Sustainable Canada Dialogues, is key to the long-term environmental and economic sustainability of Canada's energy system.

As of 2013, approximately 20% of Canada's electricity was generated by fossil-fuel-based sources[1]. Due to favourable geography where over 60% of the country's electricity needs can be met with clean hydroelectricity, and existing infrastructure that supports nuclear and large scale renewable energy sources, Canada's electrical grid is less reliant on fossil-fuel-based energy than other nations. However, producing 20% of our electricity from fossil-fuel-based sources produces 12% of Canada's greenhouse gas (GHG) emissions (90 Mt $CO_2e$ per year as of 2011), which are contributing to the degradation of our climate[2]. Action must be therefore taken to minimize the carbon footprint of our electricity production.

In recent years strides have been made across Canada to develop the renewables industry, with the aid of tariffs and other incentive-based programs. Canada's installed capacity of solar PV in particular increased from 13.9 MW in 2004 to 1210 MW in 2013[3]. The correlation between government incentives and renewables adoption can be clearly seen in Ontario, where a progressive feed-in-tariff program has allowed the province to develop more than 99% of all of the installed solar PV capacity in Canada[4].

1 http://powerforthefuture.ca/electricity-411/data-world/

2 https://ec.gc.ca/ges-ghg/985F05FB-4744-4269-8C1A-D443F8A86814/1001-Canada%27s%20Emissions%20Trends%202013_e.pdf

3 http://cansia.ca/sites/default/files/20140403_cansia_white_paper_final_0.pdf

4 http://cansia.ca/sites/default/files/cansia_road-map_2020_final.pdf

Similar trends can be observed globally where government-sponsored subsidies and incentives have been proven to drive adoption rates and subsequently reduce the cost of solar PV technologies and installation. In the last six years alone, the global cost of solar PV modules has dropped by 80%, and the full cost of solar PV systems has dropped by more than 60%[5]. With rapidly decreasing costs and innovative technological breakthroughs, it is forecasted that by 2050 solar energy will be the world's largest source of electricity — ahead of fossil fuels, wind, hydroelectric, and nuclear[6].

These rapid cost reductions are causing electricity produced by solar PV to become competitive with grid electricity in many jurisdictions, even without government incentives. Of particular note is the effect this has on the rapid growth rates of small-scale residential and commercial decentralized PV systems. For example, in Nova Scotia, residential and commercial solar PV installations have seen an average annual growth rate of over 75% for the last five years. The Levelized Cost of Electricity (LCOE) from recent installations in Nova Scotia is currently in the range of $0.196 - $0.291/kWh in comparison to a residential electricity rate of about $0.15/kWh from the utility[7]. This increasing cost competitiveness means that decentralized solar adoption will continue to rise rapidly, regardless of government incentives. The adoption rates of solar PV on both the utility and distributed scale mean that PV is projected to be a large contributor to the electrical mix of the future.

While the rapid deployment of solar PV is a positive step to less carbon intensive electricity generation, rising penetration rates for decentralized PV systems can have a significant impact on our aging grid infrastructure. In particular, the intermittency of solar energy creates challenges for the utility as traditional generating stations and control systems are not designed to compensate for the fluctuations caused by intermittent energy sources.

As more solar PV systems are added to the grid, the challenge of meeting electricity demand peaks is amplified by the fact that the time of day when solar generation reaches its maximum output (midday) does not match the time of day with the greatest user demand (late-afternoon/early-evening). A good example of the challenges this creates can be seen in geographical areas currently experiencing higher rates of solar technology penetration. In California for example, it is estimated that by 2020 the utilities will need to be capable of ramping up 13 000 MW of generation capacity within three hours to offset a daily imbalance on the grid as solar power production falls and demand increases[8].

The intermittency of existing demand profiles of end users coupled with variable renewable energy power generation is currently balanced by utility providers' traditional generating services. These usually include on-line generators (including oil, gas, coal and hydroelectric) and off-line generators (normally gas-turbine peaking plants), which can be brought on-line quickly as required, yet are costly to operate and maintain, and typically produce considerable GHG emissions.

It is unsustainable from an environmental and economic perspective to rely on fossil-

5 https://www.iea.org/publications/freepublications/publication/TechnologyRoadmapSolarPhotovoltaicEnergy_2014edition.pdf

6 Ibid.

7 http://www.questcanada.org/sites/all/sites/default/files/private/files/QUESTNS%20Submission%20No%202.pdf

8 https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

fuel-based peaking plants and centralized ancillary services to compensate for the intermittency of renewable assets. As consumer adoption of renewables continues to climb, a new grid model must be developed. While *Acting on Climate Change: Solutions from Canadian Scholars* proposes to combine hydropower with solar and wind energy, solar PV needs to be deployed with complementary micro-grid technologies such as battery based energy storage, micro combined heat and power (CHP) generators, and grid-interactive controls. This new decentralized energy system will consist of large traditional utility generating assets working in conjunction with these networked micro-grid systems.

Integrating solar PV with energy storage technology allows end users to gain increased control over when the electricity produced is consumed. This optimizes the impact of a solar PV system and is creating disruptive forces for traditional utility providers. In conjunction with solar PV technology, the cost of energy storage technology is also currently reaching historic new lows and, for the first time, small scale decentralized solar with storage systems is making economic sense for end users.

By utilizing energy storage, grid stability can be improved by storing the solar energy produced during the day and shifting for use during peak demand times. Furthermore, adding a low-emissions backup generator such as a micro-CHP system to decentralized PV arrays allows end users to run off-grid during peak demand hours, or to act as a net-exporter of energy to the grid despite what the output of the solar system may be. This is especially beneficial in Canada's northern climate where the peak demand on the electrical grid is experienced in the evening during the winter months. During these times, after the sun has set, there is no support for peak load reduction from the solar system alone. With a cogeneration system, the battery bank and micro-CHP system can work in tandem to reduce the load on the grid and allow the utility to minimize its dependence on the highest marginal cost generating assets, which can be two to three times as expensive as solar PV energy generation[9].

Integrating battery storage and micro-CHP with solar PV further enhances environmental benefits by minimizing the grid power consumed by the user, and minimizing the utility's need to generate power from fossil-fuel-based power stations. A conventional fossil fuel power plant is only about 35-40% efficient in its conversion of fuel to electrical energy[10]. By combining a small electrical generator with a heat recovery system, micro-CHP units have a combined thermal and electric efficiency in the range of 85-95%. Furthermore, concentrating the energy generation (PV and micro-CHP) at the end user also eliminates power losses due to distribution from a large generating station. These distribution losses can be up to 10%[11]. A study published by researchers from two Canadian universities has demonstrated that a combined system of solar PV, battery energy storage, and CHP can reduce GHG emissions by 50-90% in comparison to traditional fossil-fuel-based power plants[12]. The environmental benefits of integrating solar PV with backup generation and energy storage to end users are quite clear. And as cost erosion of these new technologies continues, the integration of decentralized energy generation with the

9 http://www.lazard.com/PDF/Levelized%20Cost%20of%20Energy%20-%20Version%208.0.pdf

10 http://www.c2es.org/technology/factsheet/natural-gas

11 http://www.hydroone.com/RegulatoryAffairs/Documents/EB-2007-0681/Exhibit%20A/Tab_15_Schedule_3_Distribution_Line_Losses_Study.pdf

12 Nosrat, A.H., Swan, L.G. and Pearce, J.M. (2013). Improved performance of hybrid photovoltaic-trigeneration systems over photovoltaic-cogen systems including effects of battery storage. Energy, 49: 366-374.

grid is going to come regardless of subsidies or other incentive programs.

Decentralized micro-grid systems and the threat of "load defection" (when residential and commercial clients move off-grid with the majority of their energy needs (primarily through batteries and storage) and use the grid as a back-up when needed) can be seen as a risk for utility providers under traditional utility business models. It is forecasted that by 2030 parts of the U.S. will see sales erosion of 50-60% across both residential and commercial users as energy generation shifts to decentralized renewable sources[13]. In the Northeastern region of the U.S. alone, this erosion will account for a loss of US$34 billion in revenue for utilities each year. This lost revenue is particularly concerning given the required costs to maintain existing electrical grid infrastructure. For reference, in the U.S. it is estimated that the electrical grid will require US$100 billion in investment each year between 2010 and 2030 just to maintain operations[14]. With future maintenance costs in mind and the potential losses in revenue that decentralized energy generation facilitates, it's unsurprising that many utility providers see decentralized renewable energy assets as a threat to the existing system. While this may encourage utility providers to reduce incentives for adopting renewable energy, or abolish structures such as net metering all together, these types of short-term solutions will only delay the inevitable evolution of our energy system in an economically painful way.

The unidirectional grid model is becoming outdated, and regulatory changes are needed that treat decentralized micro-grids as an opportunity rather than a risk. Decentralized renewable assets with energy storage can offer a wide variety of benefits to the electrical grid including: increased renewable integration, variability management, peak management, voltage and frequency regulation, and grid resiliency. By intelligently integrating more renewable assets to the grid, our electrical grid can reduce its dependence on GHG-emitting energy generation. Additionally, the development of renewable assets will usher in many new and exciting economic opportunities including high-tech jobs in engineering, technology development, installation, and maintenance. These trends are already becoming apparent in our economy. In 2013, 37% more Canadians worked in the renewable energy sector than in 2009 and the renewable energy industry in Canada currently accounts for more direct Canadian jobs than the oil industry[15].

Decentralized micro-grids are leading a shift to where the centralized electrical grid serves a backup role while onsite generation and storage serve end users' primary energy needs. For this transition to occur smoothly, utility business models need to evolve. Now is the time to begin experimenting with new rate structures and regulations that will support the development of tomorrow's electrical grid to a more environmentally sustainable system.

By not taking proactive steps to establish the proper regulatory structure for distributed energy resources while the micro-grid system is still in its infancy stages, utility providers will likely experience significant challenges as mass consumer adoption comes regardless of government subsidies. The economic benefits of generating one's own energy will become apparent with or without utility support as technological advances

13 http://www.rmi.org/Knowledge-Center/Library/2015-05_RMI-TheEconomicsOfLoadDefection-FullReport

14 Ibid.

15 http://cleanenergycanada.org/wp-content/uploads/2014/12/Tracking-the-Energy-Revolution-Canada-.pdf

further drive down the cost for renewable energy. Consumers are demanding clean energy as our current electrical grid induces further strain on our planet's climate, and these needs can be met through the aid of renewable technology. The existing grid model can either evolve to establish barriers that isolate end users and further erode the existing integrity of our electrical system, or provide the means for a decentralized system that is resilient and interconnected.

By embracing decentralized renewable micro-grids with new business models and rate structures, (1) governments and utility providers can help prevent climate change while leveraging the inherent benefits of distributed energy resources, and (2) the foundation for a reliable, affordable, low-emissions integrated grid can be developed.

ABOUT THE INITIATIVE

# SUSTAINABLE CANADA DIALOGUES

This contribution is part of a collection of texts, *Acting on Climate Change: Extending the Dialogue Among Canadians*, stemming from interactions between Sustainable Canada Dialogues, an initiative of the UNESCO-McGill Chair for Dialogues on Sustainability, and business associations, First Nations, non-governmental organizations, labour groups, institutions, organizations and private citizens.

Sustainable Canada Dialogues is a voluntary initiative that mobilizes over 60 researchers from every province in Canada, representing disciplines across engineering, sciences and social sciences. We are motivated by a shared view that putting options on the table will stimulate action and is long overdue in Canada.

Together, the contributions enrich the scope of possible solutions and show that Canada is brimming with ideas, possibilities and the will to act. The views expressed in *Acting on Climate Change: Extending the Dialogue Among Canadians* are those of the contributors, and are not necessarily endorsed by Sustainable Canada Dialogues.

We thank all contributors for engaging in this dialogue with us to help reach a collective vision of desired pathways to our futures.

FOR MORE INFORMATION, VISIT OUR WEBSITE

sustainablecanadadialogues.ca/en/scd/acting-on-climate-change