Understanding the Factors that Shape Solar Electricity in Alberta

With lesson’s learned in Ontario

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Introduction

Solar businesses must be conscientious of the locally applicable market tools and signals available for success in Alberta. Alberta is a province that leads the country in per capita investment[1] and is in a unique position in relation to growth in this sector: over the next few decades, Alberta will require over 7000 megawatts of new power.[2] However, while energy demand is predicted to increase, 85% of the Province's coal plants are planned for decommissioning.[3] Aging infrastructure, as well as pressure to reduce emissions, are giving Alberta the opportunity to take advantage of alternative energy sources, such as wind and solar. Alberta's economy is highly dependent on oil and gas production, which has slowed substantially within the last year due to low oil prices and the resulting recession. A new provincial government has also taken power within the last year and has unveiled its energy strategy, supporting the transition toward alternative and renewable energy. The strategy includes phasing out Alberta's coal plants; converting to renewable energy; creating an energy efficiency program; and putting price on carbon.[4] The transition toward increased use of alternatives in Alberta will stem from the combination of both new regulation and market signals to incentivize alternative energy.

Consumers, regardless of wanting to support the environmental benefits of solar power generation, will be swayed to support it primarily based its economic viability. The price of solar components have been falling due to more efficient manufacturing processes, increased number of manufacturers and economy of scale. However, there are many other factors to consider when estimating the consumer cost of electricity produced by distributed solar systems in relation to utility grid electricity. The current price of solar is determined through various assessments that both consider the operational expenses incurred and return on investment (ROI), as well as how solar energy is valued. However, these assessments prioritize and consider different factors that affect the end consumer price, making solar energy pricing (and electricity pricing in general) a complex and ambiguous topic for consumers. There are also other market and regulatory elements that add additional complexities to this subject. In understanding whether or not sustainability is compatible with growth, Canada's solar market answers the question with: "It depends".

Cost versus value of solar energy

One of the obstacles faced by solar companies is the marketability of solar power in relation to other energy sources. It is still a common misconception that solar photovoltaic (PV) is extremely expensive compared to other energy types.[5] At this point, the solar industry is attempting to overcome a market failure of identifying the true value of solar, in order to price it adequately, especially in comparison to other forms of electricity. Currently, solar PV is calculated to cost $130/MWh by way of a Levelized Cost of Electricity (LCOE) assessment, while coal at $96/MWh, natural gas at $65/MWh, and wind at $80MWh remain much more affordable.[6] It would seem that solar energy, a free energy source, would be one of the least

[1] (Alberta 2015)
[2] (Canadian Solar Industry Association (CanSIA) N.d.)
[3] Ibid
[4] (Thompson 2015)
[5] (Branker 2011)
[6] (Energy Information Administration 2015)

expensive forms of energy to produce. Although the price of solar energy remains higher than wind, gas and coal, the "value of solar" is based on four factors, which should be considered when setting the price of solar. These include: replacing energy purchased from more carbon intensive, polluting sources; long-term energy production at a fixed rate; replacing the need to build future power plant infrastructure in accordance to future energy needs; and reducing infrastructure maintenance costs related to depreciation and failure.[7]

Valuing electricity generation is a complex issue and prices are difficult to calculate and compare among different types of energy sources. In making decisions to support new energy projects, the largest factor considered is the economic viability of the project and how financially competitive the energy generated will be compared to other forms. Assessments are required to determine if the investment and expenditures on a project will be worthwhile in covering operating and capital costs, as well as produce a ROI in order to create shareholder value.[8] If distributed generated PV electricity is to be economic, it must be on grid parity, which is where solar electricity costs are similar to conventionally technological electricity prices.[9] Economic barriers such as unequal valuation of energy sources must be removed in order for alternative energy to be able to replace carbon intensive electricity sources.

Pricing solar according to its value means that the market pricing is transparent. It must reflect adequate compensation for the energy produced by solar, as well as the costs incurred by the utilities company's infrastructure usage.[10] In Alberta, solar is valued through both net-billing and export, which was priced at $14.5 cents/kWh for consumption and $8.5 cents/kWh for export.[11] Canadian Solar Industry Association (CanSIA) has developed what they believe to be a "Minimum Total Value" of solar, priced at 20.7 cents/kWh. This includes "Time of Generation" at 13.5 cents/kWh, "Location of Generation" at $0.5 cents/kWh, "Price Certainty" at $3.6 cents/kWh, and "Low Environmental Impact" at $3.1 cents/kWh.[12] New research indicates that the utility company benefits from micro-generation, but the benefits are not apparent since the price of solar electricity produced has been traditionally tied directly with the cost of electricity rather than what solar is actually valued at, sometimes at higher prices than what conventional electricity rates are.[13]

Levelized Cost of Electricity

The standard way of comparing costs between energy sources is through the Levelized Cost of Electricity assessment (LCOE). LCOE's are useful in simplifying the comparison between different energy projects and the costs required to build and operate each projects' electricity infrastructure over its lifespan. This metric is used widely in comparing different electricity sources and is the method that the U.S. Energy Information Administration (EIA) employs in determining how economically competitive different forms of electricity are.[14] LCOE's are based in dollars/kWh and considers capital costs, fixed and variable operations and maintenance costs, fuel costs, assumed utilization rate, and other financial costs for different

[7] (Farrell 2014)
[8] (Aggarwal 2015)
[9] (Branker 2011)
[10] (Farrell 2014)
[11] (Canadian Solar Industry Association (CanSIA) N.d.)
[12](Canadian Solar Industry Association (CanSIA) N.d.)
[13] (Farrell 2014)
[14] (Energy Information Administration 2015)

types of plants.[15] LCOE's are meant to remove biases between different electricity generating types.[16]

Although LCOE's are useful and offer instructive information, they have been criticized as not being sufficient and even misleading. There is also a lack of transparency on assumptions and justifications, which sweep across all energy technologies compared.[17] It is very difficult to accurately assess different types of energy resources, across different regions, with varying energy supply and demand characteristics. For instance, plant decisions change depending on the local features, type of technology used, load requirements, existing energy sources and other considerations. These factors go into calculating the project utilization rate.[18] As well, the existing resource mix has an affect on plant development, as one source of energy will displace others, resulting in changes in the economic feasibility.[19] Another regional aspect that must be considered is the capacity value, which is dependent on the energy requirements and existing energy sources in the area, and how the electricity is delivered, whether continuous, demand following, or intermittent.[20] Further criticism on LCOE's include the ineffectiveness of this method in accounting for how electricity is sold at different prices,[21] dependent on the type of electricity, varying between utility rates, and retail rates[22]. As well, fuel and chemical co-producing plants cannot be included in the assessment. Additional costs related to the project, administration, financing and negative externalities may also not be accounted for.[23] In the case of distributed rooftop solar, assessment methods are challenged by the combination of high capital costs, and low marginal cost of intermittent power generation.[24]

Issues related specifically to LCOE's and solar power include the fact that buildings are being constructed and retrofitted to become more energy efficient and therefore, requiring less energy, making the LCOE increase in relation to the system's costs. However, utility scale solar is often only calculated in LCOE's rather than distributed solar, leaving out further useful information, especially as distributed generation increases.[25] Further, financing costs and utility bill comparisons must also be considered. Regardless, the LCOE's of alternative energy are falling while fossil fuel costs are increasing, which still makes a case for alternatives and renewables using this method of analysis.[26] Once the LCOE of alternatives fall past the LCOE of fossil fuels, utilization of alternatives will increase due to their economic competitiveness, however this may not occur due to the flaws in this type of assessment.[27] According to the EIA, solar PV has one of the highest average LCOE estimates compared to both alternative or renewable, and non-renewable energy sources.[28]

A Calgary based solar installation company, Solar Hero, has completed a LCOE assessment for solar energy in Alberta. This assessment calculates the average cost of

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[15] Ibid
[16] (Branker 2011)
[17] Ibid
[18] (Energy Information Administration 2015)
[19] Ibid
[20] Ibid
[21] (Devere 2011)
[22] (Branker 2011)
[23] (Branker 2011)
[24] (Ferris 20)
[25] (Bronski 2014)
[26] (Kost 2013)
[27] (Ueckerdt N.d.)
[28] (Energy Information Administration 2015)

generating one unit of energy.[29] The calculation considers the lifetime of the source (PV lasting approximately 25 years), maintenance costs (PV at zero), the installation cost (variable between $2.5 and $3.5 cents/W) plus financing. The LCOE is based on the amount of solar energy available in southern Alberta, between 1,000-1,300kWh per kW per year. The solar energy costs are compared to the 2013-2014 cost of grid power in Calgary, Alberta. Because system sizes can vary, the assessment was calculated as per kilowatt rather than total system size. The results indicated that the fixed cost of energy for solar over 25 years was between $7.69 and $14.89 cents per kWh dependent on the variables above, with the higher price point being what consumers pay during high demand periods through conventional electricity generation. However, if the system were paid for in cash, or if other variables fell on the lower end of their spectrums, the levelized cost would be less than what consumers paid for electricity in 2013-14.

SkyFire Energy out of Calgary Alberta performed another LCOE. The "best case" cost of solar was $3.75/kWh and "worst case" was $5.25/kWh. They determined that the difference between consumers choosing to use conventional electricity sources was between $0.167/kWh and $0.305/kWh (dependent on assumptions) whereas residential solar fell between $0.122/kWh to $0.204/kWh.[30]

An alternative LCOE that has been proposed is the System LCOE.[31] The difference between the two metrics is that the System LCOE includes indirect integration costs as well as generation costs. These costs may include transmission expansion or storage. This assessment is informative because alternatives interact differently with the grid than dispatchable energy source do. System LCOE's would generally increase the cost of certain alternatives, such as solar, in comparison to dispatchable energy sources due to increased integration costs.

Levelized Avoided Cost of Electricity

Levelized Avoided Cost of Electricity (LACE) provides a better insight into the value of different electricity sources as it shows the costs required in generating electricity that may be displaced by the development of new, often alternative, sources of electricity.[32] In other words, it shows how much it would cost to provide the same amount of electricity if the other source wasn't available. It is calculated by taking the entire economic value of one project, such as a new coal plant, and divided into equal annual payments over the course of the project's life. Then, dividing the result by the average annual output of the coal plant produces the avoided cost.[33] In order to determine if the project's value is more than its cost, you can compare the LCOE to the LACE. When the LCOE is less than the LACE, projects become economically appealing. Solar PV utility scale generation has one of the highest average costs according to the EIA when assessed through LACE, and also the widest range between highest and lowest cost estimates of all the electricity sources, not including offshore wind and solar thermal.[34]

Both these calculations make assumptions on capital and operating costs, future prices of fuel, cost of carbon, and upcoming government policies, such as environmental regulation.[35]

[29] (Solar Hero N.d.)
[30] (Kelly, D., Vonesche, D., & T. Schulhauser)
[31] (Ueckerdt N.d.)
[32] (Energy Information Administration 2015)
[33] (Energy Information Administration 2015)
[34] Ibid
[35] Ibid

Different outcomes my occur that conflict with the prediction provided by LCOE's or LACE's because of newly introduced subsidies, tax credits, technology changes, or other unforeseen non-economic factors. Unfortunately, both these assessments are not well positioned to address environmental concerns or externalities, or climate change.

Levelized Value of Energy

Another way of pricing solar electricity is through the Levelized Value of Energy (LVOE) or value of solar (VOS), which is a bottom-up calculation.[36] While LCOE's and LCOA's consider the generator's standpoint, LVOE considers the user's standpoint.[37] This type of assessment has only been implemented in two areas: Minnesota and through Austin Energy.[38] This alternative method is value focused rather than price focused, but not widely used at this time. The value of electricity is increasingly becoming recognized as an equally useful tool alongside the cost of electricity. This method is calculated year-by-year according to energy generation, dependent on electricity rates. The calculation can also factor in hourly consumption rates; additional fees incurred; hourly distributed generation amounts; compensation methods such as feed-in tariffs or net-billing; rate of bill savings over time; and discount rate (discounted cash flow) for levelization. It also can account for features such as avoided losses, price of alternatives, avoided impact of catastrophic events, income opportunities, and timeliness of supply.[39] As well, it can assess the availability of electricity during high demand times, idle power availability, and voltage and frequency stability.[40] Dispatchable and non-dispatchable sources can be included in this assessment and they are valued differently dependent on the sources' flexibility during demand.[41] This method of assessment may also include consumer "willingness to pay" in order to justify values derived, for instance, positive externalities such as the ability to displace conventional electricity forms. LVOE is useful for potential distributed generators to calculate different options. It would provide evidence that solar energy generation is more valuable than what a conventional LCOE would express. Some regions provide a value of solar (VOS) tariff in order to compensate for the real value that solar energy provides.[42] However, the tariff is not enough to compensate for the installation of solar products and services in some markets. However, according to the LCOE from Solar Hero, a VOS tariff may be equal to the LCOE due to it being at grid parity.

If this method of assessment is used in pricing solar, it can be used in a "buy-all sell-all" transaction that allows customers to purchase electricity at the rates provided by their utilities company, and sell their solar energy at the VOS price while still allowing the utility to recover fixed costs.[43] This process can accompany different solar programs such as net-billing. Different organizations such as the National Renewable Energy Laboratory (NREL), Clean Power Research, Rocky Mountain Institute (RMI), Electric Power Research Institute (EPRI), and Interstate Renewable Energy Council (IREC) have conducted research on the valuation of solar in order to better understand this topic.

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[36] (Taylor, et al. 2015)
[37] (Reparacionesdelhogarjuancarlos. 2014)
[38] (Taylor, et al. 2015)
[39] (Reparacionesdelhogarjuancarlos. 2014)
[40] (Kost 2013)
[41] (Farrell 2014)
[42] (Taylor, et al. 2015)
[43] (Taylor, et al. 2015)

If solar and other intermittent renewables were evaluated based on their market value, as well as the revenue they generate, this source of energy could be competitive with fossil fuels. If economic assessments incorporated additional costs incurred by fossil fuels such as externalities, and the future effects of using these fuels on our health and environment, alternatives would definitely be cost competitive. Regardless, widely used LCOE's are not comprehensive enough to accurately compare each energy source to one another even economically, let alone any factors over and above the financial costs. LVOA or VOS would provide enough accurate information for policy-makers, utilities companies and consumers to create incentives and take advantage of solar pricing.

Willingness to pay

Although competitive pricing is a valuable tool in marketing solar energy, when the price of solar is assessed at being higher than conventional fuels, this tool may be ineffective. Alternatively, willingness to pay (WTP) for the additional perceived value could be the driving force that makes solar energy a successful alternative. Consumers are willing to pay a premium for alternative energy because of the non-economic benefits.[44] Recent studies also show a positive willingness to pay in support of alternative energy using contingent valuation (CV) methods in order to value non-market goods. For instance, Herbes *et. al* compiled research from other studies that showed that consumers are willing to pay more for alternative energy, between 3% and 19%.[45] This study also found that consumers' WTP was in the upper end of the range stated, despite the fact that the respondents lived in Germany and already pay the highest premiums for energy in Europe.[46] Marukami *et. al* found that consumers were willing to pay $0.31 per month in order to reduce greenhouse gas emissions by 1% and had a willingness to pay $0.71 for a 1% increase of alternative energy usage.[47] In fact, solar energy is the primary energy source preferred out of all alternatives available.[48] WTP is a tool used in developing energy policies and as well, a consideration when implementing renewable portfolio standards (RPS).[49] These studies show that consumers are willing to purchase renewables over conventional fuel sources, even if they have to pay a bit more for them. However, if solar costs continue to fall, tools such as the LVOE are used, and the actual costs of fossil fuels are reflected in energy prices, consumer willingness to pay could be the catalyst that pushes solar to become even more widely utilized within our energy grid.

Programs and policies that affect solar pricing in Canada

Feed-in tariffs

Feed-in Tariffs, such as the one that stimulated Ontario's solar boom, offer a simple, standardized contract and a fixed, long-term price based on the value of solar production. Solar energy is purchased from the generator completely separate from the electricity billed to the generator during times of need.[50] Customers can choose between net-metering or in some cases,

[44] (Farhar 1999)
[45] (Herbs 2015)
[46] Ibid
[47] (Murakami 2015)
[48] (Borchers 2007)
[49] Ibid
[50] (Farrell 2014)

VOS, when participating in the feed-in tariff program. Feed-in tariffs also may consider whether or not the solar producer is a utility customer, and if so, whether the producer would be paid for the energy produced over and above their individual usage. This program then looks at whether the generator can sell its energy in a separate transaction or if bill credits are to be given instead.

Net-Metering and Net-Billing

Net-metering is a compensation plan for residential PV users who can sell their electricity overages back to the utility for the same rate they pay to purchase it using a single meter to track imported and exported energy.[51] Net-metering has increased demand for distributed solar however, some have criticized that this program has increased the price of electricity for non-net-metering customers.[52] Distributed micro-generators have access to the grid in order to sell back their excess electricity, while utilities companies operate and maintain the infrastructure. Some of the costs related to updating infrastructure to allow the utility company incurs two-way power flows.[53] These expenses are passed down onto both non-micro-generators and micro-generators evenly, however there is criticism that PV generators are compensated for their energy production through net-metering, reducing their costs as a subsidy funded by the other customers on the grid.[54] These fears have been proven to be untrue, as a study conducted in 2013 found that customers saved $1.54 for every dollar spent on net-metering due to reduced spending on power plants, transmission and distribution infrastructure, and reduced electricity loss over power lines.[55] Other studies that assessed different states found that the financial benefit of net-metering programs was positive and did not shift costs or raise expenses for non-participants of the program.[56] Some states have proposed additional charges or taxes for solar producers using programs such as net-metering to offset these costs however, issues over these charges has also been raised.[57] Policy must be developed in order to have micro-generation pricing reflect these costs fairly so they don't get passed onto those not participating in distributed power generation. One way of addressing this issue is transparent pricing of the VOS, in comparison to a LCOE pricing system.[58]

Alberta uses Net-billing, which is the process where credits are received when excess electricity is generated and sent back to the utility grid by using two meters to measure the import and export of electricity into the micro-generating system.[59] Alberta does not have net-metering at this point in time. Over and above credits, there are no incentives related to participating in the net billing program as a micro-generator, such as revenue generation. However, it does offer the customer the choice of deciding where their electricity is produced as Alberta has a deregulated electricity industry.[60]

In order for these programs to be economically beneficial, solar must be at grid parity. With regard to utilities companies purchasing back generated electricity, there are different

[51] (Massachusets Institute of Technology (MIT) 2015)
[52] (Pfund 2015)
[53] (Massachusets Institute of Technology (MIT) 2015)
[54] (Craig 2013)
[55] (Pfund 2015)
[56] Ibid
[57] Ibid
[58] (Farrell 2014)
[59] (Alberta N.d.)
[60] Ibid

ways that utilities companies measure the price of the returned solar power, which also affects the economic viability of these programs. For instance, in some cases, solar electricity is credited at a rate that offsets the costumers own electricity usage. Alternatively, credits can come at an "avoided cost", which is often at a lower rate.[61] Net-metering is criticized as making the value of solar unclear as it is priced at what conventional fossil-fuel electricity is priced at, with very different factors affecting fossil fuel electricity market compared to solar.

Renewable Portfolio Standards

Alternative portfolio standards (RPS)'s are a regulatory mandate that states that a certain amount of power must be produced through alternative energy.[62] Recently during the Canadian Solar Industry Association's (CanSIA) Western Regional Conference, many of the keynote speakers spoke favorably about provincial policies being developed to incorporate an effective hybrid RPS.[63] This RPS includes carbon pricing and would specify alternative procurement with a "solar carve-out" or "set-aside" feature to encourage building solar capacity in Alberta. CanSIA stated that an achievable target of 1.5% of Alberta's electricity be sourced through solar energy by 2022.[64] The concern was that without an RPS that includes a stipulation of solar energy incorporation into the portfolio, the market would be driven to reduce emissions without fostering the development of this alternative.[65] There have been concerns related to increased consumer prices of electricity where RPS's were implemented, however differences were negligible, as electricity pricing was found to be only $0.9 cents/kWh higher for RPS areas, than areas that did not in have RPS's in 2013.[66]

Standard offer and power purchase agreements

Another factor that affects the cost of electricity for consumers includes Power Purchase Agreements (PPA). PPA's are a purchase agreement between a buyer and a third-party, for a certain amount of time, which develops, operates, maintains and owns an energy source.[67] These agreements are in decline but they are worth mentioning as they are still in use due to long agreement timeframes. Standard offer programs, such as the Renewable Energy Standard Offer Program (RESOP) in Ontario, or BC Hydro's Standing Offer Program (SOP), are purchase agreements designed to assist provinces in generating more alternative energy by offering a guaranteed price for electricity for a period of time.[68] Due to high overhead costs and other factors, Ontario's RESOP was replaced with it's more current Feed-in Tariff program.

Carbon offset programs: Internalizing the external cost of carbon intensive energy

Fossil fuel based energy has an artificial cost advantage over clean energy. The first comes in the form of externalities that may not be accounted for such as greenhouse gas emissions or other forms of pollution. The cost of pollution and carbon emissions are slowly

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[61] (Farrell 2014)
[62] (Pfund 2015)
[63] (Canadian Solar Industry Association 2015)
[64] (Canadian Solar Industry Association (CanSIA) N.d.)
[65] (Canadian Solar Industry Association 2015)
[66] (Pfund 2015)
[67] (Pfund 2015)
[68] (Ontario Energy Board 2015)

being factored into the price of fossil fuels, but many times, consumers still may bear the costs in the form of environmental degradation and health impacts. Pollution and emissions would decrease if emitters were responsible for these costs. Further, if resources were priced to reflect how scarce they are becoming, productivity would inevitably increase as well.[69] We need to consider the atmosphere as a scarce resource in order to make it more expensive for companies to deposit carbon emissions into it.[70]

National carbon pricing is required in order to internalize the pollution costs created by fossil fuel industries, either through carbon taxes or a cap and trade program, and as well to develop market signals in order to increase demand.[71] A report by the Pembina Institute stated that in order to stimulate clean energy technology nationally, the Federal government must send the right price signals through streamlined carbon pricing across the country.[72] Recent federal climate change policy changes are ensuring that carbon targets will be met by each provincial government. The provinces are in charge of developing their own policies in order to meet the targets set by the federal government. Alberta currently has a carbon tax of $15/tonne, which is scheduled to increase shortly to $30/tonne.[73] For every $30 of carbon, solar electricity can offset about $0.2 cents/kWh, a fact that still remains unaccounted for in the price of solar.

Ontario, Quebec and Manitoba recently signed an agreement to work together under new cap and trade policy.[74] Although the impact on consumer electricity pricing is yet unknown, utilities companies who still source their energy from fossil fuels will have to purchase allowances or permits in order to do so, potentially passing the costs onto consumers.[75] This incentivizes consumers and utilities companies to find cleaner energy, as fossil fuel pricing becomes more expensive.[76]

A national plan to create demand for clean energy is necessary in order for market forces to fulfill consumer needs and to remove barriers for clean energy entrepreneurial projects, such as this project. Without these incentives, clean energy companies face many challenges while fossil-fuel energy development and consumption will continue to grow. One option available is to have policies target emissions within the Province's electricity sector in relation to the Emissions Intensity Standard and more specifically, the "Clean Electricity Standard" (CES).[77] The CES outlines a maximum emissions intensity threshold for electricity retailers and would provide clear market signals from the government on how retailers could reduce their emissions intensities.[78] The CES could work with an RPS in developing a "solar-carve-out" option that would ensure a certain amount of energy in Alberta be provided by solar.

Fossil fuel price advantages: Subsidies, tax rules & discount rates

Fossil fuels have an artificial advantage over clean energy in the way of subsidies that reduce the end cost of fossil-based products. The Organization for Economic Co-operation and Development (OECD) has stated that fossil fuel subsidies should be removed.[79] A report by

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69 (Smith 2011)
70 (Woynillowicz 2013)
71 Ibid
72 Ibid
73 (The Globe and Mail 22)
74 (Kives 07)
75 (California Public Utilities Commission 2015)
76 Ibid
77 (Canadian Solar Industry Association (CanSIA) N.d.)
78 (Canadian Solar Industry Association (CanSIA) N.d.)
79 (Organization for Economic Cooperation and Development N.d.)

Massachusetts Institute of Technology (MIT) also argued that solar could be cost competitive if fossil fuels had their subsidies greatly reduced in order to be "appropriately penalized for carbon dioxide . . . emissions".[80] Canada is planning on phasing out these subsidies, but this is just one part of the equation in accurately reflecting the true costs of fossil fuels.[81]

A report by the Pembina Institute stated that in order for the clean technology industries to thrive in Canada, preferential tax treatment for fossil fuel production needs to cease.[82] Fossil fuel production receives the benefit of multiple supportive tax measures, including "accelerated depreciation for physical assets in mines (including coal mines, but not oil sands mines) and for successful oil, gas and mineral exploration expenses; flow-through shares, which allow a corporation to transfer unused exploration and development expenses to their shareholders; and the ability for small oil and gas companies to reclassify some development expenses as exploration expenses under the flowthrough share scheme".[83] As well, royalties from oil, gas and mining are fully deductible from income. Although income tax and royalty treatment of these industries are continuing to go through reform, Alberta still offers royalty-reduction programmes to stimulate specific oil and gas projects.[84]

Discount rate, the time value of money, is not specified,[85] and this rate may be technology dependent reflecting perceived risks involved.[86] Although discount rate related to discounted cash flow is often incorporated into LCOE analysis's, discount rate with regard to future environmental and health impacts may not be. This is an important aspect that must be considered when addressing the externalities that contribute to climate change and pollution. Since environmental costs, pollution, health effects and other factors are difficult to quantify, they may not be built into an price assessments unless it is calculated through a tax or existing regulatory mandated program expenditures. If a low discounted rate were adopted to reflect the future costs of the carbon produced today, alternative energy becomes more cost competitive than conventional fuels.[87] Fossil fuel generated externalities could cost twice the actual incurred cost by using that fuel, such as in the case of coal and oil and 30% more by gas.[88] This is why pricing assessments that are improperly developed and applied can result in poor decisions related to projects, have negative policy implications, and have even worse environmental effects.[89]

Intermittent electricity generation and supply & demand

Places that have seen increased levels of solar energy and other renewable penetration have experienced price reductions to less than what is paid nationally.[90] This creates a double edge sword, as if there is the perception by consumers that a larger share of alternatives is in the energy mix, it may drive down the consumer's willingness to pay a premium for alternative electricity.[91] Therefore, with alternatives currently sitting at only 7% of the energy mix in the

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80 (Massachusets Institute of Technology (MIT) 2015, xiii)
81 (Woynillowicz 2013)
82 Ibid
83 (Organization for Economic Cooperation and Development N.d.)
84 Ibid
85 (Devere 2011)
86 (Branker 2011)
87 (Roberts 2014)
88 (European Comission 2001)
89 (Branker 2011)
90 (Pfund 2015)
91 (Roe 2001)

United States[92] and 17% of Canada's energy mix,[93] consumer willingness to pay remains high, as does the price of alternative energy in comparison to fossil fuels.

Another factor that affects solar PV electricity pricing is the timing related to when PV electricity is generated, and when it is used, in relation to cost competitiveness. Intermittent energy sources are not directly comparable to non-intermittent sources due to their nature.[94] Measurement of electricity is calculated by wattage/hours, differing between 24-hour base load generation, or intermittent generation.[95] Intermittent alternatives like wind and solar are non-dispatchable and cannot react to, and produce more energy when prices are low, like non-intermittent power sources can. Therefore, lower wholesale prices are produced when power generation is higher however, this lack of flexibility does affect the value of solar energy.[96] An interesting effect of increased generation through wind and solar during low demand times is the creation of negative daytime electricity prices in some regions, resulting in other electricity producers being forced to reduce their prices and in some cases, offering to pay for the export of their own electricity.[97]

Since solar is produced during the daytime rather than at night, and corresponds when the price of electricity is highest, its going rate will reflect this trend, benefiting distributed generators. These prices will be reduced the more PV comes online, and with the costs being as competitive as they are, the result could be less revenue, especially for utility scale solar.[98] This effect will continue with more PV being installed until a breakeven point emerges, potentially making photovoltaics unprofitable.[99] Until multi-hour energy storage technologies are utilized, high penetration levels may not be cost competitive and will slow the PV distributed generation market.[100]

Ontario's solar energy experiment

Ontario is the leader in alternative energy in Canada due to the polices that have created incentives for solar and other renewable energy. The result of these policies is that Ontario produced over 91% of Canada's installed solar capacity by 2011.[101] Much of the solar capacity was utility scale, however the micro-FIT program assisted with distributed solar installations. Ontario's current energy mix includes nuclear (37%), hydro (24%), gas (28%), wind (9%) and biofuel (1%).[102] Alternatively, Alberta's energy mix includes coal (55%), gas (35%), hydro (2%), wind (4%), biomass (2%) and other (0%).[103]

The first program that made headway was the Renewable Energy Standard Offer Program (RESOP) that ran between 2006 and 2008, with pricing set at $0.42 / kWh for solar.[104] At this point, PV system costs were much higher and utility scale solar was still an emerging

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92 (Energy Information Administration 2015)
93 (Natural Resources Canada 2013)
94 (Energy Information Administration 2015)
95 (Devere 2011)
96 (Ferris 2015)
97 (Parkinson 2014)
98 (Massachusets Institute of Technology (MIT) 2015)
99 Ibid
100 (Massachusets Institute of Technology (MIT) 2015)
101 (Natural Resources Canada 2012)
102 (Independent Electricity System Operator (IESO) 215)
103 (Alberta 2014)
104 (Ontario Sustainable Energy Association 2013)

industry.[105] This program was later replaced by the Feed-In Tariff (FIT) program and microFIT program spurred by *Ontario's Green Energy and Green Economy Act, 2009.[106]* The Act attempted to reduce barriers for renewable energy development and create employment within the industry. As well, the Province's goal was to create green industry jobs by requiring domestic content provisions within the two programs to be included, which would provide manufacturing opportunities for solar products in the Province. This feature was later dropped when the World Trade Organization decide that this provision was a breach in international trade law.[107] Ontario's Long-term Energy Plan, created in 2011, commits that by 2030, solar will provide 2% (almost 3000 GWh) of electricity for the province. By 2013, Ontario had removed all coal-powered plants from its energy supply in alignment with the Green Economy Act.

Although the solar industry has deemed Ontario's solar progress a success, many criticized the policies and programs that were created in doing so. One such criticism is the price paid to utility scale solar electricity generators who receive $0.42 / kWh in comparison to Ontario's Independent Electricity System Operator's costs of $0.08 / kWh (or $0.14 / kWh during peak hours), creating an unfair advantage for solar power generators.[108]

Further, consumers in Ontario are paying one of the highest rates for electricity in North America, with electricity rate hikes increasing 15% in 2016 alone.[109] On average, Ontario residents pay about $45 more per month per 1000 kWh for electricity compared to Alberta.[110] That amounts to $0.15/ kWh for Ontario residents and $0.11 / kWh for Albertan's.[111] The MicroFIT rates ranged between $0.64 / kWh to $0.80 / kWh, and FIT pricing between $0.44 / kWh and $0.71 / kWh, depending on the mount style (ground or rooftop) and sizing requirements. These prices have since been recommended to come down as much as 31% due to dropping solar costs.[112] This program will last for 20 years, with rates guaranteed by the Province through the Green Energy Act. A recent report states that over the next 20 years, residents will pay approximately $9.2 billion over and above what the program should have cost in order to cover the expense of the high subsidies paid.[113] Not only are the costs enormous for Ontario residents, but these mistakes have also impacted consumer trust in government policies related to renewable energy.

Although the policies did spur development in alternative energy in Ontario, electricity prices still remain high for residents, making it difficult for the public to support these initiatives, despite the positive impacts the industry has had both environmentally and economically. Ten years later, many still criticize the decisions made to push Ontario to be Canada's renewable energy leader at the expense of higher electricity costs and increased taxes. Some say this resulted in lost manufacturing capacity due to cost increases, as well as a loss in jobs in those sectors. However, it wasn't specifically the implementation of programs supporting renewable energy that was the source of the price increases. Instead, it was a combination of factors that created the high consumer prices for electricity in Ontario. These include infrastructure upgrades, a transition away from coal-generated electricity resulting in

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[105] (Natural Resources Canada 2012)
[106] (Ibid
[107] (Blackwell 2014)
[108] (Yakabuski 2014)
[109] (The Globe and Mail 2013)
[110] (Manitoba Hydro 2015)
[111] Ibid
[112] (Natural Resources Canada 2012)
[113] (The Canadian Press 2015)

increased supply costs, and only a small portion of cost increases were associated with newly added renewable energy power supply.[114] With Alberta transitioning off coal generated electricity and newly created carbon taxes, Alberta's electricity rates may increase as well.

Conclusion

We are at the cusp of the announcement of major policies being developed to support renewable and alternative energy in Alberta. By understanding the economic factors that contribute to solar pricing, and comparing Ontario and Alberta's electricity industry and policies, we can see how the introduction of increased renewable energy penetration can affect consumer pricing and public perceptions. It is useful to see how Ontario spurred the solar energy sector in Canada through its RESOP and feed-in tariff program, in order to understand what policies could potentially work, or not work, in Alberta. Almost ten years later after the introduction of Ontario's RESOP, solar energy is now close to, or in some cases, at grid parity, removing the requirement of additional subsidies to make solar and other alternatives market competitive. Although the Alberta government has yet to reveal what "incentives" are being rolled out to encourage alternative energy, the results of the program will most likely have much more success Ontario's due the competitive nature of solar in Alberta, and the what has been learned from previous experience.

Is sustainable energy compatible with growth in Canada? In Ontario's case, it depends on which lens you view growth from: the green energy sector grew substantially but at the expense of the taxpayer, the consumer, other industries who were already struggling. In Alberta, I feel confident that by using the lessons learned in Ontario, we will find that sustainability and growth can indeed be compatible.

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[114] (Dewees 2012)

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