Developing a Model for Promoting Solar Photovoltaics in Ontario, Canada

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29 August 2014

A Major Paper submitted to the Faculty of Environmental Studies in partial fulfillment of
the requirements for the degree of Master in Environmental Studies
York University, Toronto, Canada

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Abstract

Through the enactment of Ontario's Green Energy and Green Economy Act of 2009, Ontario has set targets to increase the share of renewable energy. However, widespread renewable energy development still faces several barriers. Some of the key barriers to adoption, especially for solar photovoltaic technologies, are the high up-front installation costs, the lack of attractive financing options and the dominant share of nuclear energy in Ontario's energy mix. This paper examines some of the key adoption issues in Ontario and looks at how other jurisdictions have sought alternative models for financing renewable energy projects. Using this information, a model is proposed for Ontario that will reduce the burden of high up-front financing costs for Ontarians with more accessible financing options and a plan for addressing the nuclear energy issue.

Foreword

Although my Plan of Study focuses on corporate responsibility to the environment, one of its major components is the development of renewable energy. Looking specifically at the context of Ontario, the province along with its wholly owned corporations must engage in more responsible energy development that ensures environmental as well as social benefits. In the Ontario Long Term Energy Plan of 2013, it can be observed that renewable energy will play a crucial role in Ontario's future energy mix. However, to make a true shift from nuclear power and for greater renewable energy substitution, communities and local residents have to become more involved in the production of renewable energy. This will also create greater awareness and understanding of the role of renewable energy and its benefits to Ontario. Therefore it is important to eliminate the barriers to the adoption of renewable energy.

The purpose of this paper is directly connected with my learning objectives in the renewable energy section. The research highlights the key barriers to renewable energy and also provides a viable solution. In this paper, I focus specifically on the issue of high investment costs of solar photovoltaic technologies. By offering financing through the proposed model, local energy distribution companies can spur the growth of the green energy economy in Ontario.

Acknowledgements

I would like to express my deepest gratitude to my advisor and supervisor, Dr. José Etcheverry, for his inspiration, guidance and encouragement over these two years.

A special thanks to Dr. Christina Hoicka for her advice and feedback during the MES process.

I thank the entire faculty and professors who have helped me and broadened my knowledge of this very important area of study.

Last but not least, I would like to thank my father whose love and support has helped me through this journey.

This paper is dedicated to the memory of my beloved mother,
for without her sacrifice and love I wouldn't be here.

Table of Contents

Abstract ..... **ii**

Foreword ..... **iii**

Acknowledgements ..... **iv**

Chapter 1: Introduction **1**

Chapter 2: A Brief Overview of Ontario's Electricity Landscape **3**
- *History of Energy in Ontario* *3*
- *Ontario Green Energy Incentives* *5*
  - 2.1 Net Metering 6
  - 2.2 Renewable Energy Standard Offer Program 7
  - 2.3 Feed-in-Tariff (FiT) 7
- *Ontario's Long Term Energy Plan* *8*
- *Chapter Summary* *10*

Chapter 3: Barriers to Renewable Energy **11**
- *1. Politics of renewable energy* *14*
  - Rising energy costs 15
  - Wind Energy 16
  - WTO ruling 18
- *2. The Staying Power of Nuclear* *20*
  - The cost of nuclear power 20
  - Nuclear lobbies 22
  - Inflexible energy 23
- *3. Consumer affordability of renewable technologies* *24*
  - Residential considerations 25
  - Household Expenditure, Income and Debt 25
- *Chapter Summary* *34*

Chapter 4: Examples of financing models **35**
- *Manitoba Hydro* *36*
- *British Columbia* *37*
- *Property Assessed Clean Energy Financing* *38*
  - Brief History 38
  - Examples of the PACE program 39
  - Benefits of the PACE program 41
- *SolarCity* *41*
- *Financing options* *42*
  - The steps 43
- *Chapter Summary* *45*

Chapter 5: A model for Ontario **46**
- *1. The Local Distribution Company (LDC) funds the project* *48*
- *2. Home energy audits* *53*
- *3. Installation of the systems* *55*
- *4. Post-Installations* *56*
- *5. On-bill financing* *56*
- *Understanding the costs and benefits under this model* *57*
- *Advantages* *61*
- *What would it look like without the FiT program?* *62*

Concluding remarks **65**

Appendices **70**
Appendix 1 – Cost comparison of solar systems *71*
Appendix 2 – Solar project funding costs *76*

Bibliography **81**

Chapter 1: Introduction

Energy has an important role in modern society as it contributes to economic and social development (IPCC, 2012). Since the dawn of industrialization, energy has been mainly derived from fossil fuels, such as coal, petroleum and natural gas (Goldemberg, 2012). However, with the growth of industrialized society, the demand and use for fossil fuels has increased and has lead to rising levels of greenhouse gas emissions, which causes climate change (IPCC, 2012). Renewable energy not only has the ability to satisfy growing energy demand but also acts as climate change mitigation strategy (Goldemberg, 2012; IPCC, 2012). In addition to the obvious environmental benefits, such as low carbon emissions and lack of toxic waste (Pembina Institute, 2013 and OSEA, 2012), renewable energy also provides numerous economic benefits, such as the development of the green energy industry and the creation of jobs (Gipe and Weis, 2011). Germany is considered an excellent example. In 2000, the German government enacted the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz). Since then, the share of renewable energy in Germany's electricity supply has increased to approximately 23 percent (BMU, 2013). The share of renewable energy in 2012 was 12.5 percent of total energy consumption in Germany (BMU, 2012b). However, the EEG not only increased the share of renewable energy but also spurred economic development. By 2012, the renewable energy sector had created more than 382,000 jobs in Germany (BMU, 2012a). Furthermore, this sector is rapidly growing in both domestic and export markets. However, like other energy sources, renewable energy is not an energy source without economic and environmental impact.

Thus, the development and implementation of renewable energy technologies requires careful planning.

The purpose of this research is to present a model for Ontario, whereby local energy distribution companies within municipalities help make more accessible new financing options available to homeowners and provide better services for solar photovoltaic projects. In this paper, I will first highlight the current energy landscape in Ontario with consideration to the Ontario Long Term Energy Plan of 2013. I will also look at the current relevant barriers to the adoption of renewable energy. Then, I will look at financing models in other jurisdictions, primarily SolarCity and the PACE program in the United States as well as other programs in Canada. These important aspects will set the foundation to develop a suitable model. Using the information from the literature review of the above stated topics, I will then outline and explain the framework for the proposed model.

This paper will mainly consider solar photovoltaics as the feed-in-tariff program provides benefits only for solar photovoltaic installations and not for solar water heaters, heat pumps, or other energy efficiency installations. Additionally, solar photovoltaics can be more easily adopted by a homeowner living in a city, compared to wind turbines, because of the logistics, size and cost of this system.

Chapter 2: A Brief Overview of Ontario's Electricity Landscape

This section will examine the history and evolution of Ontario's energy landscape.

History of Energy in Ontario

The energy sector has played an important role in the growth of Ontario and has transformed itself since the early 1900s. In the 1800s, the electricity market had been entirely unregulated in Ontario. The province eventually gained jurisdiction over the flow of Niagara Falls and in the 1900s, construction was underway to harness the potential of electricity from the Niagara Falls for communities in Ontario (McKay, 1983). Then the Hydro-Electric Power Commission of Ontario, the world's first publically owned utility company, was formed in 1906 to take responsibility for the power generation at Niagara Falls and its transmission to other municipalities. However, in 1972, it was converted into a Crown Corporation, which turned it into a profit driven organization (McKay, 1983). It was also renamed Ontario Hydro.

Although hydro was the primary source of electricity, Ontario Hydro began diversifying into other forms of electricity production, such as coal and nuclear, between the 1950s and 1960s (McKay, 1983). Nuclear electricity in Ontario was created not only to reduce dependency on fossil fuels, which was spurred by the OPEC oil embargo, but also to maintain Ontario's economic development.

In 1965, Ontario's first commercial CANDU nuclear reactor came on line at Douglas Point (McKay, 1983). The nuclear generation then expanded and out of it came the Pickering Nuclear Generating Station and later the Bruce Nuclear Generating Station, in

1971 and 1977 respectively. The last nuclear plant, the Darlington Nuclear Generating Station, began construction in 1978 (WNA, 2014). However, the project experienced several delays and though the initial cost estimate was $2.5 billion, the final cost more than tripled to $14.4 billion (OCAA, 2011).

It also became apparent that after many years of constructing energy projects, Ontario Hydro had created an unnecessary need for electricity in Ontario. As McKay (1983) points out, Ontario Hydro was meeting its internal mandate, which was to increase the production of electricity and along with it the need for increased consumption, without actually considering the needs of the province. To reduce these inefficiencies and to put an end to the nuclear expansion, Maurice Strong, the then Chairman of Ontario Hydro, was tasked with restructuring the company in 1994 (Keith and Stewart, 2004). This would also eliminate monopoly and introduce competition in the electricity system (Winfield et al, 2004). In this way, Ontario began to deregulate its electricity system and the provincial government began to privatize Ontario Hydro. In 1998, the company was privatized by the Conservative government under the leadership of Mike Harris (Keith and Stewart, 2004). This was to be done by means of the *Energy Competition Act* of 1998, which was passed by the provincial government.

However, by the following year, Ontario Hydro had incurred a $6.6 billion loss and was split into five successor groups – the Ontario Power Generation (OPG), Independent Electricity System Operator (IESO)[1], Hydro One, Electrical Safety Authority and Ontario Electricity Financial Corporation (Keith and Stewart, 2004). Hydro One would handle the transmission of electricity and the IESO would become responsible for directing the flow of

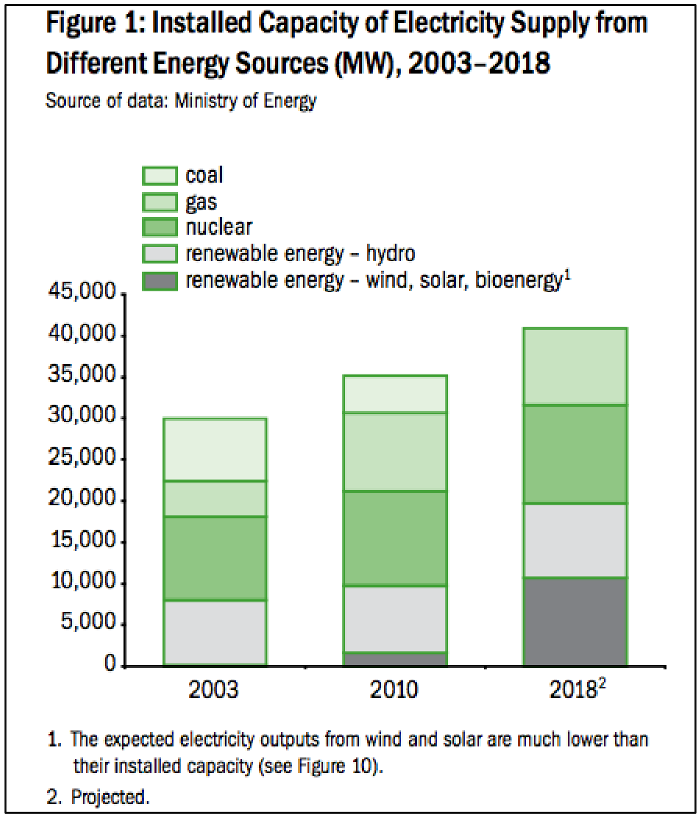
[1] The Independent Market Operator was renamed Independent Electricity System Operator (IESO) in 2005.

electricity as well as the electricity market. OPG was responsible for the production of energy from nuclear reactors, hydro stations, fossil fuel plants and renewable sources (OCAA, 2011). At that time, Ontario Hydro's debt and liabilities amounted to $38.1 billion, which was mainly debt from nuclear projects (Winfield et al, 2004). The huge debt of $19.4 billion that was incurred in the process, known as "stranded debt", is still being paid off by Ontario electricity consumers (OCAA, 2011; OEFC, 2014). In 2010, the province's stranded debt still had an outstanding balance of approximately $15 billion (OCAA, 2011).

Ontario Green Energy Incentives

In 2003, most of the electricity used in Ontario was supplied from coal, hydroelectricity and nuclear generators, while non-hydro renewable energy sources played little to no part of the provincial energy landscape (See Figure 1 below) (Office of the Auditor General of Ontario, 2011). However, during the elections that same year when Dalton McGuinty was running for Premier of Ontario, he pledged to decrease greenhouse gas emissions by shutting down Ontario's coal-fired plants by 2007 to address the adverse health issues caused by emissions (Green, 2007; Clean Air Alliance, 2013). However, this date was then moved forward to 2009, but Ontario eventually became coal-free in 2014 when the Thunder Bay Generating Station burnt its last supply of coal (Green, 2007; Leahy, 2014). It was also during the elections of 2003 that McGuinty promised to replace the dirty coal-fired plants with clean, renewable energy (Spears, 2013a).

Figure 1: Installed Electricity Supply Capacity



Source: Office of the Auditor General of Ontario. (2011). Reports on Value-for-Money (VFM) Audits and Reviews. *2011 Annual Report*. Queen's Printer for Ontario.

The Liberals kept their promise and were committed to enhancing Ontario's renewable energy portfolio. The following subsections will consider the different types of programs that the government of Ontario put in place since 2005 to expand the share of renewable energy.

1. Net Metering

In 2005, the government placed a new regulation that permitted net metering for Ontarians (Ontario Ministry of Energy, 2005). Net metering is targeted primarily to those that produce electricity for their own use from renewable technologies of 500 kW or less

(Ontario Energy Board, 2012; Hydro One, 2013a). Any excess electricity generated by the producer is provided to the distributor and the producer receives credits on their energy bill for the excess generated (Ontario Energy Board, 2012). Net metering is an option for those that perceive a benefit in producing and consuming their own energy.

2. Renewable Energy Standard Offer Program

In 2006, the province of Ontario introduced the Renewable Energy Standard Offer Program (RESOP) that was administered through the Ontario Power Authority (OPA) (OSEA, 2012b). The RESOP allowed small-scaled renewable energy producers to receive a guaranteed price per kilowatt-hour of electricity sold to the OPA for a 20-year contract (Ontario Energy Board, 2012). However, the projects allowed under this program were limited to those below 10 MW in size and compensated wind, water and biomass technologies with .11$/kWh and solar photovoltaics with .42$/kWh (OSEA, 2012a). Although the province had set targets to generate 1,350 MW of renewable energy under the RESOP, they only managed to secure contracts for 55 MW of renewable energy generated by September of 2008 (Nishimura, 2012). In the following year, on October 1, 2009, Feed-in-Tariff (FiT) program replaced the RESOP (Ontario Energy Board, 2012).

3. Feed-in-Tariff (FiT)

Ontario launched the Feed-in-Tariff (FiT) program and the microFiT program in 2009 as policy mechanisms, through the enactment of the Green Energy and Green Economy Act of 2009, to increase the production of energy from renewable sources (CanREA, 2013). Similar to the RESOP, the FiT program allowed renewable energy producers to sell the electricity to the grid at a fixed price per kilowatt-hour for 20 years

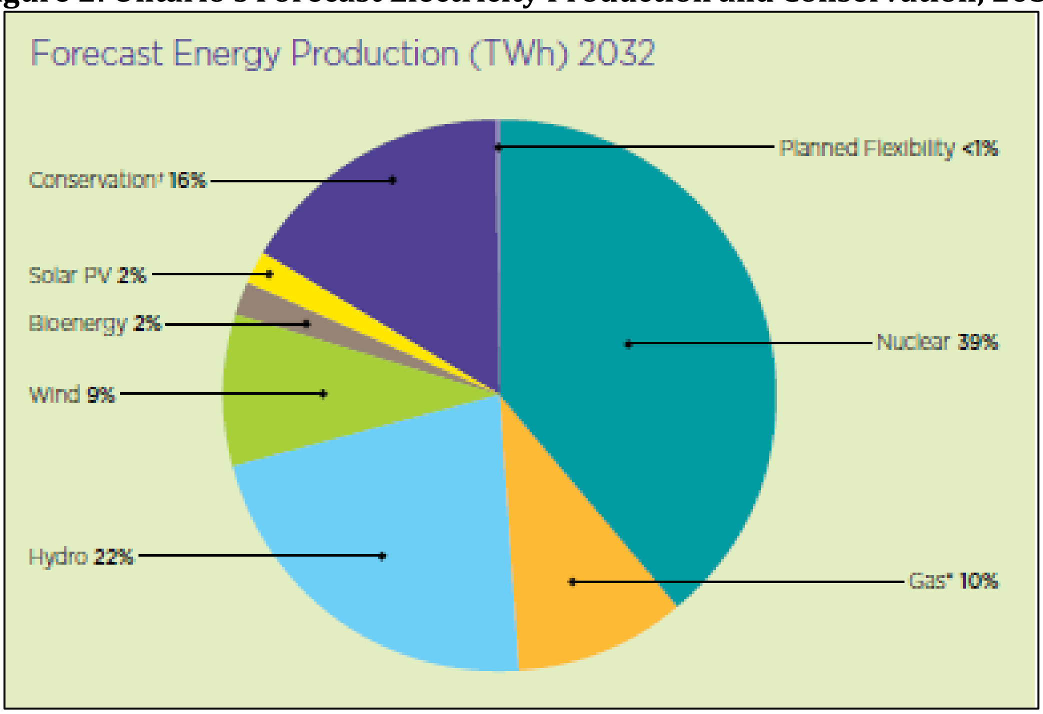
(Ontario Energy Board, 2012). However, unlike the RESOP, the FiT program did not limit the projects to those under 10 MW (Ontario Energy Board, 2012). This allowed for much larger and faster renewable energy developments. The FiT program catered mostly to renewable energy developers with projects (such as bioenergy, wastepower, solar photovoltaics and wind) that were larger than 10 kW, whereas the microFiT program was geared primarily towards homeowners for projects under 10 kW (OPA, 2013a; OPA, 2013b). Furthermore, the FiT program offered differentiated prices depending on the type of renewable technology that was used.

In the following year, Ontario's Long-Term Energy Plan of 2010 stated that by 2018, 10,700 MW or 13 per cent of Ontario's energy mix would be generated by renewable energy sources (Government of Ontario, 2010). The FiT program combined with Ontario's long-term plan was a massive leap towards a more rigorous and ambitious development of renewable energy in Ontario.

Ontario's Long Term Energy Plan

Ontario's Long-Term Energy Plan of 2010 stated that renewable would obtain a 13 percent share in Ontario's energy mix, however, nuclear power would maintain a 50 percent share (Government of Ontario, 2010; OSEA, 2012). In the Long Term Energy Plan of 2013 (OLTEP), nuclear power accounted for 56 percent but renewable energy (wind, solar PV and bioenergy) was only 5 percent (Government of Ontario, 2013). The OLTEP of 2013 also states that although the construction of the two new nuclear reactors at Darlington will not proceed, both the Darlington and the Bruce Generating Stations will begin refurbishment in 2016. Nevertheless, the OLTEP of 2013 focuses on conservation as a way to manage rising electricity prices (Weis, 2013). For renewable energy, the OLTEP states that by 2025 renewable energy will represent about half of Ontario's installed capacity, i.e. 20,000 MW, and 10,700 MW of wind, solar and bioenergy will be phased in by 2021. Moreover, the targets for renewable energy will be reviewed annually (Government of Ontario, 2013). Figure 2 shows the role conservation and renewable energy will play in the future of Ontario, while at the same time the province will see a decreased reliance on nuclear power.

Figure 2: Ontario's Forecast Electricity Production and Conservation, 2032



Source: Government of Ontario. (2013). *Achieving Balance – Ontario's Long-Term Energy Plan*.

Chapter Summary

In 2010, only a year after the enactment of the Ontario's Green Energy and Green Economy Act, the installed capacity from renewable energy increased to 2,000 MW (Office of the Auditor General of Ontario, 2011). This increase between 2003 and 2010 can be observed in Figure 1 taken from the Auditor General Report. Although the increase might appear to be immaterial, it indicates that the Green Energy and Green Economy Act was relatively successful in increasing the renewable electricity share in Ontario. Furthermore, the decision to shut down coal plants in favour of clean energy proves that Ontario's electricity sector can be transformed to include more renewable energy if the problems with the *status quo* are exposed and better solutions are implemented.

The 2013 OTLEP proves that renewable energy and conservation will play a much greater role in the future of Ontario's energy mix. With Ontario's aging infrastructure and high construction costs of nuclear plants, the phasing out of nuclear power plants is essential to open-up significant new market opportunities that enable the province to move towards energy production that would add value to Ontario's economy. Adding new, renewable energy also allows Ontario to balance its energy portfolio and reduce dependency on one particular type of energy.

Chapter 3: Barriers to Renewable Energy

The growing concerns of the impacts of climate change have created a recognized need to shift to cleaner forms of energy production, such as renewable technologies. Renewable energy can mitigate the impacts of climate change and also provide other social and economic benefits, but only if good policies are created to implement them properly (IPCC, 2012). Nevertheless, the growth of renewable energy sources still faces many barriers when compared to more conventional forms of energy.

Barriers to renewable energy:

- High up-front costs
- Lack of public awareness (especially related to costs of renewable energy technologies)
- Policy uncertainty (in Ontario due to the minority government)
- Issue of intermittency and high costs of storage technologies
- Local opposition to renewable projets (NIMBYism)
- Lack of adequate infrastructure
- Inability to develop proper subsidies to promote investment

Sources: Etcheverry, J., O'Malley, L. and Taylor, L. (2009). *Ontario's Road Map to Prosperity: Developing Renewable Energy to its Full Potential*. Research Paper written for the Toronto and Region Conservation Authority. International Energy Agency. (2011, November). *Renewable Energy: Policy Considerations for Deploying Renewables*.

In order to compete with more conventional energy sources, such as coal, natural gas and nuclear, renewable energy requires heavy subsidies globally. However, critics often leave out the fact that conventional energy, especially the fossil fuel industry, is also heavily subsidized. Although subsidies are difficult to calculate, the International Energy Agency (IEA) claims that global fossil fuel consumption subsidies totalled to $409 billion in 2010 and increased to $544 billion in 2012 (IEA, 2012; Anderson, 2014). However this is a rather conservative estimate. Recently, the International Monetary Fund (IMF) put forth a $1.9 trillion figure for global fossil fuel subsidies, which factors in the negative externalities of energy consumption (IMF, 2013). Regardless of whichever figure is used, renewable energy subsidies were only $66 billion in 2010 and increased to about $101 billion in 2012 (Worldwatch Institute, 2012). Compared to 82% for fossil fuels, renewable sources only account for 11% of the global energy supply mix (World Energy Council, 2013). Very few figures factor in the negative impacts of fossil fuels on the environment and the global climate and the positive benefits of renewable energy. Nevertheless, fossil fuels still remain the status quo and 100% shift to renewable energy is still seen as an unrealistic option by many. A paradigm shift of this kind faces a lot of resistance by those that stand to lose their current market share and therefore the focus on subsidies is often exaggerated to nullify the emerging competitors.

Intermittency is cited as another major criticism for renewable energy, especially solar and wind energy, and is often cited by critics as a barrier for renewable energy technologies to achieve greater market penetration. Although renewable energy variation can be addressed through technical solutions (e.g. storage), good planning and system management is required. It should be noted that conventional energy also experiences reliability issues, which include issues like construction costs, demand fluctuations, power outages and volatility of fuel costs (Sovacool, 2009). However, the discussion of intermittency usually shifts towards energy storage, which is regarded as a necessity if renewable sources are to play a major role in energy production. Although energy storage options are well developed and available, they also require smart policy solutions to ensure that their associated costs and benefits can be addressed to facilitate deployment. In systems where energy storage is not available or where base load generators are not forced to come off-line, grid operators are forced to sell power at negative rates at times of high renewable energy production. Renewable energy also requires more coordination amongst various jurisdictions and different government levels and innovative planning to design energy systems and policies that allow for variability and integration amongst energy users (e.g. transportation, heating and cooling, electricity users and generators). Since the transition to 100% renewables can be technically demanding and very disruptive to the business case of established and dominant generators (e.g. fossil fuels and nuclear), it often becomes common for most jurisdictions to simply maintain the status quo.

The following sub-sections will reflect and discuss how the barriers to renewable energy prevent Ontario from achieving an optimized energy mix. Due to the space and scope limitations of this paper, only a sub-group of the most relevant barriers identified in the literature will be discussed.

1. Politics of renewable energy

The political landscape of the province with regards to renewable energy can be examined in great depth. However, this section will only discuss some of the relevant political issues that have hindered the full development of renewable energy in Ontario since the Green Energy and Green Economy Act of 2009.

When the Liberal government came into power in 2003 under the leadership of Dalton McGuinty, they declared that they would phase out coal-fired power plants entirely by 2007. In 2009, the Green Energy and the Green Economy Act (GEGEA) was created in what they hoped would revive Ontario's ailing manufacturing sector and replace them with 'green jobs'. The renewable energy created as a result of the GEGEA would also replace the energy produced by the coal plants. In this manner, the Liberal Party became the champions of green energy in Ontario and the Conservatives have since always opposed the GEGEA and the development of renewable energy. However, the Ontario Liberals had made these policies reforms under a majority government. In the following election in 2011, they were only able to form a minority government, which made it challenging and caused a lot of uncertainty in the renewable energy sector.

The implementation of renewable energy policies has faced a lot of backlash. Stokes (2013) summarized well the four main political hurdles faced due to the implementation of renewable energy policies in Ontario:

1) Political consensus does not translate to grassroots support
2) Asymmetries between government and private sectors, especially where renewable energy pricing is concerned

3) Difficulty maintaining stability in policies to ensure investor confidence while at the same time adapting policies to reflect new information
4) Conflict when multiple jurisdiction pursue same policies simultaneously

These issues reflect clearly the politics of renewable energy in Ontario since the enactment of the GEGEA. The following sub-sections will highlight the specific challenges Ontario has faced on the political front.

Rising energy costs

In Ontario, the rising costs of electricity have become unavoidable, which in turn leads to high electricity bills for the consumer. The costs of refurbishment of nuclear plants, costs of new transmission lines and distribution and costs of new power plants all contribute to the rising electricity bills (Gorman, 2014). Moreover, though the Debt Retirement Charge will end in 2016 and consumers are expected to see annual savings of a little under $70, the residential electricity bill is expected to actually increase by $120 in the same year (Artuso, 2014). Additionally, the cancelled gas plants in Oakville and Mississauga could cost taxpayers up to $1.1 billion (CBC News, 2013b).

Nevertheless, critics of renewable energy usually place the blame on the high subsidies the government offers for renewable energy technologies through the Feed-in-Tariff program. A recent study, which was sponsored by Environmental Defence Canada, actually suggests that renewable energy (solar, wind and bioenergy) makes up only 9 percent of the consumer's electricity bill in Ontario, while other forms of energy make up 48 percent (Blackwell, 2014). Moreover, the Conservatives have, for the most part, opposed and criticized the Liberal's green energy policies on several occasions (Spears, 2014a; Howlett, 2011). In the recent Ontario elections of 2014, Progressive Conservative leader

Tim Hudak said that ending the Feed-in-Tariff program would save the province $20 billion per year in energy costs, however, he did not mention how he would bring down energy prices (Benzie and Brennan, 2014). Furthermore, the savings cited by Tim Hudak were completely out of proportion as the total electricity expenditure of the province is only $18.7 billion per year (OPA, 2014d).

Although the rising energy costs have little to do with renewable energy and more to do with Ontario's aging energy infrastructure, green energy policies often come under fire as they are perceived as more expensive due to the subsidies they receive. Further, the Conservatives have often used this as an excuse to scrap the Feed-in-Tariff incentives that promote renewable energy in the province. Until the 2014 election in Ontario, where the Liberal's won a majority, the future of green energy in Ontario had been more or less uncertain.

Wind Energy

Wind energy, one of the major forms of renewable energy, has an installed capacity in Ontario of 4.3 percent or 1,500 MW as of February 2013 (IESO, 2013a; IESO, 2013b). Nevertheless, the wind sector has experienced several problems and pushback from local communities, which led to political decisions that limit the development of renewable energy.

Ontario Wind Resistance and Save the Bluffs are examples of anti-wind groups in Ontario that strongly oppose the development of wind turbines by emphasizing potential negative health impacts of wind power to local residents (Ontario Wind Resistance, 2013; Save the Bluffs, 2010). However, a 2010 report on the potential health impact of wind turbines concluded that scientific evidence shows that there is no direct link between the noise of wind turbine and detrimental health effects (CMOH Report, 2010). The Chief Medical Officer of Health, Dr. Arlene King, stated:

> "According to the scientific evidence, there isn't any direct causal link between wind turbine noise and adverse health effects." (OMOHLTC, 2010)

By emphasizing the adverse impacts of wind turbines, anti-wind organizations have created antagonism among residents. However, it is also important to note that most wind farms in Ontario are owned and operated by private sector companies, which restricts community involvement (Blackwell, 2013). A lack of community ownership fosters resistance and scepticism about the benefits of wind energy, which in turn hampers the growth of the industry.

The moratoriums placed on offshore wind energy also provide an insight into the politics of renewable energy. To date Ontario has placed two moratoriums on the development of offshore wind farms. The first moratorium was placed in 2006 to determine the impacts of offshore wind on the surrounding environment (Blackwell, 2011). After adequate assessment, the government decided to lift the moratorium in 2008 (Taylor, 2011). This allowed companies that were interested in offshore wind in freshwater lakes to bring forth the potential for wind development. Trillium Corp, a company interested in wind development, was planning on a 500 MW offshore wind farm in Lake Ontario (Spears, 2013b). However, just before the agreement was made, the province slammed the second moratorium on February 11, 2011 (Spears, 2013b).

Since wind farms in freshwater lakes are not common across the globe, with the exception of a couple of pilot projects in Sweden and in Lake Erie, Ontario would have been a lucrative investment (Taylor, 2011). More investment in the renewable energy sector would also lead to economic growth, job creation and a greater share of renewable energy.

A Conference Board of Canada paper calculated a potential income between $4.8 and $5.5 billion from the offshore wind industry to the provincial economy from 2013 to 2026 (Antunes and Coad, 2010). Additionally, the province of Ontario has at least 2,000 MW of easy to develop offshore wind generation capacity (Antunes and Coad, 2010). These figures indicate that the 2011 moratorium was indeed a costly mistake and a huge step backward for renewable energy development in Ontario.

Many critics claim that this decision was purely a political move on behalf of the Liberal government to win the provincial elections. During the months preceding the election of 2011, the Liberal government faced tremendous opposition. Liberal Leader Dalton McGuninty was greeted by anti-wind protestors in several communities across the province as he had earlier dismissed concerns of residents that opposed wind turbines (Blackwell, 2011). The protests had a significant impact on Liberal strongholds and public opinion became a primary concern for them, as they wanted to retain power in Ontario. Due to the proposed development of offshore wind, several Liberal ridings were under threat. Consequently, the election of 2011 became the centre of the policy decision that put a halt to the development of offshore wind. The offshore wind moratorium of 2011 was an effective tool that was used by the Liberals prior to the elections, enough to temporarily pacify the voters and gain their support in the upcoming elections.

WTO ruling

In November of 2012, the World Trade Organization (WTO) stated that Ontario had breached an international trade agreement through its Green Energy and Green Economy Act (GEGEA) (Howlett et al, 2012). The complaint, filed by Japan and the European Union, stated that it forced producers of renewable energy to buy their products and services from local companies (Howlett et al, 2012).

According to the GEGEA, between 2009 and 2011, all renewable energy projects were required to have 25 percent domestic content that was produced in Ontario (CBC News, 2012a). Beginning in 2012, the local content requirement for renewable energy projects increased to 50 percent (CBC News, 2012a). The local content requirement would allow the renewable energy industry to flourish in Ontario and create thousands of local jobs. Supported by the Government of Canada, Ontario defended its position by stating that the energy produced from the projects are procured by the government and it is thus exempt from the General Agreement on Tariffs and Trade (Neumann, 2012). However, on May 6, 2013, Ontario lost its appeal at the WTO and the province was required to adhere to the rules set by the WTO (CBC News, 2013a; Spears, 2013c; McCarthy, 2013).

The WTO ruling was an example of how political conflict arises when other countries or jurisdictions create similar targets. The local content requirement was a major selling point for the development of the renewable energy sector in Ontario. It would also contribute to the economic development of the province by adding 50,000 jobs by 2018 (Gipe and Weis, 2011). Nevertheless, Ontario's GEGEA was amended to comply with the WTO ruling and all domestic content requirements have been eliminated. Although this decision will allow for more price competition and lower costs of technology for the consumer, the increased competition could also stifle the growth of the green manufacturing sector in Ontario.

2. The Staying Power of Nuclear

In an era of rising concerns of climate change and impacts of greenhouse gases, nuclear energy is often praised for its low contribution to greenhouse gas emissions (Butler et al, 2011). This ideology is reflective in Ontario's adamant pursuit of maintaining its fixed share of nuclear power. This is evident by the green light given to the refurbishment of the Darlington Nuclear plant that will be undergoing repairs in 2016, which only reinforces the dominance of nuclear energy (Macleod, 2013).

The cost of nuclear power

Ontario's Long-Term Energy Plans (OLTEP) not only states the government's support for nuclear power over renewable energy in Ontario, but also the province's dependence on nuclear energy. However, the energy debate has been complicated by the exorbitant investment the province has made in its nuclear reactors (Weis and Stewart, 2010).

Nuclear reactors in Ontario will require extensive repairs and refurbishment as they are approaching the end of their lives. These repairs are estimated at approximately $12.9 billion (Spears, 2014b; Spears 2014c). By observing historical decisions, it can be deduced that the renovations of the reactors always surpass expected costs by substantial amounts. When the Darlington nuclear facility was finally constructed, the costs totalled $14.7 billion compared to its projected cost of $3.4 billion (David Suzuki Foundation, 2013). Therefore, it is expected that the costs for the Darlington refurbishment will be approximately 2.5 times its estimated costs, ranging between $21.25 and $35 billion (Clean Air Alliance, 2010).

Moreover, the Pickering Nuclear Generation Station (NGS) is the oldest nuclear facility in Ontario. Although the operating licenses for Pickering expire in 2014 and 2015, which marks their end of life, their licenses have been extended until 2018 (Government of Canada, 2014). However, they are a huge cost burden for the province. The operations, maintenance and administrative (OM&A) costs for Pickering A and B in 2012 was $145 and $226 million, respectively (Power Advisory LLC, 2012). With a grand total of $371 million in OM&A costs, Pickering NGS is not only the most expensive nuclear generating station in Ontario but also has one of the worst operating records among nuclear plants globally.

An opportunity for Ontario

This is an opportune time to shut down Pickering NGS immediately. Pickering has a total installed capacity of 3,094MW (Pickering A – 1,030MW and Pickering B – 2,064MW) (Power Advisory LLC, 2012). The freed up capacity as a result of an early shut down would make way for 2-3GW of renewable energy sources.

If Pickering were to be shut down today, Ontario would save approximately $840 million per year, which is 5.3% of Ontario's total electricity costs (OCCA, 2012). These savings could be then reinvested in cleaner, cheaper and more decentralized sources of energy production, such as renewable energy technologies and new conservation programs.

The high costs of repairing nuclear facilities will directly affect the public, who will see high electricity costs in the future. The decision to decommission the Gentilly-2 reactor in Quebec proved to be an economically viable option. It was estimated that after the refurbishment of Gentilly-2, the electricity produced would cost consumers 5.3 cents per kilowatt-hour more than what they are currently paying (CBC News, 2012b). Similarly, an increase in electricity costs can also be expected in Ontario if the Darlington plant is refurbished. Moreover, nuclear reactors also incur large maintenance costs over their useful life ultimately making it more expensive than renewable energy sources (OSEA, 2011). Furthermore, the decommissioning of the Gentilly-2 nuclear plant is expected to cost around $1.8 billion (CBC News, 2012b).

Compared to renewable energy technologies that have seen a significant decline in capital costs, the costs for nuclear energy only seem to be increasing (Bridgepoint Group Ltd., 2012). Unlike renewable energy that provides direct benefits for its producers and society at large with more jobs and a cleaner environment, nuclear energy in effect becomes a burden for society with its overwhelming maintenance and decommissioning costs.

Nuclear lobbies

It is imperative to state that the nuclear lobbies in Ontario are strong and forceful, while the proponents of renewable energy are few and scattered. Although organizations such as the Ontario Sustainable Energy Association and the David Suzuki Foundation realize Ontario's potential as a renewable energy leader, the nuclear industry does not fail to portray nuclear power as a clean source of energy that contributes to economic development.

In 2011, the general manager of the Organization of Candu Industries, David Marinacci stated in defence of the Darlington nuclear plant:

> "these plants would act as a catalyst to rejuvenate the nuclear industry and revitalize the Canadian nuclear supply chain, creating thousands of high-paying jobs locally and across Ontario." (Spears, 2011)

This argument represents a one-sided and biased perspective that is absorbed by many without understanding the true costs of nuclear energy.

Furthermore, the nuclear lobbies have proved to be adroit in campaigning for nuclear energy through television commercials (BrucePower4You, 2013). These commercials showcase the nuclear reactors in Ontario as a source of employment for the many Canadians that depend on it. Additionally, they state that nuclear energy is both clean and renewable. This poses a conundrum for renewable energy lobbyists who now have to educate the audience about the problematic information distributed by these nuclear lobbies.

Inflexible energy

Unlike natural gas plants, nuclear generators are not flexible as they cannot easily start and stop their electricity generation. This means that the power output produced by nuclear energy cannot be increased or decreased to meet immediate changes in electricity demands or electricity generation from variable sources (Mills, 2010). Due to the high amount of nuclear energy on the grid, Ontario now has to curb the wind energy production that is generated by Ontario wind power companies (Spears, 2013b). Furthermore, when there is too little demand, the Independent Electricity System Operator (IESO) will turn off the power generated by these wind turbines and will provide a partial compensation for the wind companies (Spears, 2013b). By turning off energy that is produced by a fuel source that is free and compensating producers to do so, Ontario is sub-optimizing its renewable energy production in favour of nuclear power.

3. Consumer affordability of renewable technologies

An opinion poll conducted in Ontario in November of 2012 that surveyed 1,000 people showed a strong support for green energy. Nearly 83 percent of the respondents stated that it is very important to have renewable energy (Friends of the Earth, 2012). Although this survey did not examine why people prefer renewable energy and how it compares to conventional sources of energy production, it would suggest that Ontarians generally have a positive attitude to renewable energy. Another survey conducted in the Eastern Ontario Highlands revealed that residents strongly supported renewable energy technologies, in particular solar technologies (Fast and McLeman, 2012). Nearly 87 percent supported solar rooftop installations and 79 percent supported solar farms. Although one of the goals of the Green Energy and Green Economy Act (GEGEA) was to increase community projects, most of the renewable energy projects in Ontario are owned by large companies, unlike Germany, where more than 50 percent of production is owned by its citizens (REM, 2012; Blackwell, 2013; Iler and Iler, 2013). While the surveys show that Ontarians support renewable energy, there is certainly a lot less public investment in this sector.

Although the awareness and attitudes toward renewable technologies is usually assessed through primary research, a few key facts and statistics can be analyzed to determine if Ontarians can actually afford renewable energy technologies. The following sub-sections will look at different aspects, such as dwelling, household expenditure, income and debt, costs of the technology, which would be considered prerequisites for consumers to install renewable energy systems, specifically solar photovoltaics.

Residential considerations

Homes need to fit certain criteria in order for homeowners to install solar photovoltaics. In 2011, according to Statistics Canada, approximately 58 percent of households in Ontario comprise of what is termed as single detached dwelling (Statistics Canada, 2013a). Furthermore, the likelihood of these dwellings being owned by those who live there is also high, as nearly 67 percent of all households in Ontario were owned dwellings (Statistics Canada, 2013a). Since a good number (39%) of these homes are single detached and owned, they would most likely not belong to a condominium society giving the owners freedom to install renewable energy technologies as compared to homes that are rented or part of a condominium development.

Household Expenditure, Income and Debt

1) Expenditure

The household expenditure shows the monetary amount a household requires to meet its needs. The average household in Ontario comprises of 2.6 individuals (Statistics Canada, 2013b). The average household expenditure in the province of Ontario was $77,554 in 2011 which was the second highest in Canada, after Alberta (Statistics Canada, 2013c). This shows that Ontarians enjoy a high quality of life. However, the nature of the expenses can be better understood by considering the specific categories of expenditure (See Table 1 below). For example, household furnishings and equipment, clothing and accessories, recreation, tobacco and alcohol, games of chance and miscellaneous expenditures, which although are somewhat essential, can be adjusted and reduced. In Table 1, it can be determined that Ontarians on an average spend 15.7% of their total expenditure on these items, which is not significantly lower than the Canadian average of

16.4% (Statistics Canada, 2013d; Statistics Canada, 2013c). If Ontario households spend roughly $12,000 each year on such expenditures, a fair assumption can be made that they can make some allowance in their yearly expenditure for an investment in renewable energy technologies, depending on their preferences. Thereby, the miscellaneous expenditure component can be quite variable and flexible.

Table 1 – Average household expenditure (Ontario)

Average household expenditure, by province
(Ontario)

	2010	2011
	$	
Total expenditures	**75,163**	**77,554**
Total current consumption	55,803	57,514
Food expenditures	7,709	7,832
Shelter	16,760	16,960
Principal accommodation	15,120	15,809
Other accommodation	1,640	1,151
Household operation	3,934	4,458
Household furnishings and equipment	2,090	2,123
Clothing and accessories	3,658	3,624
Transportation	11,506	11,290
Health care	1,828	1,859
Personal care	867	1,090
Recreation	3,428	3,706
Education	1,456	1,575
Reading materials and other printed matter	177	217
Tobacco products and alcoholic beverages	1,088	980
Games of chance	131	159
Miscellaneous expenditures	1,172	1,641
Income taxes	13,359	13,603
Personal insurance payments and pension contributions	4,128	4,400
Gifts of money, alimony and contributions to charity	1,874	2,037

Source: Statistics Canada. (2013c, January 30). *Average household expenditure, by province (Ontario)*. Retrieved May 2, 2013 from http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil130g-eng.htm.

2) Income

Table 2 below breaks down the total income level by the number of individuals in each income group. In 2010, nearly 95 percent of Ontarians fell in the 'under $50,000' income category (See table 2 below) (Statistics Canada, 2012a). The median total income in Ontario was $29,520 (Statistics Canada, 2012a). However, the median income for families with two or more people was $71,540 compared to the national average of $69,860 in 2010 (CBC News, 2012c; Statistics Canada, 2012b). Although individual income levels are important, the income of families is more relevant in this case as renewable technologies, primarily solar photovoltaics are usually applied to detached homes where families comprising of two or more people would most likely live. Since the median family income is high, compared to national levels, families living in detached or semi-detached homes in Ontario probably have a higher likelihood of installing renewable technologies. However, the adoption of renewable energy in the residential sector has been slow.

Table 2 – Individuals by total income level (Ontario)

Individuals by total income level, by province and territory (Ontario)

	2006	2007	2008	2009	2010
	number of persons				
Ont.					
Total, all income groups	**9,150,570**	**9,222,080**	**9,363,100**	**9,487,810**	**9,627,930**
Under $5,000	906,280	830,210	845,850	888,840	891,310
$5,000 and over	8,244,290	8,391,880	8,517,250	8,598,980	8,736,610
$10,000 and over	7,392,820	7,576,750	7,716,880	7,799,470	7,998,820
$15,000 and over	6,501,680	6,684,280	6,836,080	6,892,570	7,050,370
$20,000 and over	5,619,110	5,814,630	5,965,030	6,010,420	6,127,700
$25,000 and over	4,927,620	5,110,150	5,251,330	5,273,620	5,375,000
$35,000 and over	3,737,310	3,919,210	4,068,870	4,076,910	4,185,550
$50,000 and over	2,306,600	2,463,610	2,599,940	2,604,040	2,714,250
$75,000 and over	1,021,470	1,134,570	1,225,130	1,231,850	1,305,780
$100,000 and over	461,670	520,970	565,070	566,380	602,790
$150,000 and over	174,200	192,640	205,080	203,170	212,370
$200,000 and over	99,560	107,060	111,410	107,690	112,250
$250,000 and over	67,020	71,830	73,390	69,790	72,850
	$				
Median total income	**27,900**	**29,080**	**29,700**	**29,280**	**29,520**

Source: Statistics Canada, CANSIM, table 111-0008.
Last modified: 2012-06-27.

Source: Statistics Canada. (2012a, June 23). *Individuals by total income level, by province and territory (Ontario).* Retrieved May 3, 2013 from http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil105g-eng.htm.

3) Debt

Since installing renewable energy systems requires a substantial capital investment, it can be expected that a majority of the population would take bank loans to finance their projects. The household debt to personal disposable income ratio has been increasing in Canada and has recently crossed 150 percent (Chawal and Uppal, 2012). The national household debt averaged at $114,400, however, household debt in provinces such as Ontario range between $124,700 and $157,700 (Chawal and Uppal, 2012). Although the family income in Ontario might be high, a large household debt could prevent households from making large capital investments which would impede the adoption of renewable technologies.

4) Cost of solar photovoltaics

Although wind energy usually makes up the greatest share of renewable energy sources, wind turbines are generally more suited to rural installations or on farmlands due to their size, space requirement and need for a wind pattern that is not obstructed by tall buildings (CanWEA, 2008). On the other hand, solar panels generally offer urban consumers a feasible solution, although it is necessary to know the amount of solar radiation a certain location would receive throughout the year. Furthermore, approximately 99 percent of microFiT applications are for solar photovoltaics (OPA, 2011). A business case for solar photovoltaics is considered in this paper, since it is the most popular renewable energy technology

In this section, the potential costs of installing solar panels on residential rooftops are examined based on price quotes from an online vendor in Ontario. Solartrader.ca, a website that sells solar energy technologies, provided their prices for a sample of panels. These prices varied by the type of module (such as monocrystalline, polycrystalline or thin film), the wattage, number of cells, performance and the manufacturer.

Table 3 is a comparative study of the potential costs of solar panels of three different companies. As illustrated, the total upfront costs to install a 5kW solar photovoltaic system are approximately $20,000 that would need to be funded through external borrowings.

Table 3 – Cost comparisons of solar systems

	Eclipsall	Siliken	Heliene	**Average***
Specifications				
Approx. size (kW)	5	5	5	**5**
Approx. size (W)	5000	5000	5000	**5000**
Actual size of system (kW)	4.90	4.90	4.95	**4.92**
Cost per panel	$239.99	$245.00	$278.82	**$255**
Wattage of module (W)	245	245	275	**255.00**
Number of panels required	20.41	20.41	18.18	**19.67**
Actual number of panels required	20	20	18	**19.33**
Costs				
Panels	$4,800	$4,900	$5,019	**$4,906**
Racking System	$2,815	$2,815	$2,815	**$2,815**
Inverter	$2,927	$2,927	$2,927	**$2,927**
Miscellaneous	$1,000	$1,000	$1,000	**$1,000**
Labour	$3,375	$3,375	$3,150	**$3,300**
Application fee - OPA	$500	$500	$500	**$500**
Application fee - Local energy company	$2,500	$2,500	$2,500	**$2,500**
HST	$2,329	$2,342	$2,328	**$2,333**
Total upfront costs	**$20,246**	**$20,359**	**$20,239**	**$20,281**
Energy Generation				
Avg. sunlight in Toronto/year (hours)	1025	1025	1025	**1025**
Optimal generation of system (kWh/year)	5023	5023	5074	**5040**
Average generation (kWh/year)	4730	4730	4778	**4746**

*Average of the three numbers in the columns Eclipsall, Siliken and Heliene
(Refer to Appendix 1 for a detailed breakdown of the calculations, assumptions and references)

Costs

The cost of a 245W polycrystalline panel manufactured by Eclipsall costs approximately $240, and a similar panel by Siliken costs $245 (Solar Trader, 2014a; Solar Trader, 2014b). However, the cost of a 275W polycrystalline Heliene panel is about $280 (Solar Trader, 2014c). For example, if a homeowner were to install a 5kW system (approximation), it would require a set of 20 panels from Eclipsall and Siliken, which would cost $4,800 and $4,900 respectively, and $5,019 for 18 Heliene panels. Installing a solar system also requires a racking system, inverter, miscellaneous materials and labour costs for installation of the solar photovoltaics which are significant. Furthermore, there are costs for the application fees of the FiT program and the Connection Impact Assessment together with the Harmonized Sales Tax. The total costs amount to approximately $20,000 for a 5kW system, which would be the amount a homeowner would need to borrow from the bank if they cannot directly pay the upfront costs for such a project. Using the above example, for a 5kW project, a homeowner can receive nearly $37,000 in monetary benefits under the microFiT program at $0.396 per kWh. Using the example in Table 3, a homeowner would be benefitted by over $5,000 through the microFiT program over the expected 20-year purchasing contract provided by the program (refer to Appendix 1).

Funding options for homeowners

Ontario homeowners can obtain funding from banks in several ways. In this section two main types of bank loans have been examined – home improvement loans and home equity loans. Home improvement loans offers financing options for a home renovation or a home improvement project (e.g. RBC Royal Bank, 2014a). Home equity loans combine a homeowner's mortgage with a credit line under one plan[2] (RBC Royal Bank, 2014b). This loan can be designated for different needs including home renovations, a new car or a child's education. However, the homeowner must have at least 20% share of equity in their home. The funding costs for this project, based on the average total upfront costs in Table 3 is $20,281.

Home improvement loan: The current interest rate of 5.99% for the home improvement loan for 5 years (the regular term offered by banks for such a project) works out to

[2] Here the assumption is that the interest on the line of credit is the same as the mortgage interest and can be extended up to 20 years.

approximately $23,500 (RBC Royal Bank, 2014a). This would equal to a fixed monthly instalment of $391 per month for the entire term of the loan for 5 years. However, the benefit in net present value terms would be approximately $5,500 over the life of this project, i.e., for 20 years, with a monthly benefit of $157 obtained from the microFiT program.

Home equity loan: Alternatively, a home equity loan could be obtained. For example, BMO offers a 5-year fixed-term (closed) mortgage at 3.29% (BMO, 2014). While the benefit will remain the same under both loan types at $157 per month for 20 years, the funding payments will be significantly reduced to $115 per month. Thus, the homeowner would have a monthly benefit of $42 over the life of the project.

Table 4: Comparison of Cash Flows for Home Improvement and Home Equity Loans

	Home Improvement Loan	Home Equity Loan
Cash Flows		
MircoFiT Rooftop price/kWh for solar	$0.396	$0.396
Benefit under FiT/year	$1,879.28	$1,879.28
Benefit under FiT/month	$157	$157
Benefit under FiT (cash inflows)	$37,586	$37,586
NPV of cash inflows	*$25,940*	*$25,940*
Funding payments/month	*$391*	*$115*
Funding costs (cash outflows)	$23,479	$27,652
NPV of cash outflows	*$20,281*	*$19,084*
NPV of total cash flows	**$5,658**	**$6,856**

(Refer to Appendix 1)
Assumption: The borrowing interest rate can be renewed at the same level up to 20 years, i.e. for the life of the project.

Most solar panels do generate energy even after 20 years albeit with a slight reduction in efficiency (Zielnik, 2009). This is a simple example of how an individual homeowner can fund a typical renewable energy project, however, alternative funding options, such as community-based initiatives might also be available (TREC, 2012).

We can see from the above example that solar projects provide a direct monetary benefit for its producers, even with the high associated costs. With the large number of semi-detached or single-detached homes in Ontario, solar projects can be installed on many a rooftop. Nevertheless, rooftop solar projects are not yet observed on a significant portion of homes in Ontario. The current installed capacity in Ontario, as of 2014, is only 1,168MW with an additional 998MW of projects under development (OPA, 2014e).

Although other external factors may play a role, it is hypothesized here that the inadequate knowledge of the actual costs and benefits and the flawed perception of its affordability are preventing Ontarians from adopting renewable energy technologies. These observations are particularly salient due to the fact that high household incomes exist in Ontario and have 'flexible' expenditure capabilities. In other words, many families in Ontario are, at least theoretically, in a position to install renewable energy technologies if proper financing and better information mechanisms are implemented. Although it must be acknowledged that an already large debt would certainly prevent households from taking on additional debt to finance their renewable energy projects.

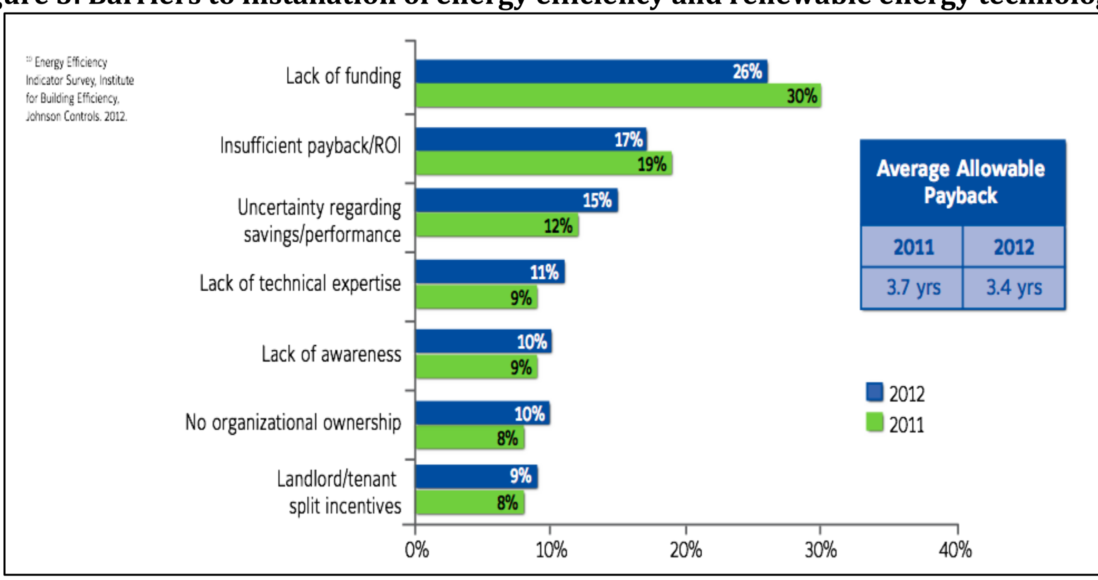
Chapter Summary

The analysis presented in this chapter indicates that unless measures are implemented to change the minds of politicians, nuclear is here to stay for the long haul in Ontario. With the politics of renewable energy policies, the reliance on nuclear power and the lack of consumer awareness regarding true costs of renewable energy, transitioning to a green energy economy may seem challenging. However, one way to tackle the difficulty in transitioning to a clean energy economy is placing the power in the hands of the energy consumer at the grassroots level. Directly involving consumers in the production of renewable energy will create an environment that can foster a sustainable energy mix in the province by increasing the share of renewable energy. It is therefore important that consumers are not burdened with the high upfront costs of energy efficiency installations and renewable energy technologies. If Pickering Nuclear Generation Station were to be shut down today, the government could create a massive 2-3 GW market opportunity overnight for new sustainable energy solutions such as renewable energy and conservation. In the next chapter I will look at examples of innovative programs aimed at addressing the barriers to renewable energy implementation.

Chapter 4: Examples of financing models

Although the cost of solar photovolatics has decreased significantly, the high capital costs still remain the major barrier to installing renewables. The chart below shows a study conducted by the Institute for Building Efficiency, Johnston Controls and PACENow. The graph shows some of the key barriers to the installation of energy efficiency systems and renewable energy technologies. As can be observed, the greatest challenge is a lack of funding mechanisms or a high cost barrier. Although some percentage of the population might be willing to invest, most people are concerned about the perceived high costs of such investments. Moreover, to finance such projects, they would need to borrow money through home equity loans or rely on government funding or incentives (NREL, 2010).

Figure 3: Barriers to installation of energy efficiency and renewable energy technologies



Source: Institute for Building Efficiency. (2013, February). *Setting the PACE: Financing Commercial Retrofits*.

In this chapter, I will summarize key examples of financing models that have been adopted in other jurisdictions to deal with the issue of high cost barriers. Although two salient Canadian examples are provided, the most prominent examples hail from the United States, i.e., the PACE program and SolarCity.

Manitoba Hydro

Manitoba Hydro is a Crown Corporation that provides natural gas and electricity, which is generated primarily through hydropower, to customers in the province of Manitoba (Manitoba Hydro, 2014a). They provide an Energy Finance Plan which is an on-bill financing for electrical systems and gas upgrades, such as air source heat pumps, unit heaters, electric and natural gas furnaces, central A/C systems, which is specified on their website (Manitoba Hydro, 2014b). This financing is available to all their customers. Each property owner can borrow between $500 and $5,000 with a maximum financing term of five years at an interest rate of 6.75% (Manitoba Hydro, 2014b). Therefore, a property owner could pay anywhere between $9.80 (for a $500 loan) and $97.95 (for a $5,000 loan) per month for five years[3]. The Power Smart Residential Loan covers more expensive upgrades that are not covered in the Energy Financing Plan, such as high efficiency natural gas furnaces, windows, doors, insulation, and ventilation equipment (Manitoba Hydro, 2014c). Under this loan, customers can borrow up to $7,500 for a five-year term fixed at 4.8%, with the exception of high efficiency natural gas furnace, which is available for a 15 year-term. To qualify for this loan only licensed contractors participating in this particular program can make the upgrades. This shows that the contractors have been vetted by

[3] The payment is calculated using the loan payment calculator on the Manitoba Hydro website.

Manitoba Hydro and are professionally qualified to make the upgrades. However, it should be noted that the loan is not transferable upon sale of the property and would need to be paid in full (Manitoba Hydro, 2014b). The benefit of this program is that customers can not only borrow directly from the utility company and finance their efficiency upgrades, but also receive on-bill financing.

British Columbia

Similar to Manitoba Hydro, British Columbia is testing out pilot projects for on-bill financing, which defer the upfront costs. The two energy efficiency pilot financing programs have been launched by the province of British Columbia, in a partnership with FortisBC and BC Hydro, in Colwood and in the South Okanagan (Province of British Columbia, 2014). Under the FortisBC Renovating for Efficiency Loan Program, eligible homeowners, in the South Okanagan region, can borrow up to $10,000 to financing energy efficiency projects with an interest rate of 4.5% for 10 years (FortisBC, 2014). The BC Hydro Home Loan Pilot Program is available to customers in the City of Colwood. This program also allows homeowners to borrow up to $10,000 at an interest rate of 4% (Province of British Columbia, 2014). The contractors that do the upgrades must be certified.

Unlike Manitoba Hydro, these programs provide the homeowners with the option of transferring the loan upon sale of the property to the new buyer. In January 2014, the pilot program, which began in 2012, has been expanded to Vancouver Island and Kelowna (Government of B.C., 2013).

Property Assessed Clean Energy Financing

The PACE program was developed in the United States as a means to remove the barriers to increase residential energy efficiencies and retrofits (NREL, 2010). It addressed this major issue of lack of capital by creating assessments, where the property is secured by a seniority of lien[4] by the local government of the property. The assessment is repaid through the homeowner's property tax bill without the necessity of any upfront payment on behalf of the homeowner. Moreover, if the homeowner defaults, the lien and the assessment, which are linked to the property, can be transferred on sale of the property (NREL, 2010). The homeowner usually repays the assessment over a period of fifteen to twenty years while receiving the benefits from the installation of renewable or energy efficiency technologies.

Brief History

The early origins of the Property Assessed Clean Energy (PACE) program can be traced back to Berkley, California in 2008 (Institute for Building Efficiency, 2013). The City of Berkley launched the Financing Initiative for Renewable and Solar Technology (FIRST) program, which ran a pilot program that allowed the installation of solar PVs using a new kind of financing system (City of Berkley, 2014). This program allowed property owners the opportunity to borrow money from the Sustainable Energy Financing District of the City of Berkley. With $1.5 million in allocated bond funding the City would be able to finance up to 40 solar installations (Green Cities California, 2013). The amount was issued at 7.75% rate for 20 years (Fuller et al, 2009). The property owner repays the bonds

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[4] Seniority of lien is the same as a senior debt, which is borrowed money that must be paid off first by a company if it goes bankrupt.

through their property tax bills over a period of 20 years. By 2009, $336,550 of the $1.5 million funding was utilized which provided 13 installations (Green Cities California, 2013).

Additionally, the FIRST program was also a tool for public education and awareness. The staff of the FIRST program conducted three public information workshops and the City also involved the local community and other stakeholders to gauge the receptiveness towards the program (Fuller et al, 2009). The program received 77 applications within the two-week window for submission of applications, however, only a few applications were accepted because of time and budget constraints (City of Berkeley, 2014).

Examples of the PACE program

In the United States, there are currently 17 PACE programs that have been developed (PACEnow, 2012). Below are a few examples of PACE programs that have been successful.

Home Energy Renovation Opportunity (HERO): The HERO program is considered the most successful PACE program in the United States. It was launched in December 2011 in cities within Riverside County in California (Clean Energy Finance Center, 2013). It has since expanded to include over 93 communities in California. This program provides financing for energy efficiency, water efficiency and renewable energy technologies. Property owners can borrow for a period of 5, 10, 15 or 20-year periods up to 15% of their property value (HERO, 2014). It appears as a line item on the homeowner's property tax bill through which it is repaid. In 2014, two years after the program began, $200 million dollars have been allocated for home energy improvements with $300 million more that were approved (Hales, 2014). The program is responsible for creating over 1,600 jobs in the region with over 1,300 registered contractors (SanBag, 2014).

Figtree OnDemandPACE™: Figtree Financing is a clean energy financing company based in California (Figtree Financing, 2014). This program provides PACE financing for commercial property owners, which helps lower their utility bills through energy efficiency, water conservation and renewable energy technologies. The Figtree OnDemandPACE was launched in 2014 to reduce the cost of financing and speed up the funding for commercial projects (PACENow, 2014). This program provides 100% financing and is designed to allow projects to be structured in less than 15 days (NJPACE, 2014). Figtree partnered with a financial institution to receive up to $60 million in capital to fund commercial PACE projects (PACENow, 2014).

Palm Desert, California: In 2008, the City launched the Palm Desert Energy Independence Program (EIP), which made affordable the financing of energy efficiency and solar energy projects (Palm Desert, 2014). The funding for this project took two forms. In the first phase of the project, $2.5 million was funded from the city's general fund (Fuller et al, 2009). In the second phase, $5 million in bonds were issued by the city's Redevelopment Agency. An average of $38,000 per project was made available in funds with 206 project applications (Fuller et al, 2009). However, most of the projects under the two phases were not residential projects. In 2010, the City released another $6 million in funding, however, half is reserved for energy efficiency upgrades and the other half for solar projects (Palm Desert, 2014).

Benefits of the PACE program

There are several benefits to PACE program which include:

- Providing loans at competitive interest rates as the local governments (or clean energy assessment districts) have good credit ratings
- Removing the high upfront cost barrier to the installation of energy efficiency and renewable energy technologies or systems
- The loans are attached to the property and not the property owner
- Payments of the assessments are made easy through smaller and manageable monthly costs
- Transferability of the investment upon sale of the property or default of the homeowner

SolarCity

Another great example that can be applied to Ontario would be the SolarCity model. SolarCity is an American company, which uses a novel approach to finance solar projects. They are involved in every aspect of the solar project, including financing, installations, permits and design, and all of this is done in-house (SolarCity, 2014). This kind of a holistic service is especially convenient for the homeowner.

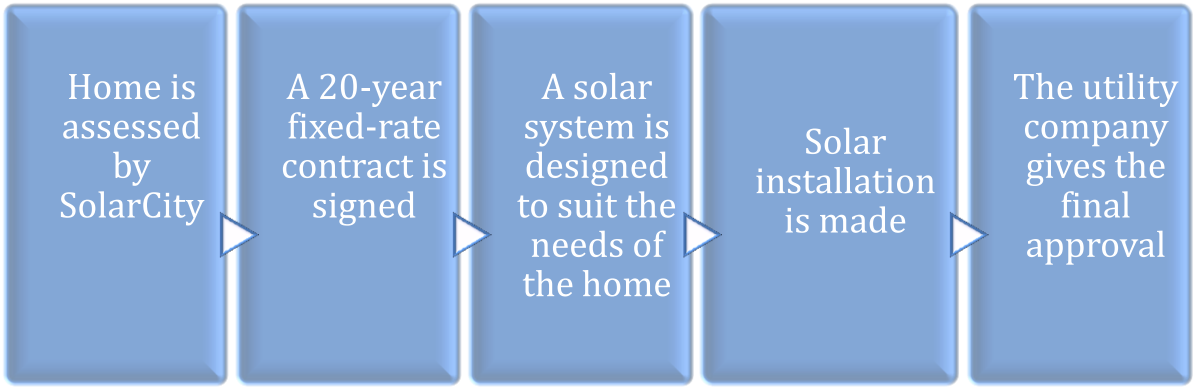
SolarCity installs and maintains solar panels and then leases them to the homeowner. The power produced by the panels is sold back to the utility company and the homeowner immediately sees a difference on their electricity bill. The savings from using the electricity produced from the panels enables the homeowner to make the lease payments for the solar system.

Financing options

For residential purposes, SolarCity offers customers three main financing options (Solar City, 2014):

1) Solar Lease – according to the company, the most popular is the "$0 down solar lease". This provides several advantages for the homeowner:
    - Eliminates the high upfront cost barrier for homeowners
    - Reduction in energy bills
    - Reliable rates that are locked-in for 20 years
    - Additionally, SolarCity provides free maintenance and insurance for 20 years
2) SolarPPA – SolarCity also offers the option of a solar Power Purchase Agreement. This is a contract, whereby the customer agrees to purchase solar power for a fixed rate, which is competitive with rates offered by the local utility. In this option, the homeowner only pays for the electricity they have purchased. The system, which is installed on the homeowner's rooftop, is maintained and owned by SolarCity.
3) Purchase Package – this option is mainly for homeowners that can afford to purchase a solar system. Here, the homeowner can obtain a 30% or more credit on their tax returns, which are federal-level and state-level solar tax rebates. The payback period on this investment is between six and eight years. Moreover, SolarCity offers a 30-year protection plan for the solar system, which involves repairs and insurance.

The steps



Firstly, SolarCity sends in their consultants to assess the home, the roof and energy use to determine the benefits of solar installations for the particular property. If the consultants determine that the home will benefit from the solar installations, SolarCity provides the homeowner with several project options to increase energy savings. Next, a 20-year contract is signed with fixed interest rates. 'Site Surveyors' are then sent in to take measurements and to conduct a roof inspection. Once this is done, a solar system is designed specifically to suit the needs of the home. Finally, the installations are completed in a single day and SolarCity takes care of all the necessary permits and inspections. The utility company gives the final approval.

It is important to note that SolarCity has received financing from the Bank of America, Merrill Lynch and Google, as well as a 30% federal tax credit for solar installations (EY, 2013). These tax credits came into effect in 2005 and in 2017 it will be reduced to 10% (EY, 2013). This will likely present some challenges for the company in the future.

Nevertheless, SolarCity has gained huge success in the US market. In 2012, SolarCity had installed 156MW of solar PV systems across the United States (Krulewitz, 2013). A Greentech media study shows that SolarCity is the leading installer within the residential markets of California and Arizona and ranks number one in other states as well (Krulewitz, 2013).

Figure 4: Residential Market Size and SolarCity Market Share

	2012 Residential Market Size (MWdc)	2012 SolarCity Market Share	Rank
CA	196	17.2%	1
AZ	62	32.5%	1
NJ	40	3.5%	4
MA	16	13.8%	1
NY	15	15.3%	2
MD	8	34.3%	1
CT	6	7.7%	4

Source: Krulewitz, A. (2013, March 18). The Numbers Behind SolarCity's Success: Greenteach Media. *Greentech Media*. Retrieved July 27, 2014 from http://www.greentechmedia.com/articles/read/The-Numbers-Behind-SolarCitys-Success.

Chapter Summary

The examples in this chapter show that such program models can fund several different kinds of energy projects (energy efficiency and renewable technologies) and obtain financing through different means (bonds, reserve funds, etc.). More importantly, the high application rates prove that these models, specifically the PACE program and SolarCity, have been successful in the jurisdictions in which they have been implemented. Furthermore, there are numerous benefits to the adoption of a similar kind of program, the most important being the availability of financing for projects with high capital costs which prevents homeowners from increasing energy efficiencies and installing renewable technologies.

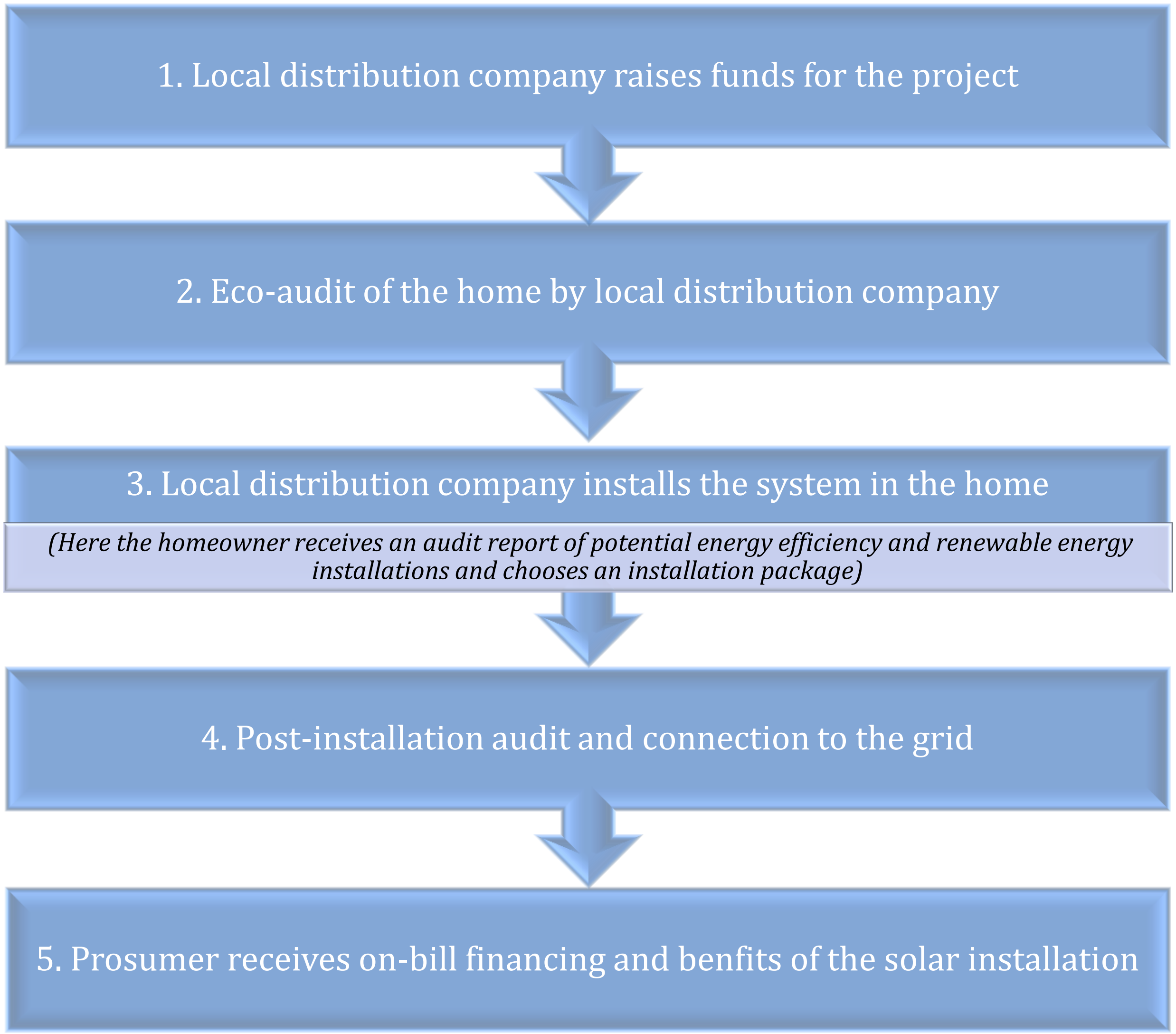
Chapter 5: A model for Ontario

In the previous chapters, I have highlighted that one of the main barriers to the adoption of renewable technologies, specifically solar photovoltaics, is the perception of the high capital costs related to these technologies and the limited knowledge about the financial benefits related to the microFiT program.

Unlike the case in the United States where the program model is adopted by the city or county, and the payments are included as an additional charge to the property taxes, I am recommending that the local energy distribution companies (LDCs) in Ontario adopt this model, since many LDCs already handle the distribution of energy and FiT applications. Also, as stated in the conclusions of Chapter 3, placing the power in the hands of the energy consumer will create a grassroots awareness of the benefits of renewable energy that can promote a sustainable energy mix in Ontario.

In this section, a model that encourages the LDCs in Ontario to adopt a financing model similar to SolarCity and the PACE program, which has been successful in the United States, is proposed. In this model, the homeowner becomes a "prosumer", i.e., a producer and consumer of energy. Although different kinds of renewable technologies and energy efficiency systems can also be applied under this model, I will only focus on solar photovoltaics (PVs) due to the limitations of this paper.

The following is an overview of the proposed model:



The following sections will go into more details about the specifics of this proposed program.

1. The Local Distribution Company (LDC) funds the project

The LDC would need to raise capital to finance this initiative. Since most Ontario's LDCs usually have good credit ratings, they would be able to borrow or raise debt capital at significantly lower rates than homeowners and other small businesses. For example, Toronto Hydro in 2012 had a credit rating of 'A (high)' according to DBRS and 'A' according to S&P (Toronto Hydro Corporation, 2012a; Spears, 2012). Similarly, Hydro One also has a credit rating of A (Hydro One, 2013b).

Why should the LDCs adopt this model?

In Ontario the distribution of electricity, from high-voltage to low-voltage transmission systems, to homeowners and other institutions is the responsibility of LDCs (OPA, 2014a). There are nearly 80 of these LDCs, which can be publicly or privately owned, but are mostly owned by local municipalities. The Ontario Energy Board regulates the electricity rates that these companies charge the consumers.

Moreover, these LDCs also maintain the local electricity wires and also create energy conservation programs. Additionally, they are also responsible for approving the connection of renewable energy projects under the FiT and microFiT programs (OPA, 2014a). Therefore, it would be fitting for the LDCs to introduce a program whereby homeowners or small business owners are able to finance their efficiency and renewable energy projects through the energy company.

The benefits for LDCs of having energy consumers become prosumers are numerous. These include less need for investment on distribution, less centralized assets and less transmissions losses, while obtaining new market and business opportunities.

Funding can be raised in the following ways:

Debt: Ontario LDCs could be encouraged by the province to issue debt, such as bonds, like the energy districts in the US examples at a lower coupon or yield due to their higher credit rating. Moreover, the debt offering can be marketed to investors as a 'socially responsible investment'. An investment is considered socially responsible when the associated company adopts environmental sustainability and alternative energy or clean technology initiatives (Investopedia, 2014). Many ethical and pension funds are likely to invest in such an offering as it can be considered a socially responsible investment and has been gaining momentum over the past few years. For example, the Canadian Pension Plan and Investment Board states on its website that they consider and integrate Environmental, Social and Governance (ESG) risks and opportunities into their investment decisions (Canada Pension Plan Investment Board, 2014). Moreover, they believe that such responsible investing will most likely create a long-term sustainable value for an organization.

The LDC could also issue callable bonds that they can redeem or pay back prior to the maturity of the bond. This enables the issuer to repay the debt and enter into a new refinancing arrangement, if interest rates fall.

An example of debt, are the bonds issued by Toronto Hydro in April 2013. Toronto Hydro sold C$250 million of 2.91 percent series 8 senior debentures due April 10, 2023 (10-year bonds) and also sold C$200 million of 3.96 percent series 9 senior debentures due April 9, 2063 (50-year bonds) (Reuters, 2013). Since the typical microFiT program is for 20 years, I have used a linear interpolation formula to calculate the rate at which the energy company can issue its bond offering or debt securities with a maturity of 20 years.

Linear Interpolation Formula (ISDA, 2010):

$$d = d_1 + \frac{g - g_1}{g_2 - g_1} * (d_2 - d_1)$$

d = rate for 20 years
d_1 = 2.91%
d_2 = 3.96%
g = 20
g_1 = 10
g_2 = 50

$$d = 0.029 + \frac{20 - 10}{50 - 10} * (0.0396 - 0.0291)$$

$$= 0.03165 \text{ or } 3.165\%$$

On interpolating the data obtained from the debts issued by Toronto Hydro in 2013, the LDC can potentially finance the project by issuing debt securities at 3.165%. However, legal and administrative costs to mobilize the debt offering would also apply, and hence I have arrived at an all-inclusive rate of 3.99% for 20 years at which the energy company can lend to the homeowners. This rate is still 2% below than the 5.99% rate for a 5-year loan that an individual homeowner would normally be able to access in the open market.

Loans: The energy company could also borrow from a lending institution. Again, since the LDCs have a better credit rating, they can obtain loans at lower rates and at more favourable terms than individual homeowners and small businesses. I have considered this rate to be the same as the debt offering, i.e., 3.99% per annum, for 20 years.

Green Bonds: The province could also issue green bonds[5]. The tax-exempt status of green bonds makes them attractive to investors. For example, the state of Massachusetts successfully sold $100 million fixed-rate, tax-exempt Green Bonds to investors, which are used to fund environmental and energy projects (Commonwealth of Massachusetts, 2013). The bonds yielded between 3.25% and 3.85% for 20-year bonds (Collier, 2014). As Ontario will be issuing Green Bonds (Gutscher, 2014), the province can earmark part of these funds towards funding LDCs for renewable energy projects.

Zero-interest finance: In 2010, the Better Buildings Partnership (BBP) offered zero-interest financing for private multi-residential rental buildings as well as institutional and not-for-profit organizations (City of Toronto, 2010). These loans were offered through the City's Sustainable Energy Funds (SEF) program. SEF used a pay-from-savings model, where the savings from the FiT program paid back the upfront capital costs of the project, which enabled them to offer zero-interest financing. Similarly, municipalities can tap into resources, such as the Green Municipal Fund[6] and other SEFs, which can be used in tandem with the LDCs to establish a zero-interest loan program to fund renewable energy projects. The funding risk of the zero-interest lending program can be underwritten by the province with part of the savings on the operating costs from an early 2014 shut down of the Pickering Nuclear Generating Station. Thus, even if the municipalities cannot help finance these zero-interest loans, the LDCs can still issue zero-interest loans with the backing of the province.

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[5] Green bonds are created to encourage investments in sustainable projects, such as renewable energy projects.

[6] Green Municipal Fund (GMF) is offered by the Federation of Canadian Municipalities to fund municipal environmental initiatives. The GMF funds projects (with below-market loans and grants), feasibility studies and plans (FCM, 2014).

Since this is a new initiative and the demand for this kind of model is yet to be determined by the LDCs in Ontario, the loan option might be a better interim solution. The LDC could have a temporary lending arrangement or use a flexible financing tool with a financial institution, such as a revolving loan facility or revolving credit. This means that the lending institution gives the borrower the flexibility to decide the number of times and intervals they choose to withdraw from the loan (Investopedia, 2014). Furthermore, this type of loan can be re-drawn, repaid or drawn-down. However, this is usually a short-term loan (Investopedia, 2014).

Using this type of financing tool, the LDC could enter into a credit arrangement with its financial institution to borrow up to $2,000,000 (which would fund an average of 100 homes[7]) or a monetary cap they foresee, and then monitor the demand for a year. This type of loan would allow the LDC to use as much money as they need, within the authorized limit, to finance the projects. They could also have a trial period of six months to a year to determine the demand for the program initiative and depending on the success of the program they could then consider issuing debt. Additionally, the local distribution company could also explore other options such as conducting a feasibility study or a pilot project for a few homes to better understand the demand-response.

[7] $2,000,000/$20,000 = 100
$2,000,000 = amount borrowed
$20,000 = the amount that is needed to finance project is ~ $20,000 (See Appendix 1)

2. Home energy audits

To assess the feasibility of the installing energy efficiency or solar photovoltaic systems, a home energy audit would need to be conducted.

The EcoEnergy Program

The ecoENERGY Retrofit program, which ran from April 2007 to March 2012, was an initiative by the department of Natural Resources Canada (Natural Resources Canada, 2012). Under this program homeowners were able to have home energy audits done to become eligible for energy efficiency upgrades. The program began with an initial budget of $160 million, which increased to $745 million due to its popularity (McKie, 2013). Moreover, it was estimated that by 2010 nearly 640,000 Canadians saved an average of 20 percent on their energy bills because of efficiencies made under the ecoENERGY Retrofit program (McKie, 2013; Government of Canada, 2012).
In order to qualify for the rebates, property owners would need to follow these steps (Natural Resources Canada, 2012):

- Owners would need to register their property and receive a registration number.
- The homeowner would then need to hire a local service organization that is licensed by Natural Resources Canada. The organization would then send in a certified energy advisor who would perform a pre-retrofit evaluation and provide the homeowner with a report with an EnerGuide rating label.
- Then the homeowner would choose the eligible energy efficiency upgrades and install them.
- Lastly, the homeowner would again contact the local service organization to conduct a post-retrofit evaluation and sign a grant application.

This process allowed homeowners to make eligible energy efficiency upgrades that included heating and cooling systems, ventilation systems, domestic hot water equipment, insulation, air sealing, windows/doors and water conservation (Natural Resources Canada, 2012). Homeowners were able to receive up to $5,000 in government rebates.
In the ecoEnergy program, energy auditors would charge a minimum fee of $200 plus tax that included a government rebate of $150 and an additional $195 plus tax for follow up energy audits (Home Performance, 2011. The follow up energy audits would include an updated EnerGuide rating that reflects on the improvements made and also the application for the $5,000 government grant. Similarly, for the proposed program, energy companies could charge a fixed fee for home energy audits. Even Windfall Solar, part of Windfall Ecology Center, which is a non-profit environmental organization and social enterprise in Aurora, Ontario, charges a $150 assessment fee to install solar photovoltaic systems (Windfall Centre, 2014). This assessment cost is then fully refunded when the customer purchases a solar system from them.

Using the example of the ecoEnergy program by Natural Resources Canada, the LDC would conduct an energy audit.

In the proposed program, the auditors would be trained and certified professionals working for the LDC. This would ensure that homeowners can be assured that only qualified personnel or contractors will be involved in the installations or upgrades to the home. The auditor would then provide the homeowner with a report containing the low-hanging fruits of energy efficiency and could also suggest renewable installations, such as solar photovoltaics, if the appropriate conditions allow for it. This assessment would qualify as a feasibility assessment of the property for any solar installations, which are already required by the local distribution companies (Enersource, 2014). Moreover, the energy audits would also provide the homeowner with a cost-benefit analysis of choosing certain energy efficiency or renewable energy installations over others. The local energy company could charge a similar rate to the ecoENERGY program between $150 and $200 for this type of assessment. If the homeowner chooses to install solar photovoltaics, the local energy distribution company could refund a portion or all of the fees.

3. Installation of the systems

To install the solar panels, the LDC would need to either employ qualified technicians or outsource the installation aspect of this project. In Table 4 (also Appendix 1), the cost of labour represents a 15% discount due to economies of scale or an outsourcing benefit. Normally, for a 5kW solar project, the labour costs would include approximately two working days with three installers at the rate of $75 an hour, which would total approximately $3,000.

Furthermore, if LDCs employ technicians or installers, they would be able to train and certify them under the Canadian Standards Association (CSA).

> The CSA group is a non-profit organization that develops and delivers standards and codes, provides trainings and personnel certification programs (CSA Group, 2014). Among other certifications, the CSA offers the Construction Electrician (NOC 7241) – Solar Photovoltaic Systems personnel certification. This certifies the knowledge and the competencies of individuals to use proper techniques to plan, implement, install and maintain solar photovoltaic systems (CSA Group, 2012).

By obtaining certification of their contractors, the LDCs would be the more trustworthy option for homeowners. Certifications and standards within this industry would not only ensure consistency in installations but also create greater efficiencies. Moreover, it would contribute to creating more green jobs in the province and further establish the importance and role of renewable energy in Ontario.

4. Post-Installations

Once the installations of the solar PVs have been made, the auditors would then come back for a second audit. During the second audit, the company would conduct the Connection Impact Assessment, which requires all LDCs to assess the generation facilities before connecting it to the grid (Enersource, 2014). The assessment would need to be conducted by a professional engineer as the plan and drawings must be submitted to the Electrical Safety Authority for approval (Enersource, 2014). These assessments cost about $2,500 with an additional $500 for the FiT application to the OPA (OPA, 2014b; Toronto Hydro, 2012b). The LDC can help the homeowner in the application process in order to obtain the benefits under the FiT program.

Furthermore, if the homeowner decides to sell this property, the loan and billings for the solar photovoltaic panels can be transferred to the buyer of the property for the remainder of the term of the contract.

5. On-bill financing

The on-bill financing makes it easier for the homeowner. The payments will appear as an additional line item on the customer's bill and will be netted off with the benefits received under the FiT program. The homeowner will pay off the costs for the solar installations for a fixed amount for 20 years while also receiving the benefits under the FiT program.

Understanding the costs and benefits under this model

To understand the financing benefits under the proposed program, the same examples and data from Table 3 in Chapter 3 are used. However, an additional column has been added to show a comparison for the numbers, including costs and benefits, under the LDC model (shaded in green) in Table 4.

The total upfront costs under the proposed model would be approximately $17,800, which represents a discount of about 12.5% off the average upfront costs for the three examples mentioned earlier. While the potential benefits under the FiT program remain the same, the loan payments under the energy company are spread over 20 years[8] at a relatively lower instalment of $107 per month. In summary, using the LDC model, the homeowner would be benefitted by over $8,000 over the expected 20-year life of the program, an increase in benefit of approximately $2,500 over the home improvement loan and approximately $1,000 over the home equity loan.

Each section on the table has been discussed in more detail below:

<u>Total upfront costs</u>:

For a 5kW solar photovoltaic system, the costs of the three different panel manufactures have been added. Therefore, an average cost of a 5kW system with 19 panels has been calculated as $4,906. The cost of panels, racking system and inverter, other miscellaneous costs and labour have been discounted by 15%.

This is primarily because LDCs are quite large and under this program they would be able to achieve economies of scale by sourcing materials directly from the manufacturer at bulk

[8] The energy company could also provide different options for customers who would wish to repay the amounts within a shorter timeframe, e.g., 5, 10 or 20 years

prices, thus avoiding any intermediaries. Further, they could either employ full-time workers as opposed to contract workers or outsource the labour component at a lower rate than existing installation companies. This could result in savings on the costs for panels, other materials and labour. Other administrative efficiencies would also likely occur through this kind of a model. The costs associated with the application fee to the LDC (which includes the Connection Impact Assessment) and the application fees to the Ontario Power Authority (OPA) have not been discounted and included at the same price. However, the LDC would have to bear the costs of the initial energy audit if the homeowner decides to proceed with the installation of the complete system. The total upfront costs including the Harmonized Sales Tax would amount to $17,748, which is a direct savings of at least $2,500 compared to the individual homeowner installation examples we have seen.

Energy Generation:

The figures under this section mostly remain unchanged. The average sunlight in Toronto will remain 1025 hours per year. The figure for the average generation of the system under the local distribution company is 4,732 kWh/year, the same as the average of the three examples.

Cash Flows:

The benefit received under the FiT program is $157 per month, which is an average of the benefits that can be obtained from the other three panels (Eclipsall, Siliken and Heliene) under both the home improvement and home equity loans. Therefore, the gross benefit a homeowner would receive would be over $37,000 over 20 years. However, using net present value, the benefit under the FiT program would be around $26,000.

Table 4 – Costs of installing solar photovoltaics with debt financing from the LDC

	Home Improvement Loan	Home Equity Loan	Local Distribution Company
Specifications			
Approx. size (kW)	5	5	
Approx. size (W)	5000	5000	
Actual size of system (kW)	4.92	4.92	
Cost per panel	$255	$255	
Wattage of module (W)	255.00	255.00	
Number of panels required	19.67	19.67	
Actual number of panels required	19.33	19.33	
Costs			
Panels	$4,906	$4,906	$4,170
Racking System	$2,815	$2,815	$2,393
Inverter	$2,927	$2,927	$2,488
Miscellaneous	$1,000	$1,000	$850
Labour	$3,300	$3,300	$2,805
Application fee – OPA	$500	$500	$500
Application fee - Local energy company	$2,500	$2,500	$2,500
HST	$2,333	$2,333	$2,042
Total upfront costs	**$20,281**	**$20,281**	**$17,748**
Energy Generation			
Avg. sunlight in Toronto/year (hours)	1025	1025	
Optimal generation of system (kWh/year)	5040	5040	
Average generation (kWh/year)	4746	4746	4746
Cash Flows			
MircoFiT Rooftop price/kWh for solar	$0.396	$0.396	$0.396
Benefit under FiT/year	$1,879.28	$1,879.28	$1,879.28
Benefit under FiT/month	$157	$157	$157
Benefit under FiT (cash inflows)	$37,586	$37,586	$37,586
NPV of cash inflows	*$25,940*	*$25,940*	*$25,940*
Funding payments/month	*$391*	*$115*	*$107*
Funding costs (cash outflows)	$23,479	$27,652	$25,716
NPV of cash outflows	*$20,281*	*$19,084*	*$17,748*
NPV of total cash flows	**$5,658**	**$6,856**	**$8,192**

(Refer to Appendix 1 for a detailed breakdown of the calculations, assumptions and references)

The monthly payment under the home improvement loan is $391 for 5 years, but the payment under the home equity loan is much lower at $115 spread over 20 years. Under the LDC model, the homeowner would need to pay $107 per month for 20 years. This is marginally lower than the home equity loan due to the cost efficiencies obtained by the LDCs on the total upfront costs. This would amount to nearly $26,000 for the life of the project and a net present value of a little below $18,000. The net benefit of the project in present value terms would be a little over $8,000. This gives the homeowner a direct monetary benefit if they install the system through the LDC rather than undertaking the project independently.

Impact

While the LDC model is favourable to the prosumer, it must be noted that LDCs may lose local electricity sales if distributed generation by prosumers catches on. This means that there would be a decreased amount of electricity sold by the LDCs as a result of this model, which in turn would reduce their revenues, but not decrease their expenses of maintaining and building their systems (Spears, 2014d). To compensate the LDCs for their losses, the province must reward them for their conservation and renewable energy projects. Although developing policy suggestions for an LDC compensation model is beyond the limitations of this paper, they are recognized as an important area of research that merits further examination.

Advantages

The proposed model provides several benefits to both the homeowner or 'prosumer' and the LDC.

Homeowner or 'prosumers':

- Credit to finance project can be more easily accessed by more homeowners
- The current low interest rates can help the energy companies issue debt or borrow at a competitive low interest rates that can be passed on to the homeowner.[9]
- Security for homeowners that only qualified people certified by the LDC will do installations in their homes.
- While an individual homeowner with good credit can normally borrow at 5.99% for a period of 5 years under a green loan program, an LDC can issue debt or even borrow for a longer term at a lower rate and pass this benefit to the homeowner. For example, on October of 2013, Hydro One issued a 30-year debt at 4.59% (Hydro One, 2013b).
- The loan and billing for the solar photovoltaic panels can be transferred to the buyer of the property (new homeowner) for the remainder of the term of the contract, unlike other loans.
- Zero-interest financing can be provided by the LDC to attract homeowners who cannot access home equity loans.
- The term of the loan from the energy company is spread over 20 years, unlike the current bank loan for 5 years maximum, which puts a much lesser burden on the monthly instalment amount payable.
- Fewer problems coordinating with various agencies for separate items as this model is a one-stop shop where the LDC facilitates and coordinates all activities.
- No upfront costs for the homeowner like labour, materials, application fees, etc., as the LDC bears all the initial costs.
- This model would be made simpler by relying on an on-bill financing for the homeowner. The cost would just be an additional line item on their utility bill, unlike a loan where the homeowner has to take care of all the bills separately from the various service providers.
- Better service, installation and on-going support because installers/support technicians are trained and certified by LDCs.
- The creation of new jobs and the further development of a sustainable economy in Ontario.

[9] The Bank of Canada has maintained its Target Overnight rate, the benchmark on which many borrowing and lending rates for consumers are based, at 1% since September 2010 in its key rates announcement on March 5, 2014 (Bank of Canada, 2014). Thus, the low interest rate regime is expected to stay for a while and debt can continue to be raised at correspondingly low interest rates.

Local Distribution Company:

- New business opportunities and growth in revenues
- Repayment is assured through the secure 20-year payments under the FiT contracts as the FiT benefit for energy produced would be potentially greater than or equal to the cost of energy consumed, resulting in fewer accounts that can default on their payments.
- Lower transmission costs due to less need for transmission from high-voltage systems. Since the electricity is generated within the local distribution system, the LDC does not need to obtain electricity from the high-voltage transmission system. The LDC would also include some grid management fees in the pricing to manage distribution and volumes on the local grid.
- Less need for transmission and distribution and centralized generation infrastructure.
- The homeowner will be charged by the LDC for energy delivery to (produced by the solar panels) and from (regular electricity usage) the grid. This will add to the revenue of the LDC as the delivery costs will be factored into the pricing. There would be a greater cost-benefit for LDCs as demand increases. More jobs and a bigger manufacturing sector would potentially generate efficiencies in technology and cost reductions for solar photovoltaics, thereby, making the model even more attractive to homeowners, resulting in increased sales.
- Additionally, the province may also consider introducing a tax-credit or benefit to the LDC based on the energy conserved, i.e., managing energy within the local grid, and savings obtained from non-transmission from the high-voltage systems. The benefit could be provided from the potential savings generated from the Pickering nuclear power plant early phase-out or the green bonds currently being issued.

What would it look like without the FiT program?

We have considered the benefits of implementing a program in Ontario similar to the PACE financing and SolarCity programs. However, due to the limitations placed on renewable energy in Ontario, there may come a time in the near future where the FiT program might be eliminated entirely. Below I briefly discuss how this model can work independently of the FiT program.

The average household in in Ontario consumes about 9,600 kWh of electricity per year, which is equal to 800 kWh per month (Ontario Ministry of Energy, 2014). The electricity costs per kW including delivery is approximately $0.17[10]. This gives an annual cost of $1,668 or $139 per month billed to the homeowner.

Now, if a homeowner decides to install a solar system under the financing model of the LDC, they would require $25,716 in funding costs for 20 years. These are the same funding costs that can be observed in green highlighted section on Table 4. This would be an additional charge of $107 per month for 20 years. If the 5kW project generates an average of 4,746 kWh per year, the cost of this electricity that is generated would equal to $825 per year or $69 per month. This is a potential savings on the homeowner's monthly energy bill. Therefore, the net payment for the solar system would be $40 per month. This means that the solar system pays off approximately 63 percent of the cost just through savings in electricity. Another interesting fact in this example is that the homeowner would be generating nearly 50 percent of their energy needs through this photovoltaic system.

Table 5: Cash flow without the Feed-in-Tariff program

	Cash flow per month	NPV of total cash flow	%
Funding payments	($107)	($17,748)	100%
Savings	$69	$11,381	64%
Net payments	**($39)**	**($6,366)**	**36%**

NPV = Net Present Value

[10] This figure is based on home electricity bill for June 2014. The total electricity bill (including delivery charges) was $128.37 and kW usage was 778. 128.37/778 = $0.165 ~ 0.17

We can see that although this project would provide a good amount of energy for a home and it does provide some savings, the project is still expensive. Moreover, this project does not consider energy storage, which will be a necessity if the system is to provide energy security or smart grid services.

At this point in time, this model project is unlikely to work independent of the benefits the Ontario government provides under the FiT program. If the program must run without government incentives, the costs of installing solar photovoltaic systems need to decrease significantly or an increase in the efficiency of the panels themselves is needed.

Concluding remarks

Ontario's energy history shows how energy production in the province, which started out with hydroelectricity, gradually evolved to include various different forms of energy, such as coal, nuclear, gas and now new renewable energy technologies. During the 1990s there was a major restructuring process of Ontario's electricity sector, primarily the deregulation of province's electricity system and the privatization and subsequent split up of Ontario Hydro. With the Liberal's assuming power in 2003, the province's energy landscape changed again dramatically. Dalton McGuinty's government not only banned and phased out coal production in Ontario but also placed greater emphasis on renewable energy through the enactment of the Green Energy and Green Economy of 2009 and the Feed-in-Tariff program. This transformation of the electricity sector indicates that Ontario can make another shift to increase the use of renewable energy. Moreover, the Long Term Energy Plan of 2013 shows a decreasing of the province's dependency on nuclear energy and an increasing of renewable energy sources and energy conservation measures.

Nevertheless, for renewable energy sources to achieve greater market penetration and an increased share in Ontario's energy mix, it is important to understand the barriers to its widespread implementation, which need to be addressed through effective planning and policy-making. Although there are several barriers to renewables, this paper examined a few of the most relevant barriers to Ontario in relation to residential adoption of solar photovoltaics. Additional barriers that still require further research include political issues, such as the rising energy prices that are blamed on renewable energy incentives, the halt on offshore wind development as a purely political move and the WTO ruling due to competing interests from other jurisdictions. Another major barrier that merits further research is whether the continued dominance of nuclear power in Ontario should remain. Although nuclear power development in Ontario is infamous for cost overruns and its production is inflexible, thus far nuclear energy still plays a prominent role in Ontario due to the much powerful and vigorous campaigning of nuclear lobbies. Consumer affordability of renewable technologies is a key barrier considered in this paper. Key statistics and models were examined, such as household expenditure, income and debt, along with the cost of solar photovoltaics installations. While it can be observed that many Ontario homeowners can afford the installations, there are not yet a significant number of homes with solar photovoltaics in Ontario. This reality indicates that high installation costs are a perceived barrier for solar photovoltaic installations. Nevertheless, to remove this negative perception, innovative financing models need to be put in place to ensure that consumers are not burdened with greater debt.

To develop a model that would work for Ontarians, I have reviewed financing models in other jurisdictions. In Canada, Manitoba Hydro and a pilot program in British Columbia provide their customers with loans for energy efficiency upgrades, albeit with high interest rates, through on-bill financing. The United States has the PACE program by which a homeowner can install renewable or energy efficiency technologies without the need for any upfront payment, as the assessment is paid through the homeowner's property tax bill over a period of 15 to 20 years. SolarCity, also in the United States, has created an innovative model for customers, whereby, they not only finance the renewable energy projects through a solar lease, but also install, design and look after permits for these projects, providing the customer with a holistic service.

Although many Ontarians are interested in renewable energy technologies, public investment is not as high. To move Ontario towards a green energy economy, energy needs to be placed in the hands of the Ontario public so that they are not only able to witness the benefits first-hand, but are also part of the movement. Using the examples of financing models in different jurisdictions, I have proposed a model for Ontario that addresses local needs. In this model, Ontario LDCs can become is a one-stop-shop for the consumer. LDCs are well positioned to provide on-bill financing for their customers who qualify for solar photovoltaic installations and help conduct home energy audits, system installations and connections to the grid. I have examined the different ways through which the LDC can finance this model, such as through debt issue or loan. The LDCs can also look at obtaining funding from their local municipality's sustainable energy funds or through the Green Municipal Fund. The province can also aid LDCs with funding from the green bonds they will be issuing this year. Moreover, my model also advocates the growth and development of the green energy economy by growing the manufacturing sector of solar photovoltaics and by increasing employment through the training and certification of solar photovoltaic installers. This model illustrates how LDCs can play a major role to facilitate the shift to renewable energy and help lower the barriers for homeowners. By providing no upfront costs, low to zero per cent interest, on-bill financing and free maintenance, LDCs can not only provide direct monetary benefits to homeowners but can also provide them with peace of mind and security as LDCs are well-established local public companies. Furthermore, renewable energy contracts under this new model can be transferred to new homeowners upon sale of the property. In turn, LDCs benefit from lower transmission losses and less need for investment on distribution. Similar to SolarCity in the U.S., LDCs have the potential to enter into an untapped market in Ontario and become local leaders in providing this form of a holistic renewable energy service.

Future Policy Recommendations:

To make the model operational, a few policy decisions would need to be concurrently addressed by the province.

- The phasing out of expensive nuclear facilities for precautionary and security reasons and for increasing the share of the renewable energy market. The costs of refurbishing and maintaining aging nuclear facilities, and the availability of additional capacity for more cleaner forms of energy production, i.e., renewable energy, should be given due consideration by the provincial government.
- The feasibility of shutting down the Pickering nuclear plant in 2014 that would result in savings of approximately $850 million per year for its remaining life and using the savings to underwrite zero-interest financing for the LDCs needs to be closely considered.
- Encouraging decentralized energy production to reduce overall transmission costs and reliance on high-voltage transmission.
- If such a distributed generation model is implemented, the LDCs would need to be compensated for the loss of local electricity sales through a new policy statement that provides a benefit program for their conservation efforts.
- Enhancing the green bonds program with more options, to include funding for LDCs to finance their renewable energy projects.

- Continuing the feed-in-tariff program until an optimal energy mix is reached or until the technology becomes cost efficient and storage technology becomes affordable.

While this model is conceptual in nature, further research needs to be conducted in some areas. This paper only examined solar photovoltaic technology in isolation, hence, further research needs to be conducted on how other energy efficiency installations can contribute to cost savings, for both the LDC and the homeowner under this model. It is also important to understand if the LDCs in Ontario have an appetite to actually evolve into this kind of a one-stop-shop for homeowners that wish to install renewable energy and energy efficiency technologies. Since the LDCs will lose on their local electricity sales, further research needs to be undertaken to determine and develop appropriate compensation for their conservation efforts and renewable energy projects. The scope of my research does not consider these costs, but simply recommends a tax credit or benefit from the cash saved on the early phasing out of the Pickering nuclear plants. Lastly, more research needs to be conducted on whether investors are willing to invest in zero-coupon or low-interest green bonds issued by the LDC or the province and the dollar amount that be potentially raised from this issue. A pilot project should be conducted to ensure that this kind of financing can be indeed successful.

Appendices

Appendix 1 – Cost comparison of solar systems

	Eclipsall	Siliken	Heliene	H. I. Loan*	H.E. Loan**	LDC
Specifications						
Approx. size (kW)	5	5	5	5	5	
Approx. size (W)[1]	5000	5000	5000	5000	5000	
Actual size of system (kW)[4]	4.90	4.90	4.95	4.92	4.92	
Cost per panel[2]	$239.99[(a)]	$245.00[(b)]	$278.82[(c)]	$255	$255	
Wattage of module (W)	245	245	275	255.00	255.00	
Number of panels required[3]	20.41	20.41	18.18	19.67	19.67	
Actual number of panels required	20	20	18	19.33	19.33	
Costs						
Panels[5]	$4,800	$4,900	$5,019	$4,906	$4,906	$4,170
Racking System[6]	$2,815	$2,815	$2,815	$2,815	$2,815	$2,393
Inverter[6]	$2,927	$2,927	$2,927	$2,927	$2,927	$2,488
Miscellaneous[7]	$1,000[(a)]	$1,000[(a)]	$1,000[(a)]	$1,000	$1,000	$850
Labour[7]	$3,375[(a)]	$3,375[(a)]	$3,150[(b)]	$3,300	$3,300	$2,805
Application fee – OPA[8]	$500	$500	$500	$500	$500	$500
Application fee - Local energy company[9]	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500
HST[10]	$2,329	$2,342	$2,328	$2,333	$2,333	$2,042
Total upfront costs[11]	**$20,246**	**$20,359**	**$20,239**	**$20,281**	**$20,281**	**$17,748**

	Eclipsall	Siliken	Heliene	H. I. Loan*	H.E. Loan**	LDC
Energy Generation						
Avg. sunlight in Toronto/year (hours)[12]	1025	1025	1025	1025	1025	
Optimal generation of system (kWh/year)[13]	5023	5023	5074	5040	5040	
Average generation (kWh/year)[14]	4730[(a)]	4730[(a)]	4778[(b)]	4746	4746	4746
Cash Flows						
MircoFiT Rooftop price/kWh for solar[15]	$0.396	$0.396	$0.396	$0.396	$0.396	$0.396
Benefit under FiT/year[16]	$1,872.91	$1,872.91	$1,892.02	$1,879.28	$1,879.28	$1,879.28
Benefit under FiT/month[17]	$156	$156	$158	$157	$157	$157
Benefit under FiT (cash inflows)[18]	$37,458	$37,458	$37,840	$37,586	$37,586	$37,586
NPV of cash inflows[19]	*$25,852*	*$25,852*	*$26,116*	*$25,940*	*$25,940*	*$25,940*
Funding payments/month[20]	*$391*	*$393*	*$390*	*$391*	*$115*[(a)]	*$107*[(b)]
Funding costs (cash outflows)[21]	$23,438	$23,569	$23,430	$23,479	$27,652[(a)]	$25,716[(a)]
NPV of cash outflows[22]	*$20,246*	*$20,359*	*$20,239*	*$20,281*	*$19,084*	*$17,748*
NPV of total cash flows[23]	**$5,606**	**$5,493**	**$5,877**	**$5,658**	**$6,856**	**$8,192**

*H.I. Loan = Home Improvement Loan
**H.E. Loan = Home Equity Loan

Notes:

1. The numbers taken for the *Home Improvement loan* is the average of the three solar systems (Eclispall, Siliken and Heliene) for the respective line items.
2. The numbers taken for the *Home Equity Loan* and *LDC* for the respective sections Specification, Costs and Energy Generation are averages of the three solar systems (Eclispall, Siliken and Heliene).
3. The numbers for the *Home Equity Loan* and *LDC* for the section Cash Flows under the respective line items (MircoFit rooftop price/kWh for solar, Benefit under FiT/year, Benefit under FiT/month, Benefit under FiT (Cash inflows) and NPV of cash inflows) is the average of the three solar systems (Eclispall, Siliken and Heliene).
4. For the *LDC*, in the costs section, a 15% discount has been added to the costs of panels, inverters, racking system, miscellaneous and labour. This discount has been added because the local energy company will have economies of scale.

[1] 1kW = 1000W
5kW = 5000W
This is the approximate size of system

[2(a)] Actual cost of the Eclipsall 245W Polycrystalline Panel = $239.99 CAD

[2(b)] Actual cost of the Siliken 245W Polycrystalline Panel = $245.00 CAD

[2(c)] Actual cost of the Heliene 275W Polycrystalline Panel = $278.82 CAD

[3] Number of panels required = $\dfrac{\text{Approx. size}}{\text{Wattage of module}}$

[4] Exact size of the system = $\dfrac{\text{(Exact number of panels required * Wattage of module)}}{1000}$

[5] Cost of panels = Exact number of panels required * Cost of module

[6] The cost of an inverter and racking system for a 5kW solar system taken from Solar Trade (Solar Trader, 2014d)

[7] Since this cost would require the collection of primary data, the costs assigned here are for the most part arbitrary. However, many sources suggest that the cost of solar panels only account for approximately 20% of the total solar installation costs and average costs of a solar array of this size (including installations) is approximately $20,000 (NREL, 2013; Eco Alternative Energy, 2013; Paid4Power, 2014). Therefore, after accounting for other

costs that are available by conducting secondary research, I have allotted a conservative estimate for labour and other miscellaneous costs.
Assumptions:
[a] Labour
The cost of labour per hour: $75
Number of hours: 15
Number of technicians: 3
Total cost of labour = $75*15h*3 = $3,375
[a] Other miscellaneous items
Wires, mounting, connection fees, et cetera ~ $1,000

[b] Labour
The cost of labour per hour: $75
Number of hours: 14
Number of technicians: 3
Total cost of labour = $75*14h*3 = $3,150

[8] (OPA, 2014)

[9] This figure includes the cost of a solar photovoltaic Connection Impact Assessment that the local distribution company is required to complete. This cost is taken from Toronto Hydro (Toronto Hydro, 2012)

[10] Harmonized Sales Tax is the sum of all costs multiplied by 13%

[11] Total costs = panels + inverter + racking system + labour + application fee (OPA + local energy company) + other miscellaneous costs +HST

[12] (Oxtoby, 2007)

[13] Optimal generation = avg. sunlight hours in Toronto/year *Actual size of system (kW)

[14] To calculate the average generation for a system of this size, a solar array system with real time data in the Toronto area has been examined. The size of this system is 2.07kW. The per year energy production for this system is as follows:
2010 – 2,090kWh
2011 – 1,874kWh
2012 – 2,030kWh
The average produced in the three years was 1,998kWh

To calculate the costs of the 5kW system, the formulae below have been used:
[a] = 1,998 * 4.9/2.07 = 4,729.6
[b] = 1,998 * 4.95/2.07 = 4,777.8

[15] (OPA, 2014b)

[16] Benefit under the FIT/year = microFIT rooftop price/kWh for solar * average generation

[17] Benefit under the FIT/month = $\frac{\text{Benefit under the FIT/year}}{12}$

[18] Benefit under the FIT (cash inflows) = Benefit under FIT/year * 20 years
This amount represents the total cash inflow received under the benefits of the FIT program for the entire 20-year duration of the FIT contract.

[19] Refer to Appendix 2

To calculate the present value of net benefits, the Present value interest factor of an annuity formula has been used (Deaves, 2009).

k (1 month effective rate) = $1 + (.0399/2)^{1/6} - 1 = 0.00329$[11];
n = 240 (months)
PVIFA (.00329;240) = $1 - \{1/(1+ .00329)^{240}\}/.00329$ = \$165.63

NPV of cash inflows = PVIFA * Benefit of FIT/month

[20] k (1 month effective rate) = $1 + (.0599/2)^{1/6} - 1 = 0.00493$;
n = 60 (months)[12]
PVIFA (.00493;60) = $1 - \{1/(1+ .00493)^{60}\}/.00493$ = \$51.83

[(a)] k (1 month effective rate) = $1 + (.0329/2)^{1/6} - 1 = 0.00273$;
n = 240 (months)
PVIFA (.00273;240) = $1 - \{1/(1+ .00273)^{240}\}/.00273$ = \$176.03

[(b)] k (1 month effective rate) = $1 + (.0399/2)^{1/6} - 1 = 0.003297$;
n = 240 (months)
PVIFA (.003297;240) = $1 - \{1/(1+ .003297)^{240}\}/.003297$ = \$165.63

Funding payments per month = Total upfront costs / PIVFA of the monthly payout

[21] Funding costs (cash outflows) = Funding payments per month * 60 months

[(a)] Funding costs (cash outflows) = Funding payments per month * 240 months

[22] NPV of cash outflows = funding payments per month * PIVFA of the monthly payout
Discount rate assumption: 5-year = 5.99%; 20-year = 3.99% based on current interest rates

[23] Net present value (NPV) of total cash flows = NPV of cash outflows - NPV of cash inflows

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[11] In Canada, the interest rate is compounded semi-annually (Deaves, 2009).
[12] 60 months is used because the loan is for 5 years

Appendix 2 – Solar project funding costs

Eclipsall

Month[1]	Remaining Principal[2]	Interest Amount[3]	Principal Amount[4]	Monthly Payment
1	$20,246	99.68	290.95	390.63
2	19955.03451	98.24	292.38	390.63
3	19662.65259	96.81	293.82	390.63
4	19368.83118	95.36	295.27	390.63
5	19073.5632	93.91	296.72	390.63
6	18776.84152	92.44	298.18	390.63
7	18478.65898	90.98	299.65	390.63
8	18179.0084	89.50	301.13	390.63
9	17877.88254	88.02	302.61	390.63
10	17575.27415	86.53	304.10	390.63
55	2298.426402	11.32	379.31	390.63
56	1919.115443	9.45	381.18	390.63
57	1537.937017	7.57	383.06	390.63
58	1154.88193	5.69	384.94	390.63
59	769.9409416	3.79	386.84	390.63
60	383.1047679	1.89	388.74	390.63

Interest rate – 5.99%[5]
Average monthly payment - $390.63
Total funding cost - $23,437.61[6]

Assumption:

a) Zero-downpayment if home mortgage has been secured by the same bank (Solar Trader, 2013e)

[1] 5 year loan = 60 months
[2] Month 1: Loaned amount
Month 2 onwards: Remaining principal of previous month – Principal amount of previous month
[3] Interest Amount = $\frac{\text{Remaining principal*5.99\%}}{(365/30)}$
[4] Principal Amount = Monthly payment – Interest Amount
[5] (Solar Trader, 2013e)
[6] Total monthly payments for 60 months

Siliken

Month[1]	Remaining Principal[2]	Interest Amount[3]	Principal Amount[4]	Monthly Payment
1	$20,359	100.23	292.58	392.81
2	20066.63337	98.79	294.02	392.81
3	19772.6163	97.35	295.46	392.81
4	19477.15169	95.89	296.92	392.81
5	19180.23242	94.43	298.38	392.81
6	18881.85131	92.96	299.85	392.81
7	18582.00119	91.49	301.33	392.81
8	18280.6748	90.00	302.81	392.81
9	17977.86489	88.51	304.30	392.81
10	17673.56416	87.01	305.80	392.81
55	2311.280389	11.38	381.43	392.81
56	1929.848128	9.50	383.31	392.81
57	1546.537955	7.61	385.20	392.81
58	1161.340626	5.72	387.09	392.81
59	774.246849	3.81	389.00	392.81
60	385.2472877	1.90	390.91	392.81

Interest rate – 5.99%[5]
Average monthly payment - $392.81
Total funding cost - $23,568.69[6]

Assumptions:

a) Zero-downpayment if home mortgage has been secured by the same bank (Solar Trader, 2013e)

[1] 5 year loan = 60 months
[2] Month 1: Loaned amount
Month 2 onwards: Remaining principal of previous month – Principal amount of previous month
[3] Interest Amount = $\frac{\text{Remaining principal*5.99\%}}{(365/30)}$
[4] Principal Amount = Monthly payment – Interest Amount
[5] (Solar Trader, 2013e)
[6] Total monthly payments for 60 months

Heliene

Month[1]	Remaining Principal[2]	Interest Amount[3]	Principal Amount[4]	Monthly Payment
1	$20,239	99.64	290.85	390.50
2	19948.3074	98.21	292.28	390.50
3	19656.02404	96.77	293.72	390.50
4	19362.30168	95.33	295.17	390.50
5	19067.13324	93.87	296.62	390.50
6	18770.51158	92.41	298.08	390.50
7	18472.42957	90.95	299.55	390.50
8	18172.88	89.47	301.02	390.50
9	17871.85566	87.99	302.51	390.50
10	2674.976967	13.17	377.33	390.50
55	2297.651571	11.31	379.18	390.50
56	1918.468483	9.45	381.05	390.50
57	1537.418557	7.57	382.93	390.50
58	1154.492603	5.68	384.81	390.50
59	769.6813839	3.79	386.71	390.50
60	382.975618	1.89	388.61	390.50

Interest rate – 5.99%[5]
Average monthly payment - $390.50
Total funding cost - $23,429.71[6]

Assumptions:

a) Zero-downpayment if home mortgage has been secured by the same bank (Solar Trader, 2013e)

[1] 5 year loan = 60 months
[2] Month 1: Loaned amount
Month 2 onwards: Remaining principal of previous month – Principal amount of previous month
[3] Interest Amount = $\frac{\text{Remaining principal*5.99\%}}{(365/30)}$
[4] Principal Amount = Monthly payment – Interest Amount
[5] (Solar Trader, 2013e)
[6] Total monthly payments for 60 months

Home Equity Loan

Month[1]	Remaining Principal[2]	Interest Amount[3]	Principal Amount[4]	Monthly Payment
1	20,281.45	54.84	60.37	115.22
2	20,221.08	54.68	60.54	115.22
3	20,160.54	54.52	60.70	115.22
4	20,099.84	54.35	60.86	115.22
5	20,038.97	54.19	61.03	115.22
6	19,977.94	54.02	61.19	115.22
7	19,916.75	53.86	61.36	115.22
8	19,855.39	53.69	61.53	115.22
9	19,793.86	53.53	61.69	115.22
234	720.48	1.95	113.27	115.22
235	607.21	1.64	113.58	115.22
236	493.63	1.33	113.88	115.22
237	379.75	1.03	114.19	115.22
238	265.56	0.72	114.50	115.22
239	151.06	0.41	114.81	115.22
240	36.25	0.10	115.12	115.22

Interest rate – 3.29%
Average monthly payment - $115.22
Total funding cost - $25,652.19[5]

[1] 20 year loan = 240 months
[2] Month 1: Loaned amount
Month 2 onwards: Remaining principal of previous month – Principal amount of previous month
[3] Interest Amount = $\frac{\text{Remaining principal*3.29\%}}{(365/30)}$
[4] Principal Amount = Monthly payment – Interest Amount
[5] Total monthly payments for 240 months

Local Distribution Company model

Month[1]	Remaining Principal[2]	Interest Amount[3]	Principal Amount[4]	Monthly Payment
1	$17,748	58.20	48.95	107.15
2	17698.78822	58.04	49.11	107.15
3	17649.68263	57.88	49.27	107.15
4	17600.416	57.72	49.43	107.15
5	17550.98781	57.56	49.59	107.15
6	17501.39751	57.40	49.75	107.15
7	17451.64459	57.23	49.92	107.15
8	17401.7285	57.07	50.08	107.15
9	17351.64872	56.90	50.24	107.15
234	667.7098309	2.19	104.96	107.15
235	562.7513325	1.85	105.30	107.15
236	457.4486259	1.50	105.65	107.15
237	351.8005822	1.15	105.99	107.15
238	245.8060689	0.81	106.34	107.15
239	139.4639497	0.46	106.69	107.15
240	32.77308482	0.11	107.04	107.15

Interest rate – 3.99%
Average monthly payment - $107.15
Total funding cost - $25,715.58[5]

[1] 20 year loan = 240 months
[2] Month 1: Loaned amount
Month 2 onwards: Remaining principal of previous month – Principal amount of previous month
[3] Interest Amount = $\frac{\text{Remaining principal*3.99\%}}{(365/30)}$
[4] Principal Amount = Monthly payment – Interest Amount
[5] Total monthly payments for 240 months

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