White Paper

Future of Solar in Manitoba

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1. EXECUTIVE SUMMARY

The following is a white paper prepared by Sycamore Energy Inc. for the purposes of advancing the penetration of solar photovoltaics (PV) into the Manitoba Hydro grid and the Manitoba economy at large. Sycamore was established in 2008 and is Manitoba's largest solar PV developer. With extensive experience in wind and solar projects across North America, Sycamore is well positioned to provide insight into the current and future states of the solar PV market in Manitoba.

In April 2016 Manitoba Powersmart established the solar energy program as a two-year pilot project. This pilot project vastly exceeded internal estimates and has resulted in a total subscription of 57MW across over 1500 projects. The solar energy program provided a purchase rebate to customers who invest their capital and make their real estate available for the installation of grid-connected solar PV systems. This program is a resoundingly successful example of the public-private partnership model and has led to significant job creation in a highly technical field.

This rebate has since ended and unfortunately is one of the only known global examples of a subsidy simply ceasing to exist without some form of gradual withdrawal. The impact of this sudden withdrawal will be that many of the smaller solar installers will simply cease to exist. The loss of small installers will likely result in cost increases for new installations along with a decrease in the market's ability to service existing installations.

On May 1, 2018 the P.U.B. presented a ruling in opposition to the solar energy program that places more than $100 million in private sector solar PV investment at risk. P.U.B. opposition was further developed in the ruling No. 90/18 dated July 13, 2018. This white paper proposes net-metering and virtual net-metering as the most cost-effective solution to the current conflict. Net metering will also resolve the current conflict with legacy solar arrays, as there are at least three different categories of small solar customers with varying levels of compensation for no reason other than the installation date. Manitoba lags behind the rest of Canada as the only province without a net metering program.

Through the solar energy program Manitoba Hydro has developed considerable capacity to evaluate, permit, and approve solar PV systems. One of the most striking developments has been the rapid decrease in the installed cost of solar PV to the level where solar PV can deliver energy at a lower cost than hydroelectric dams. Solar PV is installed for approximately $2.50/watt, where the Keeyask dam project is currently estimated to be installed for $21.50/watt, nearly an order of magnitude greater.

This white paper also highlights how solar PV along with energy storage can effectively reduce Manitoba Hydro's capital expenditures and increase grid resiliency and grid stability. A lack of improvements to the distribution network are leading to power quality issues throughout Manitoba.

The widespread adoption of solar has begun in Manitoba, and is producing benefits for the rate payers, Manitoba Hydro, the private sector, and the province at large.

2. INTRODUCTION

This paper seeks to provide the most current understanding of the trends occurring in North America and is intended to provide a framework for expanding upon the current successes of solar in Manitoba. Manitoba Hydro's Powersmart division offered a well-designed rebate to incentivize customers seeking to invest in solar for their use. The Powersmart rebate offered customers a $1.00 per watt up to a maximum of $200,000 paid upon the installation of a solar array. This rebate resulted in over 57MW of applications should be considered remarkably successful.

The electrical grid of the future is evolving rapidly, and Manitoba Hydro and the Province of Manitoba are well positioned to capitalize on the opportunities these changes will bring. Solar energy in Manitoba along with varying sizes of energy storage are changing how energy grids operate throughout North America. Solar photovoltaics (PV) is being used for generation, grid stability, and demand management. Both large and aggregated small energy storage is already in use for grid stability, load displacement, resiliency and redundancy.

As the electrification of transportation continues unabated, the demands on the electrical grid are only just now being understood. While it may appear that Manitoba has an abundance of energy coming on-line with the Keeyask dam, it is very likely that this excess capacity will be needed for electric vehicles or may be sold to other jurisdictions as they begin to electrify their transportation.

Compounding the challenges faced by Manitoba Hydro is the ever-present threat of drought. The last significant drought in 2004 cost Manitoba Hydro over $500 million in lost revenues. A drought in 2019 would have catastrophic effects considering Manitoba Hydro's financial position. Thankfully solar is well positioned to provide a significant boost to the drought mitigation strategy for Manitoba Hydro.

Manitoba stands alone in Canada as the only province without a net metering program. Net metering is seen as the bare minimum threshold required to support a growing solar energy market. Net Metering is where the utility operator pays distributed generators, (solar or wind customers), for the energy they produce. Net Metering sets the floor for price paid and establishes a baseline against which private investments in solar can be benchmarked. Net metering has driven the continued uptake of solar in jurisdictions across North America and is seen as complimentary to other financial incentives. Net-metering legislation fundamentally protects stakeholders who invest in solar from actions by the utility or regulator which may harm their interests.

3. BENEFITS OF SOLAR IN MANITOBA

3.1. JOB CREATION

Before the introduction of the Manitoba Powersmart Solar Energy Program Pilot on April 22, 2016, to the best of this author's knowledge, there were three companies delivering solar design and installation services. As a direct result of the rebate, the number of firms in the solar PV space went from three to over fifty Powersmart approved vendors, a 1700% increase. Solar Manitoba for example went from a staff level of two in 2016 to thirty-three, well paid full-time permanent positions, including executives, technologists, administrative staff and journeypersons as of the date of this paper.

The growth of the solar industry from three to fifty firms indicates a sizable pent-up market demand for solar. The appetite from the residential, commercial, industrial and agricultural markets for solar is considerable. Several technical educational institutions in Manitoba are developing related curriculum to support the training of required tradespeople.

3.2. DEMAND SIDE MANAGEMENT

Reports from Manitoba Hydro dating back to the creation of the Powersmart program state demand side management is equated on par with new generation. Several terms relating to utility operations need to be articulated at this time; installed cost per watt ($/watt), and levelized cost of energy (LCOE). The $/watt refers to the total cost of a project, including design, procurement, delivery, construction, commissioning, operations and maintenance, and dividing it by the nameplate capacity. The LCOE refers to the price per unit of electricity expected from a given generation source obtained by dividing the total cost by the total estimated lifetime generation.

Rough estimates comparing Keeyask dam and solar is as follows:

	Keeyask + Bi-Pole 3	**Example Solar PV Project**
Name Plate Capacity	695,000kW	100kW
Estimated Installed Cost	$15,000,000,000	$250,000
$/watt (installed)	$21.58/watt	$2.50/watt
Estimated production (lifetime)	440,000,000 MWh (50 Years*)	4,050 MWh (30 Years)
LCOE	$0.068/kWh	$0.062/kWh

**U.S. army corps of engineer estimate of the lifespan average for North-American hydro-electric dams*

3.3. Participating in the 'Customer-Grid' of The Future

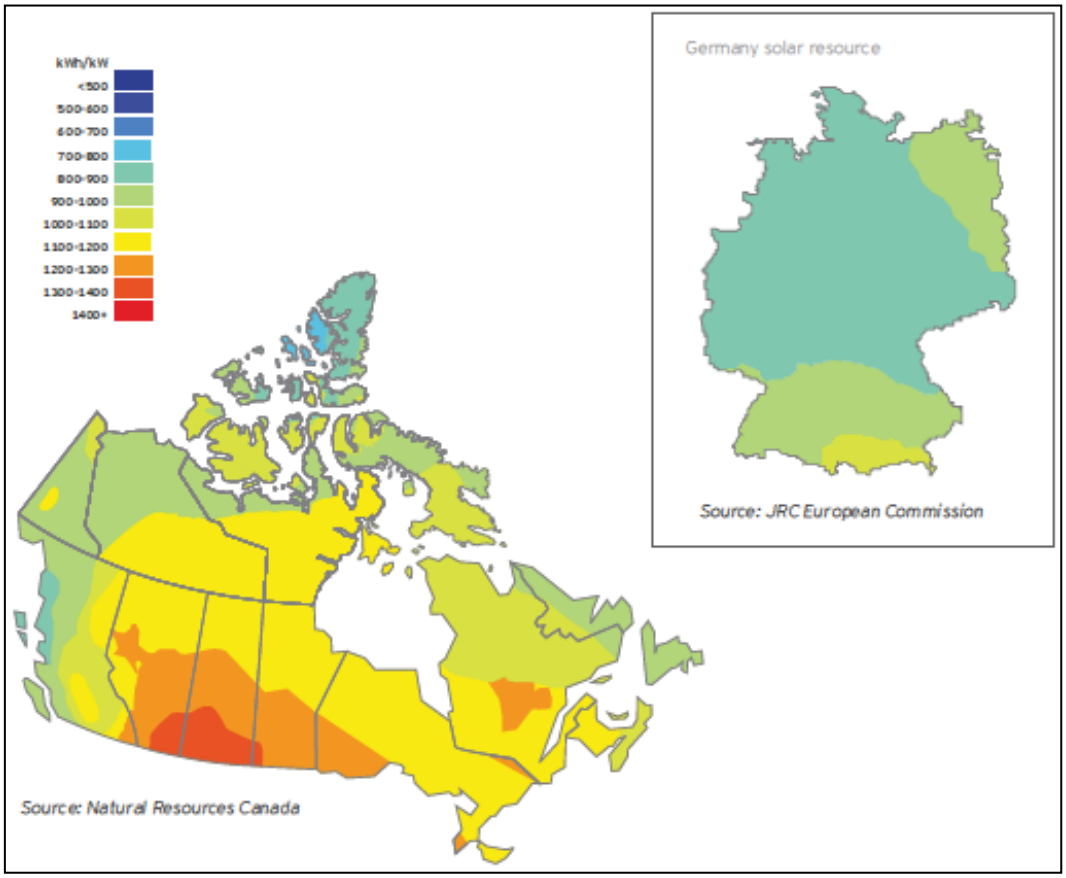
Manitoba Hydro is at a cross roads and has yet to fully internalize the rapidly diversifying energy landscape. While the Manitoba Hydro act provides monopoly status to the utility, there are great number of very disruptive technologies on the immediate horizon. A concept gaining a great deal of traction in the renewable energy space is the idea of the 'customer-grid'. This is a near-future concept wherein utility customers will also become sources of generation and energy storage. In this future a major role for the utility is one of market arbiter for the sale of energy between a generator and a consumer.

The customer-grid is being actualized in states such as California and New York where customers are trading energy credits amongst themselves using block-chain technology. Some customers are also investing heavily into energy storage. Technology firms are developing software to coordinate the buying and selling of energy in response to spot market prices by using the combined energy storage of thousands of electric vehicles. These are only a few of the interesting and potentially lucrative opportunities being presented by solar and storage technologies.

3.4. Capitalizing on Manitoba's Solar Resources

The availability of solar energy striking Manitoba on an annual basis is considerable. The following solar irradiation map does an excellent job of comparing Canada, with its relatively poor solar deployment to date to Germany, which has some of the highest solar pv penetration in the world. Solar penetration is the term used to describe the % of the energy, generated by solar photovoltaics. This map may appear counterintuitive as the Prairie Provinces are considerably colder than British Columbia or Ontario, but solar irradiation is not tightly correlated with air temperature. As a bonus for Manitoba, Solar modules perform better in the cold since heat increases electrical resistance and decreases performance. Subterranean resource maps* are used as part of provincial mining strategies, and solar resource maps should be used as part of provincial energy strategies.

*see image on next page



3.5. Four Off Grid Communities

There are currently four diesel powered communities, Shamattawa, Lac Brochet, Brochet, and Tadoule Lake. These four communities represent an incredible opportunity for Manitoba's solar PV industry to participate in developing diesel mitigation solutions.

These communities are sufficiently removed from access to the current energy grid that building and maintaining transmission lines is cost prohibitive. It is our understanding these communities will remain disconnected from the main Manitoba Hydro power grid, presenting a significant opportunity to develop solar pv alongside storage as the main solution.

Manitoba Hydro has currently chosen to provide electrical services to these communities by way of large diesel generators. 1 L of Diesel generates approximately 3kWh of energy, so at $1.00/L the effective rate is at least $0.33/kWh vs. $0.05/kWh for solar leaving aside the costs of fuel, the maintenance of the generator, and carbon pricing effects. These diesel communities carry considerable logistical challenges for Manitoba Hydro including but not limited to:

1. Ensuring sufficient quantities of diesel is available to maintain services.
2. Re-fueling is almost exclusively carried out via the winter road network.

3. When insufficient diesel is transported via winter road, Manitoba Hydro must send bulk diesel fuel by air at enormous costs.
4. The collapsing winter road season is a direct threat to the continued economic viability of the diesel communities.

Manitoba Hydro has put out several requests for information to mitigate risks associated with energy in the northern communities, but implementation has not been forthcoming.

The Manitoba Hydro Act requires Manitoba Hydro delivery energy services to these diesel communities at the same price as other grid-connected rate payers. This is a legislated subsidy of diesel communities at the expense of Manitoba Hydro ratepayers. There are several exceptions to this subsidy including federal government institutions (nursing stations, and RCMP), and private business (grocery stores) who pay market price for this energy. This very high cost of energy is a direct headwind for economic development in northern Manitoba and ultimately results in higher costs to government and to individuals purchasing goods and services from private businesses.

In addition to some of the highest energy prices in the world, remote communities are also burdened by small market sizes, poor customer liquidity and access to capital. Improving energy security and reducing energy prices for northern communities will bring considerable economic and social benefits.

3.6. First Nations Environmental Stewardship & Economic Engagement

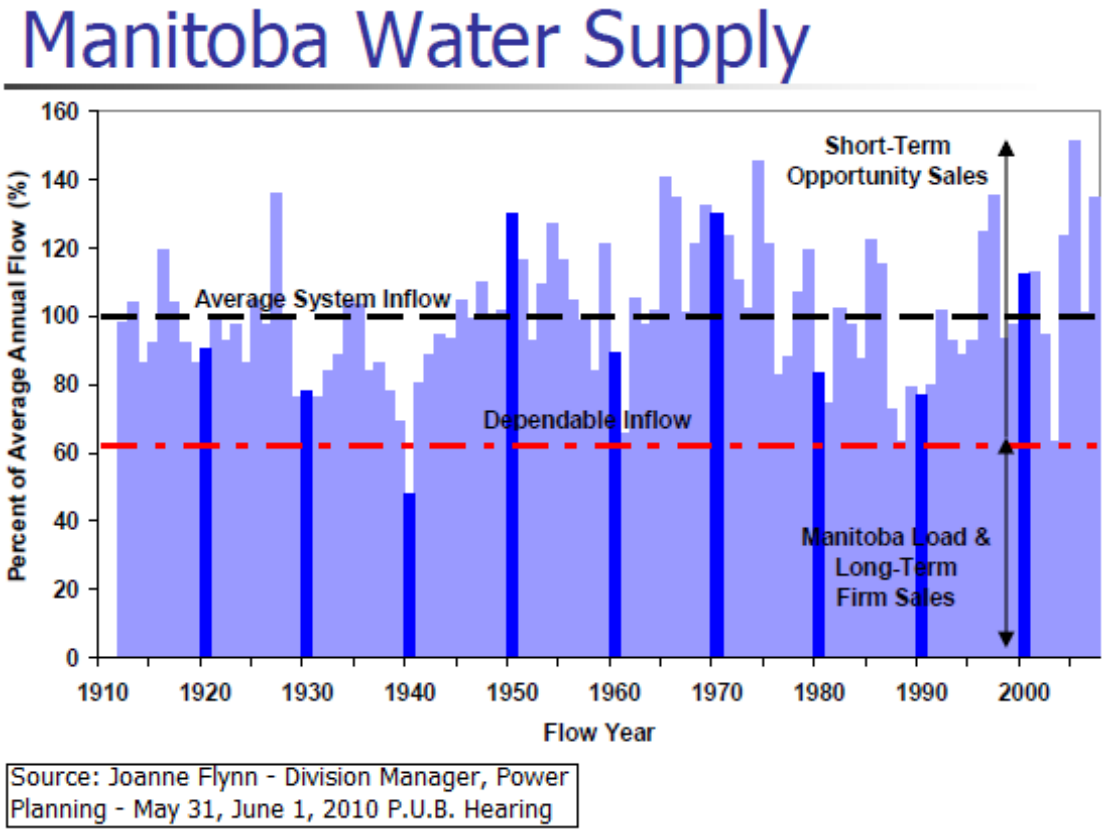
Having environmental stewardship embedded in their culture, Manitoba's First Nations are well positioned to be part of the future of solar PV in the province. With a young and growing population, along with access to capital and debt for entrepreneurs, First Nations have a strong potential to create businesses, increase employment, and contribute considerably to Manitoba's economy through the solar PV markets. Increasing access to opportunities presented by Solar should be a critical part of the engagement strategy with Manitoba's First Nations.

3.7. Drought Preparedness

With the bulk of the generation assets hydro-electric dams, Manitoba Hydro has a high level of risk exposure to the quantity of water in its river systems.

Publicly available data suggests the drought of 2004 caused Manitoba Hydro a loss of $436 million in revenue, equating to $554 million in 2018 inflation-adjusted dollars.

Pictured below is a graph showing water levels for the past 100 years, and Manitoba Hydro's assumptions around these water levels. The 2004 drought can clearly be seen on the graph. Note this drought level matches the "Dependable Inflow" level. It is striking to consider Manitoba Hydro to use a loss producing drought level as dependable inflow. Given Manitoba Hydro's relatively shallow dam construction, the ability to reserve water from one year to another is limited.

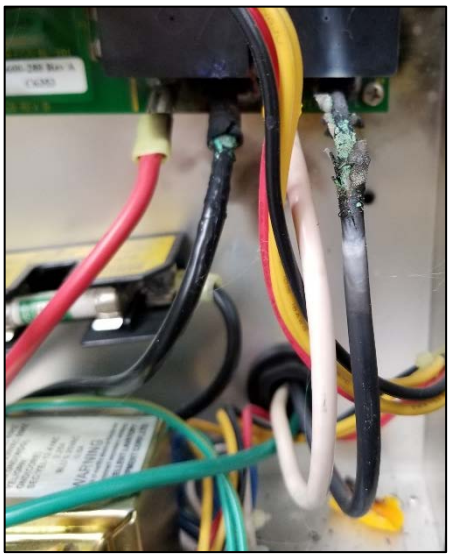


Source: Joanne Flynn - Division Manager, Power Planning - May 31, June 1, 2010 P.U.B. Hearing

Every unit of solar installed on the Manitoba Hydro grid is one less unit of water that needs to be released from a dam. Solar has a direct impact on mitigating Manitoba Hydro losses from drought. Given Manitoba Hydro's "razor-thin margin for error" according to Manitoba Hydro CEO Kelvin Sheppard in a February 17, 2017 interview, reducing the damage from a moderate-probability, high-impact event is a wise course of action. The installation of solar, the diversification of the generation mix, and the drought-risk mitigation will presumably all bode well with credit rating agencies.

3.8. Grid Resiliency

The U.S. National Infrastructure Advisory Council (2009, 8) defines critical infrastructure resilience as: "…the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event."



There are a variety of locations on the Manitoba Hydro grid that experience voltage and frequency irregularities. Simply put, there are dark spots on the Manitoba Hydro distribution network that do not experience the level of power quality that other areas enjoy. The issue with voltage and frequency fluctuations is the actual, and measurable, damage to sensitive electronics. Residences experience voltage spikes that cause damages to hot tub circuit boards with a cost of $1000 to replace, and businesses suffer spikes that can damage industrial machines worth millions. Farmers suffer damage to grain drying motors that potentially threaten an entire season's crop. The damage currently suffered by Manitoba Hydro due to power quality issues is real and growing as the demands on the grid increase.

It is important to highlight this is not an issue of the amount of power available from the generating stations or on the transmission lines, but rather a real-time failure of the distribution network. The distribution network is the small wires that take electricity from the substations to homes and businesses across Manitoba.

Solar has the unique property of providing a power correction factor. Older solar PV inverters would have trouble with providing the reactive power component of their output, which would result in a degrading of the power factor, however current inverter technology incorporates reactive power control, which results in an increase to the grid stability. Simply put, more distributed solar generation resources on a grid has an additive effect on the power quality of the grid. A farmer who installs solar would be smoothing the grid out for the neighboring farms.

3.9. Deferred capital expenditures

An increasing amount of solar PV on the grid, especially when it is distributed generation >500kW, results in a decreasing capital expenditure from Manitoba Hydro. Simply put, solar saves Manitoba Hydro capital expenses.

At present, Manitoba Hydro has made major capital expenditures in the generation and transmission portions of their energy infrastructure, to the detriment of the distribution

network. Distribution networks are not as flashy as large generating stations, or expansive transmissions lines, but are nonetheless crucial for safe and profitable operations of a vertically integrated utility.

Solar pv adds stability to the grid, along with reducing demand on the substations, transformers, switches, and capacitors in the distribution system. This reduction in loading on the distribution system allows Manitoba Hydro to delay, or defer, the required upgrades by 5-10 years according to most estimates. The value of deferring these upgrade costs cannot be overstated!

3.10. Leverage Private Investment: Triple P

The current grid-tied solar PV systems are a shining example of a public-private partnership. Private capital, on private land has been used to install solar PV systems for the benefit of both Manitoba Hydro and the given land owner. These land owners have sacrificed a portion of their capital and property to install a mini power plant that not only reduces their electrical consumption, but also occasionally over-produces allowing Manitoba Hydro to sell that excess electricity to neighboring properties through their distribution system. In addition to the retail sale of additional electricity, Manitoba Hydro also benefits from a reduced demand on the distribution network, and a reduced demand on capital investment required to upgrade and maintain the distribution system. When the issue of drought preparedness is added to the equation, Manitoba Hydro has benefitted enormously from the increased penetration of solar PV systems into their grid.

3.11. Manitoba: Centre of Excellence

Sycamore Energy Inc. launched an initiative several years ago to encourage the development of an initiative which would see Manitoba become a Centre of Excellence for Sustainable Energy & Green Technology. The economic benefits of this Center of Excellence will be significant. Of greatest significance will be the creation of an ecosystem that generates companies, investments, jobs, and profits relating to Sustainable Energy and Green Technology. Many of the components of this ecosystem are in place, including the academic resources, the applied research facilities, and a world class utility (MB Hydro). Please see Appendix A for further information.

4. Market Experience with Manitoba Hydro Solar Rebate

4.1. Description

On April 26, 2016 Manitoba Hydro's Powersmart announced a 2-year Solar Energy Program (SEP) pilot. This pilot provided a purchase rebate of $1.00/watt (DC) to customers who chose to purchase solar arrays. Powersmart limited the rebate value to the size of solar array needed to meet the customer's energy load on an annualized basis. The rebate value was set between $1,000 to $200,000, or a 1kw to 200kw system size. The rebate could be assigned to the customer or to the contractor and was paid out upon completion. See Appendix B for a screenshot of Manitoba Hydro's website describing the solar energy program.

4.2. Design considerations

The rebate was designed after reviewing the financial incentives provided by various other jurisdictions. Some jurisdictions, such as Ontario, offered a feed-in-tariff where the utility would enter into a long-term power purchase agreement and pay a premium price for the solar. This style of incentive may distort the energy market since this premium must be compensated by the rest of the rate payers. Tax credits, which are used in some jurisdictions, were not available to Powersmart as it is not a tax collecting agency. The decision was made to provide a purchase rebate, like other programs Powersmart has run, including replacing windows and improving a building's insulation.

4.3. Successes

4.3.1. Job creation

The exact number of jobs created through the rebate program is difficult to pin down, however the number is likely in the hundreds. These are well-paying permanent, full time positions that contribute considerably to the Manitoba economy.

4.3.2. Environmental credits

Through very insightful design, the Powersmart rebate requires the end user to assign all current and future environmental credits to Manitoba Hydro. The value of these credits carries little tangible value at the time this paper was written, however these credits may soon carry value. Through a clause in the customer's solar contract, Manitoba Hydro has secured these environmental credits in perpetuity.

4.3.3. Training & Education for Manitoba Hydro Staff

Prior to the solar energy program, Manitoba Hydro had very limited experience with solar. Most of the institutional knowledge relating to solar would likely have remained within the Office of the Fire Commissioner, as the jurisdiction having authority for off-grid energy projects. With the successful completion of the pilot, Manitoba Hydro and Powersmart are now very familiarity with solar, its design, inspection and commissioning and are now equipped with processes to manage future solar installations.

4.4. LESSONS LEARNED

The Manitoba Powersmart Solar Energy Program pilot project has been met with several challenges. Identifying those challenges and determining means of overcoming them is presumably one of the major objectives of this pilot project. The following is a summary of the challenges from Sycamore's perspective.

4.4.1. Lack of Awareness

At the outset of the pilot project the industry was informed that Powersmart was not going to advertise this rebate project to the public. This advertising void has caused the market to evolve in very unusual ways with market education left to private, for-profit, corporations to deliver to the public. As a result, there has been a great deal of misinformation provided to customers, which has caused market distortions.

4.4.2. Asymmetry of Access to Opportunity

It is typically incumbent upon a government agency to ensure, to a reasonable degree, a level playing field for the market. An unusual aspect of this lack of public education from Powersmart has been where the pilot project uptake has occurred. For a variety of reasons, the clear majority of Sycamore's customers both in terms of quantity and size of systems has been in the agricultural sector. This has led to residential and commercial customers largely being shut out of an opportunity to significantly improve the economic future of their home or business.

4.4.3. Pre-Rebate Preparation within Manitoba Hydro

From our discussions with front-line staff at Manitoba Hydro, Hydro employees were made aware of the solar energy rebate at the same time as the public. The general lack of awareness at the ground level in Manitoba Hydro led to a great number of delays and confusion surrounding the deployment of solar energy under the pilot project at the outset. Sycamore has lost count of the number of educational conversations it has had with electrical inspectors and planners regarding how an industry standard solar installation should occur. To the best of Sycamore's knowledge Manitoba Hydro's policies and staff education regarding solar PV were only finalized on August 1st, 2017. To their credit, Manitoba Hydro's front-line staff have generally been very professional to work with throughout the entire learning process.

4.4.4. Conflict with the PUB Ruling

At present the Public Utilities Board and Manitoba Hydro disagree regarding the rate paid to consumers who contribute solar to the grid. On January 19, 2018 Manitoba Hydro committed to purchase excess solar energy and committed to a given rate depending on when in the rebate program the participate entered. See Appendix C for Manitoba Hydro's policy announcement relating to excess solar generation. The rulings described below, and the changing rate paid for customers at the outset of the pilot program compared with those after January 29, 2018 represent market confusion and potential risk to stakeholders who have invested in solar PV.

On May 1, 2018 PUB ruling 59/18 (19.1) states "The Board is concerned that Manitoba Hydro implemented the Solar Energy Program with a rate for excess solar energy without prior Board approval", and "While Manitoba Hydro ultimately pays the cost for the power, this does not detract from the fact that Manitoba Hydro is setting the price for the supply of a particular form of power. Therefore, the price for customer-generated solar power is a "rate for service" subject to the Board's review and approval under The Crown Act."

On July 18, 2018 PUB Order No. 90/18 4.0 states "Excess Energy Purchase Rate - Directive 7 of Order 59/18 directed as follows:
IT IS THEREFORE ORDERED THAT:

> *7. Manitoba Hydro credit net-metered customers' excess energy put on the grid at a rate of 8.196¢/kWh for 2018/19. Manitoba Hydro must apply to the Board for approval of any future net-metered rate or changes to the 8.196¢/kWh rate.*

Directive 7 resulted from the Board's conclusion that it has legal jurisdiction to review and approve the electricity rate Manitoba Hydro applies to customers participating in the Solar

Energy Program, or to customers with any on-site generation, for the return of excess energy to the grid. The Board expressed concern that Manitoba Hydro implemented the Solar Energy Program with a rate for excess solar energy without prior Board approval." and,

"As a result, unless and until the Board exercises jurisdiction in this area after a full canvassing of the evidentiary and legal issues in a future proceeding,
Manitoba Hydro will continue to set the rates it provides to Non-Utility Generators under its Non-Utility Generation policies and/or contractual arrangements."

4.5. Future Market Incentives

The Made-in Manitoba Climate and Green Plan has proposed uses of the federally imposed introduction of the carbon-pricing model. One use of those funds that would benefit the province and Manitoba Hydro considerably would be the re-introduction of a solar PV incentive.

The incentive should be designed in such a way where the full benefits to Manitoba Hydro are calculated in the rate setting. The two main mechanisms of purchase incentive in the solar PV sector are a $/watt purchase subsidy, or a percentage of project cost. Both have their merits, however setting the incentive as a percentage of project cost creates a greater administrative burden, and leaves some price uncertainty to the customer, as there are inevitably price adjustments to the final price of a solar PV construction project due to unforeseen circumstances. A $/watt incentive provides price certainty to the customer and the installation contractor.

4.5.1. Ratchet-Down

The solar energy market in Manitoba is in a very unusual situation at the time of this paper. Having grown exponentially over the past two years on the strength of a purchase rebate, the market was responding to price signals that indicated growth. So far as we aware there aren't any examples of a solar incentive being introduced and then eliminated full-stop. Every other example of a financial incentive in the renewable energy space, including the Manitoba incentive related to geothermal, has included a predictable and prolonged ratchet-down withdrawal. Should Manitoba consider an incentive in the future it must include a pre-designed ratchet-down period so the product providers, and customers can adjust to predictable price changes.

4.5.2. Qualified Contractors

Manitoba Hydro will also be well served to consider a more stringent vetting of participating solar installation contractors. The previous Powersmart incentive only required the vendor to sign an agreement to be bound by several terms and did not include any performance guarantees or prior qualifications. One option to consider is Canadian Solar Industries Association's contractors' guideline. CanSIA has developed an updated, robust and comprehensive Solar Business Code of Conduct, Complaint Resolution and Disciplinary Process, and a Going Solar Guide for consumers.

Companies seeking to become a Qualified Solar Vendor for the purposes of the rebate program could be required to become CanSIA members, submit required documentation to CanSIA and comply with CanSIA's Solar Business Code of Conduct. The vendor would be

required to complete an online training course offered by CanSIA and would enter into a participation agreement. The responsibilities of the Qualified Solar Vendor would include:

- Assessing the site (roof or ground) for suitability for solar;
- Estimating the total expected annual production of solar system;
- Submitting application rebates to the Solar Energy Program;
- Obtaining all required permits;
- Designing, procuring, installing the system; and,
- Coordinating Manitoba Hydro, or City of Winnipeg, inspection and interconnection.

4.5.3. Proper Advertisement

The Manitoba Powersmart solar incentive was introduced to the market via a press conference on April 22, 2016. Following that announcement there was no notable mention of it again by Manitoba Hydro or Powersmart. While there was a description of the program on the Powersmart website (Appendix B), there was no advertising for the program whatsoever. This lack of official communication led the market to advertise the program to prospective customers on its own. This market-led advertisement of the program had several unintended consequences. The first being misinformation from vendors to customers, which resulted in a tremendous amount of confusion forcing Manitoba Powersmart staff to spend time clarifying. A second unintended consequence was how the market was divided by vendors interested in pursuing a section of the market rather than the market as a whole. This market segmentation created several distortions including a lack of transparent pricing, and some potential customers being entirely excluded from participating simply because a vendor chose not to advertise to them. The commercial and industrial sectors in Manitoba are one such example of a market that mostly missed the opportunity to reduce their operating expenses using the solar pv financial incentive. This lost opportunity is a direct contributor to rising operating expenses for Manitoba's commercial and industrial sectors who missed an opportunity to improve competitiveness.

It is strongly recommended that future incentives receive consistent levels of advertising from the relevant administrators, presumably Efficiency Manitoba. Official advertising will also allow the full-spectrum of potential customers to benefit from the program rather than only those participants targeted by vendors.

4.6. SOLAR & STORAGE

Solar and energy storage has the capacity to significantly improve grid operations, reduce Manitoba Hydro's capital expenditure, and decrease operations and maintenance costs.

Combining solar and storage can provide reactive Support and voltage control service to the grid. Reactive support and voltage control service can be contracted from generators and allows the electrical system operator to maintain acceptable reactive power and voltage levels on the grid. Reactive power flow is needed in an alternating-current (AC) transmission system to support the transfer of active power over the network. All generating facilities that are injecting energy into Ontario's IESO-controlled grid are required to provide reactive support and voltage control service in accordance with the market rules, which Manitoba currently lacks. Examples for drivers of the increased need for regulation service are described in the 2016 IESO Operability Assessment Summary.

Energy storage has the potential to yield the following benefits:

- Peak shaving (demand side management)
- Capacity firming
- Deferred upgrade costs for Manitoba Hydro
- Ramp Rate control for utility scale solar projects

Frequency modulation, especially for the end of line customers

4.6.1. Behind the Meter

Behind the meter refers to the placement of the energy storage system relative to the utility meter. Those systems considered behind the meter are located on the customer's property and mainly serve their energy needs.

Manitoba Hydro stands to benefit from behind the meter energy storage as it can absorb excess solar generation, providing a stabilizing effect on the grid, but more interestingly behind the meter storage system can be linked together and controlled by Manitoba Hydro to provide on-demand energy into the grid for a variety of purposes. The largest such distributed energy storage system is the "Sonnen community" in Germany, with over 30,000 individual battery systems under the partial control of the grid operator.

4.6.2. Residential

Residential energy storage systems are mainly focused on energy back-up (resiliency). Customers either focus on critical systems back up, i.e. fridges, lights, and furnace motors, or whole system back up where their entire home will continue normal operations in the event of a grid-failure.

4.6.3. Commercial & Industrial

In addition to the two uses described above, the C&I sector is also very interested in peak shaving, to reduce or eliminate demand charges. A decrease in the demand requirements from the C&I sector will also save Manitoba Hydro by reducing the operating reserve requirements. Certain C&I customers would also benefit from the grid-smoothing effects of energy storage systems.

4.6.4. Utility Energy Storage

Utility size energy storage systems are rapidly declining in price, with some price estimates around $1.00/watt for the storage systems. Utility sized storage has tremendous potential benefits including grid resiliency and grid stability, including replacing the Brandon natural gas Peaker plant, which may be a considerable source of carbon emissions in Manitoba Hydro's otherwise sterling portfolio of renewable energy resources.

5. POLICY CONSIDERATIONS

Sycamore would like to propose the following policies for consideration and further research by analysts. These are policies that are specifically aimed at the Manitoba economy that are used successfully in other jurisdictions and will improve the functioning and financial position of Manitoba Hydro.

5.1. RESOLVE CONFLICT WITH P.U.B. RULING

As described above, commitments made by Manitoba Hydro's Powersmart under the Solar Energy Program stand in direct conflict with the recent P.U.B. ruling. This conflict has a material impact on the value of the investments made by Manitobans. 57MW of solar has been applied for under the program, this represents a $57 million-dollar investment from Manitoba Hydro, and approximately $100 million from the private sector. At the root of the conflict is the price paid for excess solar energy. The Solar Energy Program was intended to bring customers to net-zero. Net-zero is loosely defined as having the annual load (energy needed) balanced with the annual generation (energy generated). It is not possible to match Solar production with the instantaneous load profile, meaning there will be times of excess generation and times of energy purchase from the grid within any given day, most obviously at night. For this reason, the price paid for excess generation has a very important effect on the overall economics of the solar PV systems installed under the solar energy program.

5.2. VIRTUAL NET-METERING & TRADITIONAL NET-METERING

The most straightforward resolution to resolve the impasse between the P.U.B. and Manitoba Hydro is to implement net-metering legislation. Net-metering in its simplest form is the idea that a customer's electrical meter can spin in either direction and Manitoba Hydro bills for the difference between generation and consumption. When the customer is meeting their local energy needs, and excess is being fed to the grid, the meter spins backwards and the customer receives a credit for the energy generated. When the sun goes down the meter begins to spin in the usual fashion and the customer is billed for the energy consumed.

Manitoba is the only province without a net-metering program. There are many examples of successful net-metering programs in Canada and throughout the U.S. which can serve as templates for consideration.

Net-Metering legislation is a minimum requirement for Manitoba to have a foundation for future solar energy programs. Without net-metering, the utility is free to set, and change without notice, the price paid for excess solar energy generation.

5.2.1. Virtual Net-Metering

Virtual net-metering is a bill crediting system for community solar pv projects. Under a virtual net-metering program the utility credits a customer based on the proportion of a community solar project they own. The current solar energy program is biased towards those land owners with enough land or roof space for a solar array. Those industrial customers with limited space but large energy needs, or residential customers who live in apartment or condominiums, are excluded from benefiting from solar simply due to the space requirements. Other examples of successful virtual net-metering are rural municipalities capitalizing on their unused real-estate to provide community benefits. Rural municipalities have the opportunity through virtual net-metering to use spare land for solar, contribute to their financial well-being, and most-importantly reduce their financial requests to the province.

Virtual net-metering levels the playing field for all customers regardless of their access to enough land or roof-space and is currently in use throughout North America.

5.3. Renewable Electricity Standard

An additional piece currently missing from Manitoba's The Made-in Manitoba Climate and Green Plan is a renewable electricity standard on par with other North American jurisdictions. A renewable energy standard is defined as a mechanism placing an obligation on electricity supply companies to produce a specified fraction of their electricity from renewable energy sources. A renewable electricity standard would legislate Manitoba Hydro to continue to pursue generation from non-hydroelectric sources. This pursuit of non-hydroelectric sources will contribute to drought mitigation described above.

In 2015 the National research energy laboratory stated:

"Combining RESs with Other Actions to Ensure a Robust and Effective Policy Environment. Renewable electricity standards are often developed as one element of broader renewable energy policy packages that can include other critical elements such as provisions to ensure renewable energy grid access, establishment of project finance support mechanisms (e.g., power purchase agreements), and the design of complementary policies (e.g., feed-in-tariffs, tax incentives, and net metering). Renewable electricity standards can also work in conjunction with climate policies, such as carbon cap and trade systems (Bird et al. 2010). Evaluating interactions across policies is also critical and can be supported by some resources highlighted below. Developing robust renewable energy support packages can help both ensure long-term sustainable outcomes and achieve broader policy goals. For instance, in the United States, combining RESs with federal production tax credits has supported a broader enabling environment for renewable energy in several states."

5.4. Billing – Time of Use

Time of use billing is common in many jurisdictions and is the application of varying rates to energy based on the time of day the energy is consumed. This policy accommodates for the additional costs Manitoba Hydro needs to bear to meet best practices for energy utility operation. Usage at peak periods costs more for the customer, and usage at off-peak periods cost less. This policy will encourage conservation and permit Manitoba Hydro to recover costs associated with the spinning reserve. This policy will require the wide-spread installation of smart meters, but these costs will be made up for through improved billing revenues and decreased operating expenses.

5.5. Billing – Power Factor

Manitoba Hydro would be well served to consider billing customers for their power factor. B.C. Hydro defines power factor as "the ability of your electrical system to convert electric current into useful work such as heat, light, and mechanical motion. To use electrical power efficiently your system should draw mostly real power, measured in kilowatts (kW), from our system. If your equipment draws too much reactive power, measured in kilovolt-amperes-reactive (kVAR), it can't perform work as efficiently and limits the capacity of our lines to deliver real power and quality voltage to your facility." Also noted by B.C. Hydro is "Poor power factor at your site can cause voltage fluctuations and power quality issues for neighboring facilities, which negatively affects their equipment. It also limits the capacity of our lines to deliver energy to you and to our other customers. To counteract these effects, we need to install capacitors on our system to use our lines efficiently and to maintain power quality for all customers on the line."

Solar + Storage provides a solution to those customers with poor power factor, and, as described above, is excellent alternative to capital expenditures from Manitoba Hydro to upgrade their grid.

5.6. Building Codes

While outside the purview of Manitoba Hydro, establishing and updating building codes certainly is within the mandate of the Manitoba Government. At present building codes are moving quickly towards the integration of solar and energy conservation into new and upgraded buildings. Upgrading the building codes to reflect best practices in solar + energy conservation will have a direct result in the total carbon emissions from Manitoba and will result in considerable savings for Manitoba Hydro and the Manitoba tax payers.

California for example has updated the building code to require solar pv systems in all new construction. Greentech Media reports "The new rules apply specifically to all new residences and major home renovations on buildings under three stories, starting on January 1, 2020. In the event a building isn't suitable for a rooftop array, the standards

require homes have access to community solar or offset energy usage through additional efficiency gains, while some homes may be exempt."

5.7. Establishment of an Ancillary Services Market Similar to the IESO in Ontario

From the Ontario ISEO website, "The IESO contracts for four ancillary services to help ensure the reliable operation of the power system: certified black start facilities, regulation service, reactive support and voltage control service, and reliability must-run." The ancillary services market provides the vehicle through which the private sector can facilitate successful grid operation while reducing Manitoba Hydro's capital expenditure associated with these services. Since Manitoba Hydro is currently a vertically integrated utility, this ancillary services market is as yet undefined in Manitoba. The lack of ancillary services market in Manitoba is placing undue hardship on Manitoba Hydro's capital budget, along with resulting in poor power quality to large sections of Manitoba Hydro's ratepayers.

5.8. Jurisdiction Review Resources

CanSIA has excellent resources relating to jurisdiction review including, but not limited to, Distributed Generation Task Force - Recommendation Report - March 17, 2016 - www.cansia.ca

APPENDICES

APPENDIX A

SEnergy Manitoba: Centre of Excellence in Sustainable Energy

Where did we come from?

Started as an idea and LinkedIn post by Justin Phillips on November 26, 2015. The idea caught the attention of people from a broad spectrum of interest who want to push it forward.

What will we do?

Create an ecosystem that generates companies, investments, jobs, and profits relating to sustainable energy in Manitoba

Why must we exist?

To bring the elements of the ecosystem together: government, business, venture capital, academics, applied research, utilities, NGOs, etc.

Name

The name: **SEnergy Manitoba:** ***Centre of Excellence in Sustainable Energy*** captures most of the key ideas that were brought forward in our general and strategic planning meetings.

- "**SEnergy**" is a concatenation of "Sustainable" and "Energy". We recommend this name as capturing the essence of what we represent without being an acronym.
- "**Energy**" is the element that we all have in common. Other alternatives like "clean tech", "wellness", "well-being", "sustainability" seemed to be too broad. To achieve results, we need focus.
- We choose to use "**sustainable**" rather than "renewable" because it connects to sustainability. Sustainable development includes the three pillars of environment, economy, and community/society and therefore, brings in some of the intent of the alternatives above.
- "**Centre of Excellence**" is the term that brought us together. It is an exciting term - positive and inspiring. "Centre of Excellence" is consistent with the ideas of a "hub" or a "gravity well".

Purpose

The purpose of this initiative is to develop Manitoba's reputation as a Centre of Excellence in the sustainable energy sector.

Manitoba has many of the necessary pieces to be a Centre of Excellence in the production and delivery of sustainable energy. There is a wealth of innovation in the business sector, significant government interest, and engaged not-for-profits. The critical mass of knowledge and abilities to have a truly sustainable energy industry in Manitoba is nearly here.

Scope

We focus on aspects of **sustainable energy:**

Supply-Side Management

- **GeneraBon** - Increase the supply of energy from renewable / sustainable sources
- **Storage** - Ways to store energy until needed
- **Smart Grid** - Way to manage and balance generation and demand.

Demand-Side Management

- **ReducBon** - Encourage people to choose to use less energy
- **Efficiency** - Increase efficiency in our use of energy. Use less to get the same result

Vision

These statements reflect what members believe we should be moving towards:

- To be the place people look to for sustainable energy information and connections
- To be a catalyst for adopting sustainable energy in Manitoba
- For Manitoba to be a leader in sustainable energy

Mission

Enhance sustainable energy by fostering information, connections, development, and commercialization.

- facilitate growth within the industry in Manitoba.
- commercialize the sustainable energy sector
    - Identify relevant stakeholders
    - Facilitate meetings between these stakeholders.

Core Activities

Gather / Create Information and Knowledge

SEnergy wants to be the "go-to" organization for sustainable energy technology and knowledge in Manitoba.

- **Build a repository of Information** about sustainable energy as it pertains to Manitoba. This information might include these elements:
    - **Players** - Build an inventory of players (contractors, researchers, funders, incubators (e.g. Eureka project, North Forge)
    - **Research** - Collect and link to research that has been done / is ongoing in Manitoba or that would relate to Manitoba's reality. Commission or conducting independent research
    - **Projects** - Identify projects underway or completed that we may learn from.
    - **Policy** - Efforts with respect to policy will be in three areas:
        - **Research** to identify relevant and applicable policy and legislation here and in other jurisdictions.
        - **Development** of alternative policy or determination of recommended policy.
        - **Advocacy** for policy.

Mobilize information and connections

We need to share information both within our organization and with the broader community. Make the information accessible. Communicate. Generate interest.

- **Branding & marketing** - Create a logo, brand, message, and marketing strategy.
- **Website** - Build and maintain a website.
- **Educate** - Create an education program with speakers and courses.
- **Events** - Develop networking and educational events.

Put information and connections to work

Create an ecosystem (Gravity well, Hub) to foster development and commercializa4on, networking, and connections. Encourage implementation. This is where
Networking / Coordination / Sharing / Partnership building happens. We want to make a visible difference. Success is measured when the wheel is turning, the ecosystem is alive.

- **Business development -** Facilitate the commercialization of research. This may include finding venture capital.
- **Linkages** - Develop local and international linkages. Sharing and partnership building within Manitoba and then exporting to Canada and the world.
- **Mentorship** - Develop a network connecting newbies to mentors.
- **Pool resources** - Pool existing resources and develop some necessary shared resources (time, expertise, capital)

Timeline

The initiative would have a **five-year mandate** to accomplish this goal. A five-year mandate adds the **urgency** of time to capitalize on this opportunity and provides a **clear end date** to ensure interest in the work of this initiative remains high.

Metrics

A clear measurable metric will need **to be determined** to gauge success. This metric should be discussed by the steering committee as a whole and could include job creation in the industry, industry revenue, etc. The chosen metrics should be easy to measure and quickly grasp in order to facilitate communication of success to stakeholders.

Basic Resources Needed

For staffing, an organization of this nature would ini4ally require a leader and one or two staff to assist with administrative tasks, research, and scheduling.

Leadership - We need a senior executive who has experience in starting organizations and has been involved in the sustainable energy sector.

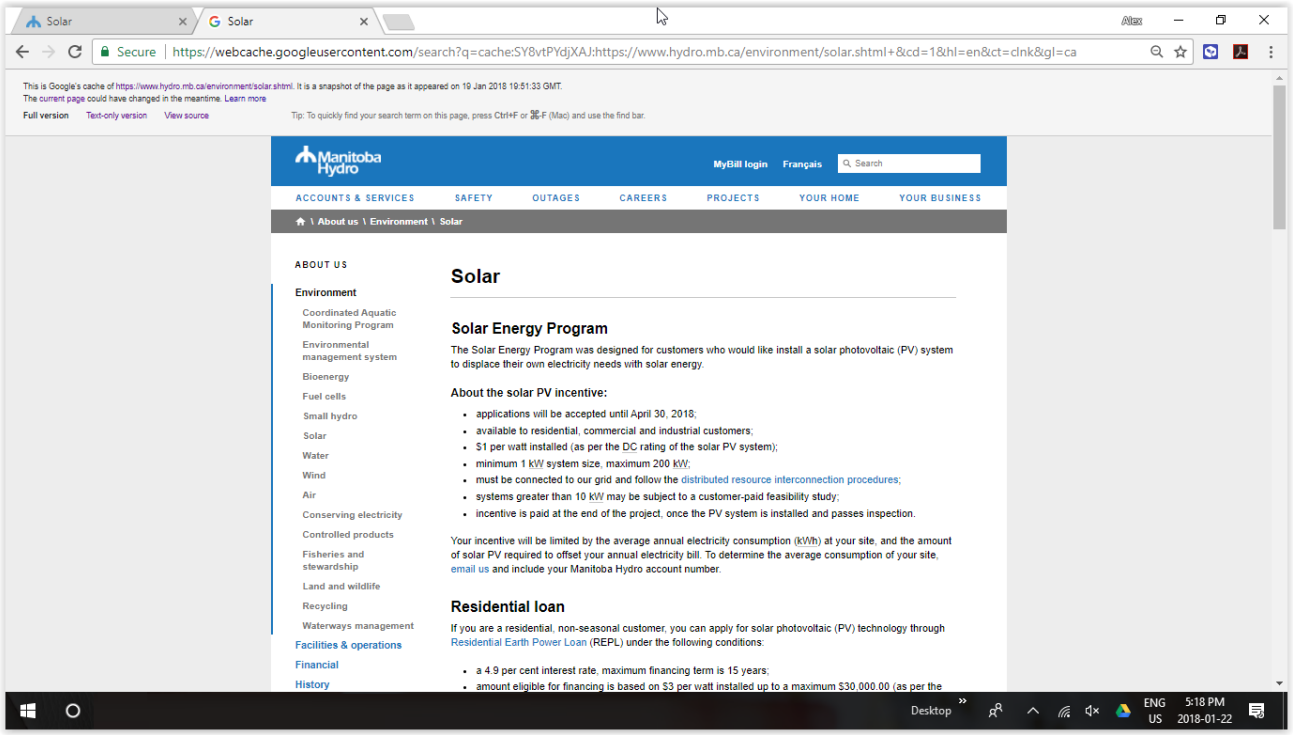
Ideally, the chosen leader would be tasked with securing funding for the initiative. Based on the proposed mandate, funding could be sought from the Provincial and/or Federal government, Manitoba Hydro, and corporate sponsors.

Membership

We need to be inclusive. We need to enlist all interested agencies and encourage and facilitate working together.

APPENDIX B

Solar Energy Program



APPENDIX C

Manitoba Hydro's External Communique Relating to the Solar Energy Pilot Program

EXTERNAL COMMUNIQUE

Notification for Solar Energy Pilot Program

Manitoba Hydro's two-year pilot Solar Energy Pilot Program is coming to an end and will stop accepting new applications effective end of day (11:59 pm) April 30, 2018.

The Solar Energy Pilot Program (SEP) was announced April 22, 2016 as a two-year pilot offering financial support for home and business owners to adopt solar power, to allow Manitoba Hydro to learn more about how customer-owned solar PV systems interconnected with Manitoba Hydro's system. The SEP was offered to better understand the procedures and systems required to support solar energy, to understand current market pricing and to gauge customer adoption. This information will be used by Manitoba Hydro to formalize its future processes for non-utility generation systems.

Applications will only be accepted for review and approval if ALL required documentation is included. Please refer to our website for all required documentation: www.hydro.mb.ca/solar.

Manitoba Hydro reserves the right to decline applications that do not include all required documentation for pre-approval. As well, if the scope of work is significantly altered after the application has received initial approval, Manitoba Hydro reserves the right to deem the application ineligible for the Incentive.

The completion date for installation of pre-approved solar photovoltaic (PV) systems will be extended to March 31, 2019 to allow installers and customers to obtain permits, to complete installations and inspections, and to process payments. Please refer to our website at www.hydro.mb.ca/solar for all required documentation.

In addition, the data gathered through the SEP will be provided to Efficiency Manitoba as it explores the most cost-effective way to meet the province's energy savings targets.

Important Changes to Purchase Rate for Excess Energy

Effective April 1, 2018, the purchase rate for energy in excess of site load sold to Manitoba Hydro from non-utility generators such as customer-sited wind or solar photovoltaic installations, less than 200 kW will be $0.0325 per kWh. This change applies to the energy generated that is in excess of the customer's own annual electricity requirements. The revised purchase rate is based on the average annual

price determined at Manitoba Hydro's MISO pricing node and reflective of the value of that energy to Manitoba Hydro. This price will be reviewed on an annual basis going forward.

For installations made prior to this date or any application received through the Solar Energy Program by April 30, 2018, customers will be offered the ability to fix their purchase rate for energy in excess of site load at the current applicable run-off rate. This grandfathered rate option will be effective until April 1, 2023, at which time it will be re-adjusted to the current market-based purchase rate. For residential customers, the grandfathering option would be fixed at $0.082 per kWh and for commercial customers the grandfathering option would be fixed at $0.0394 per kWh.

A communication to all customers eligible for the grandfathering purchase rate option will be forthcoming.

Continuation of Earth Power Loan

The Earth Power Loan program will continue to provide on-bill financing for homeowners wishing to install solar photovoltaic systems.

If you should have any questions, please contact earthpowerinfo@hydro.mb.ca.

Thanks again for your continued support!

Kind regards,

Solar Energy Program Team