UNIFYING SUSTAINBILITY AND AFFORDABILITY THROUGH PLANNING AND POLICY: SOLAR ENERGY SYSTEMS AS AN ELEMENT OF GREEN AFFORDABLE HOUSING IN ONTARIO

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Abstract

The purpose of this major research paper is to examine how existing policies and programs in socio-political contexts comparable to Ontario's make the inclusion of solar energy technology with affordable housing possible. The paper begins with the investigation of Ontario's housing and energy systems. Following this assessment is the analysis of existing policy and programs in the United Kingdom and California that facilitate the integration of solar energy technology with affordable housing. The programs discussed in these regions are compared to past, present and future energy efficiency initiatives in Ontario in order to identify which aspects of them can be adopted to facilitate the creation of solar-equipped green affordable housing in the province. The concluding chapter discusses recommended planning and policy actions to be taken at the municipal and provincial level that will incite the creation of solar-equipped green affordable housing in Ontario. The paper highlights the environmental, social and economic benefits of developing domestic solar energy systems as a decarbonization strategy. Together, these benefits act as an endorsement of a potential reality in Ontario in which affordable housing and sustainable housing become synonymous concepts in the age of climate change mitigation.

Foreword

This Major Research Paper focuses on solar energy systems, affordable housing and the relationship that can be created between both to produce environmental, economic and social benefits. The paper has enabled me to explore the existence and potential for the existence of my area of concentration ("The Integration of Solar Energy with Residential Planning") in three contexts. As a result, I have fostered an in depth understanding of how multiple actors and institutions can contribute to regimenting equitable access to cost-intensive decarbonization strategies such as solar energy. Additionally, this MRP has enhanced my knowledge of how sustainable practices and technology can be used as tools by all levels of government in Canada to avoid further situations of socioeconomic stratification in urbanizing regions. Through the dual lenses of housing and energy, this paper has allowed me to engage directly with the intricacies of urban planning and its general objective of establishing and maintaining equity in quality of life.

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Acronyms

CMHC – Canada Mortgage and Housing Corporation	**OESP** – Ontario Electricity Support Program
CEC – California Energy Commission	**Ofgem** – Office of Gas and Electricity Markets
CPUC – California Public Utilities Commission	**PPA** – Power Purchase Agreement
CSI – California Solar Initiative	**PV** – Photovoltaic
DECC – Department of Energy and Climate Change	**REI** – Renewable Energy Initiative
EPP – Energy Partnerships Program	**RGI** – Rent-Geared-to-Income
FiT – Feed-in-Tariff	**RHI** – Renewable Heat Initiative
GHG – Greenhouse Gas	**RO** – Renewables Obligation
GTSR – Green Tariff Shared Renewables (Program)	**RPS** – Renewables Portfolio Standard
HELP – Home Energy Loan Program	**SASH** – Single-Family Affordable Solar Homes (Program)
IESO – Independent Electricity System Operator	**SHRRP** – Social Housing Renovation and Retrofit Program
kW – Kilowatt	**TCHC** – Toronto Community Housing Corporation
LTAHS – Long-Term Affordable Housing Strategy	**TW** – Terawatt
LTEP – Long Term Energy Plan	**UCEF** – Urban Community Energy Fund
MASH – Multifamily Affordable Solar Housing (Program)	**UK** – United Kingdom
MW – Megawatt	**VNM** – Virtual Net Metering
NSHP – New Solar Housing Program	

CHAPTER 1 – Purpose and Methods of Research

1.1: Introduction

As urbanization continues to expand the built form of developed and developing nations, it is vital that society explores and implements solutions that mitigate the stress placed on the planet as a result of human settlement and consumption. Numerous academic reports and studies have laid out the facts that global patterns of human activity have contributed to rising sea levels, degraded air quality, increased temperatures and overall destruction of ecosystems (Lemmen & Warren, 2004, p. 174; Environmental Commissioner of Ontario, 2014; IPCC, 2013). Most, if not all of these activities hinge on the production, transportation and consumption of energy in its various forms. Consequently, as David Toke notes, the 'policy primacy' of energy source extraction and pollution makes it the most important environmental issue of our time (2011, p. 38).

Institutions from around the world have acknowledged the reality of climate change, largely as a result of the non-renewable energy sector. Many have pledged to implement decarbonization plans that stabilize environmental conditions to previous standards while maintaining economic equilibrium. Though changes to industrial and commercial practices are often emphasized, successfully indoctrinating decarbonization and 'green' practices[1] requires just as much attention to be paid to the construction of and subsequent consumption within residential communities.

As the most populous province in Canada, Ontario has a geographic, economic and social make-up that is more extensive than many US states and European countries (Winfield et al., 2010, p. 4116). The province has been praised globally for its 2009 *Green Energy and Green Economy Act* that outlined a commitment to incentivizing decarbonization at various scales. With provincial energy usage at 137 terawatt-hours[2] (TWh) in 2015 and estimates of 165 TWh by 2030 (IESO, 2016), smart and efficient action must be taken to ensure energy system security without further exponential damage of the environment. The anticipated continued expansion of urban agglomerations in the province will place a strain on the ageing energy system in the years to come if the province fails to innovate a resilient energy system. Relatedly, as a central component of prosperous urban development, the affordable residential built form deserves

[1] 'Green practices' or 'greening' are colloquialisms that refers to action taken to augment human living spaces in a way that reduces consumption of natural resources, generates less waste and improves human health. (Foy, 2012, p.39)

[2] A terawatt-hour is a unit of power equivalent to one trillion watt-hours.

particular attention from institutional actors that are serious about decarbonization.

For many individuals and families, energy costs are a major contributing factor to the affordability of housing. Turbulent energy prices in Ontario can result in some households being forced to spend more than 10 percent of total income on energy costs, causing them to experience energy poverty[3] (Cooperative Housing Federation of Canada and the ONPHA, 2010). Innovative renewable technologies offer promising alternatives to increasing costs of central production and distribution of non-renewable energy. One faction of technology that has been innovated largely with residential application in mind is solar energy generation technology. In particular, solar thermal heaters and solar photovoltaic panels in their various forms have experienced increased application as costs continue to decline and approach grid parity[4]. However, the full environmental, economic and social potential of solar cannot be realized without detailed policy and programs in place that incentivize engagement with these technologies for anyone striving to live a more sustainable lifestyle in a dwelling regardless of their socioeconomic status.

The concept of sustainability or sustainable development has been one informally talked about before 1987 (Brown, 1982; Clark and Munn, 1986), but that is when it was distinctly defined in the World Commission on Environment's Brundtland report. The report defined sustainable development as "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" (UNECE, 1987). The definition emphasizes that sustainability encompasses both intra-generational and inter-generational equity when it comes to quality of life. The latter is often emphasized as a pressing issue - as it should be - by politicians and other individuals of influence wishing to leave behind a positive legacy for their children. However, it is just as important that among current living generations, for development and innovative action to occur that results in 'just sustainability'. This paper seeks to analyze the environmental, social and economic harmonies that result from the equitable and sustainable practice of integrating solar technologies into affordable housing communities. The treatment of sustainability and affordability as equally important factors in decarbonization strategies is what will lead to the standardization of 'just sustainability' that is necessary for climate change mitigation to stay the course.

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[3] Both housing affordability organizations in Ontario and Europe consider households that are forced to spend 10 percent or more of their income on utility costs as sufferers of energy poverty or fuel poverty (Cooperative Housing Federation of Canada and the ONPHA, 2010; DECC, 2012).

[4] Grid parity refers to the point at which alternative sources of energy can produce electricity at a levelized cost that is equal to or less than the price of power purchased from an electricity grid. (Breyer, 2013, p.121)

1.2: Research Objectives and Methodology

This paper strives to contribute to the academic discussion around the promotion, creation and maintenance of green affordable housing in post-industrial regions. Housing just under 40 percent of Canada's population, Ontario is an important context to study what conditions are necessary to spur sustainable housing practices since successful initiatives in the province will result in environmental, social and economic harmonies that will ideally have positive spill-over effects on the rest of the diverse Canadian nation. Additionally, the affordability of housing within the province has persisted as an issue due to an absence of involvement by senior levels of government in housing policy and procurement. The problem is widely understood, and this paper serves to offer an examination of the relationship that must exist moving forward between decarbonization strategies and affordable housing in order for real progress to be made on housing affordability and climate change mitigation targets. The objective of this research paper is to answer the following questions:

> How do existing housing and energy policies in socio-political contexts comparable to Ontario's allow or negate the inclusion of solar energy with affordable housing?
>
> What elements of the existing energy and housing system must be remediated to make solar-equipped green affordable housing a reality in Ontario?

Both questions are directly related to the concept of green affordable housing within the context of Ontario and emphasize engagement with solar technology in particular which has shown great potential for increased residential application. To answer these questions, this paper will examine existing programs and policy initiatives that actively encourage the use of solar energy systems in the development of green affordable housing and relate them back to the Ontario context in order to highlight the potential for policy transfer. The seven chapters of this work will use literature review, comparative analysis and cartographic illustration to reveal answers to both research questions.

Existing policy in Ontario will act as anchoring information for this paper. Therefore, a thorough review of provincial housing and energy policy and related academic works will be completed. Additionally, in order to gauge the potential for policy -transfer this work will examine policy, programs and planning initiatives that actively encourage green affordable housing and the integration of solar energy systems with housing in two case study regions: the state of California and the United Kingdom. The case study regions were selected because of the socio-political similarities they share with Ontario.

Climate change mitigation is one of the most important socio-political issues of our time.

Western nations with distinguished histories of ecologically-damaging industrialization processes that are partially liable for climate change have a heightened responsibility to influence environmentally-conscious societal outlooks and practices through policy. Both case study regions share this western identity and have comparable political systems and policy approaches to those that exist in Ontario and Canada at large. As "developed" regions, exploration of policy and programs in California and the UK will provide insight relevant and transferable to the Ontario context. In addition to this shared identity, California, the United Kingdom and Ontario all have regionally specific renewable energy generation targets that identify solar technology as an important part of their future regional energy strategies.

In addition to a review of existing policy and literature, cartographic illustration and analysis methods will be used. Focusing on the city of Toronto and its major social housing provider, maps illustrating the various characteristics of the existing Toronto Community Housing Corporation (TCHC) housing stock and the location of existing residential solar will be used to analyze the potential for the development of 'economies of scale' that would serve to benefit from policy and programs highlighted in the case study segments. Toronto was selected as the site for cartographic analysis of the potential to increase residential solar integration since it is a major urban center in Ontario with well documented housing affordability and sustainability issues. Together, these methods will offer important insight into the policy responses that can assist in making green affordable housing a reality in Ontario.

1.3: Analytical Framework

The analytical framework guiding this paper is composed of two complementary theories: ecological modernization and environmental justice theory. Both further an argument for the progression of environmentalism alongside urbanism. The former argues for this progression on the basis of increased economic benefits while the latter emphasizes the societal advantages to fairly disseminating environmentally-conscious initiatives.

The Ecological Modernization Perspective

Ecological modernization (EM) is often linked to the 1980's 'Berlin school' of environmental research which proposed that ambitious environmental targets will lead to greater economic competitiveness and technological innovation (Szarka, 2012, p. 88). Accelerated by political recognition of strained planetary health toward the end of the 20th century, the theory grew out of the school's concern for the decoupling of environmental

degradation and economic growth. The EM perspective confronts the mentality that economic rationality should always dominate ecological rationality by highlighting that one is not subservient to the other, but rather, environmental protection and economic growth are mutually reinforcing. Eco-modern strategists contend that an ecological rationality is required in order to achieve a certain level of modernization and industrial growth. This rationality emphasizes that ecological impacts must be considered as a major part of all cost-benefit analysis since the minimization of environmental externalities will increase the efficiency of processes of production and consumption (Schelly, 2015, p. 60). As both a social theory and political program, ecological modernization is a lens through which environmental policy decisions and overall rationality of urban development are analyzed (Schelly, 2015, p. 62; Szarka, 2012, p. 88). As is the case with many other analytical theories, there are several variations of the ecological modernization perspective that differ in their objectives and consequently their view of what constitutes rational policy.

'Objectivist', or techno-corporatist EM states that ecological change only occurs if conventional industries adapt practices and technologies as a response to social pressures that call for the achievement of environmental objectives (Toke, 2011, p. 20). This variation of the theory is often referred to as weak EM since it focuses only on the creation of solutions to environmental problems by economic, political and scientific elites affiliated with corporatist policy-making institutions (Toke, 2011, p. 26). However, the reality remains that society, presently, is made up of more than just corporations and consequently ecological modernization requires engagement of a broader section of society than just the corporate elite. Contrastingly 'social constructionist' or radical EM is a variation of the theory that states environmental policy can only be successful in creating sustainable solutions if 'bottom-up' patterns of engagement are involved (Toke, 2011, p. 20). It is considered radical since it challenges the techno-corporatist mainstream version of ecological modernization that fails to highlight the importance of community level engagement with economically-viable environmental solutions.

'Identity' is a middle range ecological modernization perspective that is specific in its discussion of renewable energy technology as a catalyst for environmental change. David Toke outlines the 5 characteristics that guide this perspective:

1. Non-material or idealistic motives must be clear and accessible in order to gain widespread public support for alternatives
2. Financial support for renewable energy sector must come from dedicated financial mechanisms in order for various technologies to be deployed in large quantities
3. The renewable energy sector should have independent trade associations that act in the

interest of deployment of technology for ecological purposes first and economic purposes second

4. The aforementioned trade associations should advocate for the stability and evolution of financial mechanisms for renewable energy
5. Deployment of technology is done by independent companies that are not affiliated with major utilities.

(2011, p. 39)

The perspective calls for the analysis of actions and key actors that facilitate change to sectors that resist the integration of renewable energy technology with industries and communities. Identity EM's focus on technology deployment is what sets it apart from 'social-constructionist' EM which pays more attention to the formation of social and political organizations than access to technology (Toke, 2011, p37). 'Identity' EM proposes that public involvement with organizations pushing for a grassroots voice in environmental policy is enhanced by public engagement with technology such as solar which is used to illustrate a green technological identity. Moreover, unlike the 'objectivist' perspective, 'identity' EM is opposed to conventional or existing industry setting the pace for processes of modernization. The process of modernization must be driven by public support which is mobilized by an identity that places the quality and accessibility of environmental innovation ahead of their cost-effectiveness (Toke, 2011, p37).

Overall, 'identity' ecological modernization emphasizes that sustainability must be a guiding force for development; a concept that differs from the mainstream version which uses development to guide what the term sustainability means in a given society. By combining the "technocratic instrumentality" of weak EM and the "deliberative democracy" of strong EM (Christoff, 1996) identity ecological modernization forms a perspective that emphasizes the role of renewable energy in traditionalizing Eco-modern identities. Ideally the perspective envisions a society where innovation and integration of green practices and technologies at the domestic level leads to the re-configuration of the short-sighted and harmful practices that have continuously been validated by economic prosperity. Moreover, identity ecological modernization is closely aligned with reflexive modernization, which emphasizes the importance of mobilizing independent opinion against existing powers that endorse patterns of production and consumption that are unsustainable (Hajer, 1995, p. 282). This mobilization of opinion is aided by the integration of renewable energy technology like solar photovoltaics that reveal which households subscribe to an eco-modern identity and consequently stand against

conventional industries such as coal and natural gas that continue traditions of unsustainable consumption.

Solar energy technology is of particular importance to the EM perspective since it is a prime example of technology impacting the capitalist production process with products that generate a profit and potential for industrial longevity (Schelly, 2015, p. 60). The continued integration of solar technology contributes to the fulfilment of an important strategy of ecological modernization: embedding ecologically-sensitive technology into the normality of consumption by attaching the innovation to an identity that makes it part of consumption rituals for as large a portion of the society as possible (Toke, 2011, p. 22). Solar technology therefore has the potential to link the eco-identity associated with renewable energy to the consumption of housing by people of all socioeconomic classes.

Environmental Justice Theory

The Environmental Justice paradigm evolved out of the New Environmental Paradigm (NEP) of the 1960's (Taylor, 2000). The NEP paradigm was critical of the exploitative positions taken during the nineteenth and early twentieth century by businesses and industries who rapidly extracted resources with no regard for future needs (Taylor, 2000, p. 529). Unlike the Exploitative Capitalist Paradigm, the NEP envisioned a more harmonious relationship between nature and humans that stemmed from setting limitations to growth, encouraging widespread post-materialist values and avoiding future risks with environmental planning (Taylor, 2000, p. 532). For example, the NEP advocated for the use of soft technology (i.e. solar) rather than hard technology (i.e. nuclear industry) since the former was considered safe technology appropriate for decentralization (Taylor, 2000, p. 532). The NEP position represented a new worldview that moved away from the Romantic Environmentalist of the early twentieth century, which welcomed the preservation of wild lands and acknowledged the reality of resource depletion, but could not fathom halting the commercial development of resources in any capacity (Taylor, 2000, p. 531).

The Environmental Justice paradigm filled a void in the NEP that neglected to examine the human-to-human interactions and how they influence human-to-nature relations. In addition to dealing with the uneven geographic distribution of environmental degradation, the Environmental Justice (EJ) paradigm also addresses the distribution of environmental benefits. The paradigm outlines the necessity of responsible use of resources, environmental education that intersects with social issues of the present, intergenerational and intra-generational equity, self-determination, urban ecological policies and the participation of the public as equal

partners in the decision making process (Taylor, 2000, p. 539- 41). All of the characteristics combine to form a theory that calls for the alleviation of environmental burdens and the equitable distribution of environmental and economic benefits, especially at the scale of the neighbourhood and individual dwelling (Foy, 2012, p. 57). By examining both the human-to-human and human-to-nature relationships through the lens of race, class and gender (Taylor, 2000, p. 522), EJ theory acknowledges the intersectionality of discrimination, and advocates for sustainable solutions that address processes of exclusion. The integration of solar energy technology with affordable housing is one such solution that has the potential to allow lower-to-moderate income households to spend less money on energy and contribute to the environmental well-being.

As a service central to the livability of a home, energy is critical to housing since the cost of it can be the difference between an affordable and unaffordable dwelling in terms of operating costs. In addition to contributing to the unaffordability of housing, high energy costs can have a direct correlation to negative health effects of residents, according to a 2002 study titled *The Cold Facts: The First Annual Report on the Effect of Home Energy Costs on Low Income American's* by Citizen's Energy Corporation. In relation to this fact, environmental justice theory stresses that green affordable housing is not just about environmental health, but also aims to reduce inequalities in human health outcomes that stem from socioeconomic differences (Gomez et al., 2011). Consequently, green affordable housing initiatives that improve efficiency by their very nature serve to benefit lower income households since they have less resources to begin with. These initiatives also take a stand against elite-oriented planning that produces spaces of 'green gentrification' (Budd et al., 2008, p. 266) made up of luxury solar-powered 'eco-homes' that have initial price tags that are beyond the means of lower-income groups. Creating policy and programs that embed 'just sustainability' in urban development practices requires the analysis of various socio-political and socioeconomic challenges that underlie current Western governance systems, and the Environmental Justice theory is a lens that will provide guidance for such an analysis.

Though ecological modernization and environmental justice theory are two structurally separate frames they can be linked together to form the analytical framework for this paper since they engage with similar issues and have overlapping ideologies. Both are well suited for the comparative analysis of both case study and Ontario contexts, and together as theories are guided by one overarching objective in relation to this paper: the guaranteed growth of residential development in urban regions must be shadowed by guaranteed sustainable development practices in order for sustainability to be a lived reality for a majority of the

population instead of an aloof ideal achieved by the privileged minority. Together the two will provide a template for thinking about solar energy technology and the role it should play in creating and maintaining greening affordable housing in Ontario.

CHAPTER 2 – Ontario's Affordable Housing Policy Context

2.1: Introduction

Within Ontario, affordable housing is defined as housing that requires its occupants to spend no more than 30 percent of their gross income on shelter costs[5] (MMAH, 2011). This definition outlines the upper limits of the monetary costs of housing, but does not emphasize a baseline acceptable quality for the housing. This is important to note since in Ontario a portion of the housing stock considered affordable is of degrading and poor quality and has noticeable effects on the wellbeing of its occupants. The health impacts of poor housing place people at risk and shift a portion of the cost of housing to the health care system (Wu et al., 2007, p. 954). In order to prevent future instances of Ontarian dwellings degrading and consequently lowering the quality of life of occupants, affordable housing and sustainable housing must become synonymous concepts. The Government of Ontario advocates for this evolution of the definition since it envisions a future with "improve [d] access to adequate, suitable and affordable housing" (ONPHA, 2012, p. 11)

Affordable housing serves many purposes and offers numerous social and economic benefits. The most basic purpose of affordable housing is to provide a physical link that allows occupants to access additional forms of urban infrastructure that ultimately contribute to the economic prosperity of a region (Evans, 2007, p. 9). For example, the Board of Trade highlights that the existence of quality affordable housing is central to the reputation of a livable and competitive city since it influences the interest of potential business investment and is tied to services that keep labour and commuting costs low (Evans, 2007, p. 5). Additionally, it also fosters better social outcomes for households, the most important being agency and pride in a community. Though housing is often seen as a distinct section of the private sphere, it is inextricably linked to the quality of life experience not only by those who live in it but those who live and commute around it. With a place in both the private and public spheres of society, housing can be considered a component of 'soft infrastructure' since the quality and availability of it has similar impacts on economic and psychological health in the same way roads, sewers, schools and hospitals do (Evans, 2007, p. 3; Côté, 2013, p.1). Ultimately, affordable housing is extremely important to the evolution of the socioeconomic culture of cities, including those in

[5] Shelter costs encompass taxes, insurance, utilities and other payments associated with housing.

Ontario. By incorporating solar energy technology - a distinct indicator of an eco-identity - affordable housing can continue to inspire the evolution of urban culture in a direction that acknowledges the role all households and communities can play in decarbonization strategies. This chapter will lay out the history, present realities and future growth of affordable housing and the policy related to each period in Ontario in order to provide foundational insight that will be referenced throughout the paper.

2.2: Origins and History

For a period of time, the Canadian federal government played a large role in the provision of public housing programs, but changes throughout the late 20th century slowly allowed the senior institution to absolve itself of responsibility for the provision of affordable housing[6]. One of the first changes was the Ontario Housing Corporation Act of 1964 which was legislation that established a partnership between federal and provincial levels of government in order to improve delivery of affordable housing stock. The act assigned the Ontario Housing Corporation (OHC) the majority of responsibility for the provision and management of affordable and public housing in the province (Starr & Pacini, 2008, p. 9). Closely related to this legislation were amendments to the National Housing Act in 1964 that mandated Canada Mortgage and Housing Corporation (CMHC) to provide long-term loans to territories, provinces, municipalities and public housing agencies (Rose, 1980, p. 38). The loans were to be used to acquire or build social housing units. Together, these legislative changes had positive impacts on the amount of affordable housing that was constructed. During the late 1960's and early 1970's affordable housing starts accounted for approximately 40 to 50 percent of all new residential construction (Hulchanski, 1988, p. 13). Outside of new construction, the CMHC also provided funds to low-income tenants seeking rental accommodations through the Rent Supplement Program and introduced the non-profit housing and co-operative housing programs with the intent to disperse low-income populations[7].

[6] Affordable housing encompasses social housing, co-operative housing and private market housing.

[7] For the purposes of this paper a low-income household is defined based on the spectrum of households that are eligible for the Ontario Electricity Support Program. This definition is used since it is relevant to the paired discussion of housing and energy in the context of Ontario. For example a household with an income between $48,000 and $52,000 with 7 or more people living in a home is considered low income. Additionally, a single person household with an income of $28,000 or less is also considered low-income (Ontario Energy Board, 2015). A matrix outlining the spectrum of low-income households as they relate to this paper can be found in Appendix A.

The introduction of the non-profit housing and co-operative housing programs led to a shift in mentality of the federal government who began to encourage a move away from publicly owned and operate social housing complexes that had become stigmatized areas of cities (Hulchanski, 1988 p. 20). Changing political priorities that sought to address deficits by decreasing social support services also influenced the shift in mentality. The new hierarchy of priorities became clear when the Mulroney government took power in 1984. The Conservatives began to push a neo-liberal agenda that among other changes, created tax breaks for the wealthy with the belief that a "trickled-down effect" would occur and support those previously dependent on public funds that had been cut (Bunting et al., 2004, p. 365). The federal government subsequently transferred the responsibility of funding for social housing to the provincial, municipal and private sectors. The federal government continued to focus on eliminating deficits into the 1990's. In 1995 the Conservative Party pushed the Common Sense Revolution (CSR) which initiated cuts to shelter allowances and welfare rates, terminated the construction of 17,000 units of co-op and non-profit housing and downloaded $905 million in social housing costs to local authorities (Shapcott, 2001). Paired with the elimination of rent control rates, the CSR had noticeable adverse effects on housing affordability and was responsible for a rise in homelessness among low-income household in Ontario. For example, in Ontario at a median income, an individual could afford a typical one bedroom unit at 29 percent of their income in the late 20th century; by 2000 that ratio for the same room rose to 38 percent, illustrating the erosion of affordability in the province (Suttor, 2007, p. 43).

Following the withdrawal of both senior levels of government, Consolidated Municipal Service Mangers became responsible for the development of affordable housing in Ontario (Starr and Pacini, 2001, p. 10; ONPHA, 2012). The province's 47 Service Managers have the majority of responsibility for the administration and funding of existing affordable housing, however, they are still required to seek 'ministerial consent' from the province for changes related to social housing properties (MMAH, 2010 p. 11). In an effort to ease the transition a five year, $680 million framework called the Affordable Housing Initiative (AHI) was created in November of 2001. The initiative was a cost-sharing program between the two senior levels of government and the funds were used for the construction of new rental and owner-occupied affordable housing (CMHC, 2016). The AHI was active from 2001 to 2011, and during this time was the only direct source of federal funding for affordable housing. Over $1.2 billion was invested and matched by provinces and territories to create approximately 52,400 units (CMHC, 2016). In total, Ontario received over $452 million from the initiative, which funded the creation of just under 22,000 units.

Independent of the AHI, new construction was focused on owner-occupied developments in the form of single-family homes and multi-unit condominiums and very few purpose-built rental properties were created (Côté, 2013, p. 5; Suttor, 2007, p. 29). Condominiums had been popular since the 1970's when they were legitimized as a variety of owner-occupied housing since they were able to immediately generate a cash flow from pre-sale to help finance construction (Hulchanski, 2009, p. 7). The financial structure was attractive to both investors and municipalities ill-equipped to plan, finance and execute the construction of housing at the rate of population growth. The continued dominance of condominium development in the densest regions of Ontario has persisted into the 21st century and the "trickle-down" effect remains a socio-political myth since existing purpose-built affordable housing has been ill-maintained and has exhibited minimal levels of growth.

2.3: Present-day Policies and Realities

Housing affordability has continued to erode present day as a result of a lack of new rental tenure construction and rising prices (FCM, 2012 p.1). Both of these issues are exasperated by the lack of coordination that exists between public and private institutions to adequately fill the gap left by gradual federal abandonment of housing funding. However, progress was made with the introduction of mandatory Housing and Homelessness Plans which each of the 47 Service Managers is responsible for developing (ONPHA, 2012, p. 3). The 10-year plans must align with the objectives outlined in the province's Housing Services Act, which emphasizes a role for non-profit housing corporations and the private market in the provision of housing that "promotes environmental sustainability and energy conservation" (Housing Services Act, 2011).

In addition to these regionally specific Housing and Homelessness Plans, the Long-Term Affordable Housing Strategy (LTAHS) is an informational document that has the intention of guiding future affordable housing development and maintenance in Ontario. Originally released in 2010, the LTAHS is a road map for reconfiguring Ontario's housing system into one that is "people-centered, partnership-based, locally driven and fiscally responsible" (MMAH, 2016, p. 3). The 2016 update of the strategy emphasizes numerous points made in the early version which outlined the urgent need to respond to chronic homelessness and vulnerable low-income Ontarians by providing funds for the construction and repair of affordable housing. It also discusses the $178 million of dedicated provincial investment in affordable housing over a three year period that will go toward housing allowances, construction of supportive housing and the

creation of an Innovation, Evidence and Capacity Building Fund (MMAH, 2016, p. 2). Moreover, the update advocates of inclusionary zoning legislation that would give all municipalities the ability to require private developers to include affordable housing units in their development proposals (MMAH, 2016, p. 16). The province is likely to adopt this legislation following a consultation period with local councils, affordable housing advocates, developers and the public (Monsebraaten, 2016). Finally, one of the ideas discussed that is most relevant is the need to drastically improve the coordination of all government systems that interact with and impact affordability in order to ensure that Ontarians have the best quality affordable housing and not just the bare minimum (MMAH, 2016 p. 5). These strategies show a willingness to coordinate the wellbeing of the housing system for the benefit of people, rather than neglecting them for the sake of reducing deficits and hoping certain private sector actors will directly or indirectly address the issue.

One of the most pressing issues is the high demand for subsidized housing, which has an average wait period of four years (Monsebraaten, 2015). Subsidized housing or social housing refers to units and complexes owned and operated by municipalities or other community organizations (Côté, 2013, p. 5). Ontario has 270,000 social housing units, the majority of which were built twenty to fifty years ago and require costly repairs (Tsenkova, 2013, p. 18). In fact, over half of the providers of social housing in Ontario are not in a financial position to stay on top of major maintenance costs and capital repairs so the properties continue to degrade, impacting the health and quality of life of residents and the surrounding community (Tsenkova, 2013). Every decade the province experiences growth of approximately 60,000 to 80,000 low income renters that await access to housing that is deteriorating in quality (The Wellesley Institute, 2015, p. 1). Moreover, households that are successfully assigned an affordable unit do not always receive a housing allowance even though all low-income tenants are eligible for rent supplements (Tsenkova, 2011, p. 9). In fact, only one-third of 560,000 low-income tenant households in Ontario receive rent-geared-to-income (RGI) assistance (ONPHA, 2013). RGI subsidies are generated from the property tax base and can be worth as much as $500 to $600 per month per household (The Wellesley Institute, 2015, p. 10).

The absence of assistance drastically impacts low-income households that can be forced to spend up to 45 percent of a their gross annual income on housing costs alone while a wealthier household only spends 15 percent (Statistics Canada, 2011). Current issues with RGI assistance do not end with the under supply of supplements. Many tenants receiving the benefits are burdened by having to report changes in their income which can lead to an immediate increase in their rent (MMAH, 2010, p. 7). Tying RGI assistance to income in Ontario serves as a

poor index on its own since an increase in income does not guarantee that necessities and services become more affordable. For example, an individual can get a raise at a time when food and transportation costs increase, and reciprocal adjustments are not made to soften the blow of increased costs of either for RGI assistance recipients, leaving them paying more for rent while also pay more for food and transportation. The LTAHS highlights that this is problematic since it makes it difficult for tenants to plan for the future when their rent is raised immediately. The strategy recommends the passing of legislation that would require tenants to only declare their income once a year so they can use their pay raise as they see fit, rather than be burdened with higher rent (MMAH, 2010, p. 7). The proposed legislation would also cut down on administration costs that could be reinvested elsewhere in the housing system.

The issue of housing affordability in rural communities in Ontario shares similarities with urban regions, however the progress that is made occurs at a much slower rate. Even though rural populations are smaller, many low-income families struggle to find housing that is both affordable and suitable. The existing stock is degraded in quality and consequently heating and utility costs are high and continue to rise (Slaunwhite, 2009, p. 13). In fact, the median cost of heating a home in North Bay is over a third higher than heating a home of the same size in Toronto (Suttor & Bettencourt-McCarthy, 2015, p. 16). Additionally, the landscape and climate of the more isolated communities of Ontario shortens the construction period in which affordable units can be built (Slaunwhite, 2009, p. 26; Suttor & Bettencourt-McCarthy, 2015, p. 11).

Over the years CMHC has compiled information about housing costs that illustrate the continued existence of the issue. A 2016 Research Highlight report states that 5.8 percent of Ontario's population is in core housing need[8] based on 2011 census data (CMHC, 2016a, p. 1). Across the nation, the majority of these households are renters concentrated in urban areas such as Toronto, London and Hamilton that make less than $31, 598 (CMHC, 2016a). In March of 2016, Using CMHC and provincial data, RentSeeker Inc. summarized the average costs of 4 varieties of rental dwellings in Ontario. As Figure 2.0 shows, of the research municipalities, Toronto has the highest average cost to rent ranging from $942 to $1,531. Additionally, based on RentSeeker Inc. and CMHC data a household at the top end of the lowest 2011 national income quintile that makes $31,598 would spend $13,320 on rent in Toronto, or 42 percent of their annual income. This percentage is 12 percent above the upper limits of housing recognized as

[8] According to the CMHC a household is considered to be in core housing need if "its housing does not meet one or more of the adequacy, suitability or affordability standards and it would have to spend 30 percent or more of its before-tax income to access local housing that meets all 3 standards." (CMHC, 2016a, p.8)

affordable in the province. The same hypothetical household could only find affordable housing in half of the municipalities listed in figure 2.0, and this number declines for households making less.

MUNICIPALITY	STUDIO	1 BEDRM	2 BEDRM	3 BEDRM	AVERAGE
BARRIE	728	1006	1167	1299	1,050.00
BRANTFORD	627	779	870	952	807.00
CORNWALL	564	631	778	799	693.00
GREATER SUDBURY	610	771	953	1117	862.75
GUELPH	706	898	1027	1160	947.75
HAMILTON	590	749	917	1062	829.50
KAWARTHA LAKES	665	816	1031	1193	926.25
KINGSTON	679	921	1099	1365	1,016.00
KITCHENER	698	830	970	1146	911.00
LONDON	609	787	976	1089	865.25
OTTAWA	801	972	1176	1365	1,078.50
PETERBOROUGH	666	816	959	1169	902.50
ST. CATHARINES	643	794	963	1137	884.25
ST.THOMAS	489	656	794	N/A	646.33
STRATFORD	566	702	836	961	766.25
THUNDER BAY	603	749	917	1131	850.00
TORONTO	942	1110	1301	1531	1,221.00
WINDSOR	536	689	824	942	747.75
AVERAGE	**651.22**	**815.33**	**975.44**	**1,142.24**	**889.17**

Source: RentSeeker Inc., 2016

Figure 2.0 – The table summarizes average monthly rent in 18 Ontario municipalities for four types of rental units: studio apartments, 1 bedroom, 2 bedrooms and 3 bedrooms. Averages for each type, each municipality and the province based on the listed cities are also provided.

Moreover, another CMHC report released in April of 2016 estimated the total amount of secondary housing in the nation. Secondary housing refers to dwellings that are not purposefully constructed to be used as rental accommodation, such as tenanted condominiums (CMHC, 2016b, p. 2). They are considered an insecure form of rental housing since at any time they can be reverted to owner-occupancy (CMHC, 2016b). According to the report in Ontario, Barrie has the highest amount of secondary housing at 74.4 percent of the areas total renter-occupied housing; Toronto is composed of 50.8 percent secondary housing. Thus, in addition to being unaffordable, half of private market rental dwellings in Ontario cities such as Barrie and Toronto are an insecure form of rental housing that can change tenure at any time.

Overall, the present day unaffordability of housing in Ontario is the result of both a financially and physically patch-worked housing system and a growing need for purpose-built affordable units all over the province. Future progress hinges on creating solutions that ensure three mutually dependent, but presently conflicting goals are reflected in affordable housing in Ontario: economic prosperity, social equity and environmental protection (Evans, 2007).

2.4: Future Housing System Plans and Projected Growth

Moving forward, both the federal and provincial governments are outlining achievable visions for Ontario's housing system. In the LTAHS the province of Ontario establishes the overarching housing goal of improving access to affordable and suitable housing that allows residents to participate in the development of strong communities (MMAH, 2016). The 2016 federal budget parallels this goal by committing to growing the middle class. In order to achieve this growth, the federal government has made plans to invest more than $120 billion over 10 years in infrastructure all over Canada (Government of Canada, 2016). The first phase of the plan will take place over the next two years and will modernize public transit, rehabilitate wastewater systems, protect existing infrastructure from the effects of climate change and provide affordable housing (Government of Canada, 2016). In particular, $2.3 billion will be provided for construction and maintenance of affordable housing over two years beginning in 2016. In addition to these funds the budget proposes the doubling of federal funding for the Investment in Affordable Housing (IAH) initiative. The proposal is contrary to the previous Federal plan for funding of affordable housing that is supposed to decline to zero by 2033 (MMAH, 2010, p. 12). If the proposal is carried out it would require all provinces and territories to also double their investment in affordable housing since the initiative requires them to match federal contributions.

Both senior levels of government acknowledge that achieving these goals will require the construction of new dwellings, the maintenance of existing ones, and an increase in the number of housing allowances. All of this must be done in the wake of a rising population in Ontario that is expected to grow by 4.2 million by 2041 (Ministry of Finance, 2014). The Greater Toronto Area (GTA) is projected to be the fastest growing region in the province with populations rising from 6.5 million in 2013 to 9.4 million in 2041 (Ministry of Finance, 2014). The province has committed to annually provide municipalities access to $1.5 billion in funds for housing by 2018 (MMAH, 2010, p. 12) and the potential doubling of funding for the IAH could increase these funds. Additionally, Ontario is in the final stages of establishing province-wide inclusionary

zoning legislation that would allow municipalities to require residential developers to set aside a certain portion of units as affordable (MMAH, 2016). Municipalities would have the power to regulate what size developments must obey the regulations, if it is citywide, how affordability will be determined and the percentage of affordable units required (Monsebraaten, 2016). The funding plans made thus far by both the federal and provincial levels of government to support the economic development and maintenance of affordable housing are a good start. However, it is important that initiatives that address residential sustainability are developed in order for affordable housing to contribute to the additional goals of inter-generational and intra-generational equity and environmental health.

CHAPTER 3 – Ontario's 21st Century Energy Context

3.1: Introduction

In the previous century, Ontario's energy system was structured haphazardly with at one point 393 utilities providing power at varying prices to customers (Elston et al., 2012, p. 5). The system remained fractured until 1998, at which point the Energy Competition Act (ECA) was passed (Elston et al., 2012, p. 5). The ECA mandated the creation of Ontario Power Generation (OPG) as an electricity generation company and Hydro One Inc. as the corporation responsible for managing transmission and distribution assets previously maintained by Ontario Hydro (Rosenbloom and Meadowcroft, 2013, p. 675). The Act also created the Independent Market Operator (now known as the Independent Electricity System Operator) which had the sole responsibility of managing the competitive market and balancing the province's electricity system. Additionally, the Ontario Energy Board (OEB) was created to regulate the price rates of all utilities and oversee the operation of all of the newly created entities.

Staying true to their neo-liberal agenda, the Conservative government initiated the wholesale and retail electricity market in the province in May of 2002 (Rosenbloom and Meadowcroft, 2013, p. 675). The private electricity market was subsequently dissolved in the fall of the same year after a summer heat wave that drove up prices and generated public backlash (Simon, 2002; Rosenbloom and Meadowcroft, 2013). In the following two years the Liberal provincial government stabilized the system by creating a regulated price plan for low volume consumers, keeping the wholesale market for high volume consumers and giving the newly created Ontario Power Authority (OPA) the power to plan the electrical system, develop conservation programs and procure private generation (Wyman, 2008). The result of all these changes is the current hybrid energy system that has both wholesale and regulate price plan components to meet the varying needs of energy consumers in Ontario.

This chapter will discuss the evolution of energy generation sources in Ontario, the current long-term energy plan for the province and the potential for increased integration of solar technology beyond 2016. Together, these concepts will provide foundational knowledge about Ontario's 21st century energy context.

3.2: Ontario's Long-term Energy Plan

In addition to reassigning various responsibilities of the Ontario energy system, there was also a new focus on which sources should generate the majority of power in the latter half of the 20th century. The new focused spawned from the reality of how vulnerable fossil fuel dependence made the province during the 1973 oil crisis. World oil prices quadrupled between October of 1973 and January of 1974 causing many regions to re-evaluate their dependence on fossil fuels (Licklider, 1998). During this period nuclear energy generation began to be viewed as the preferred source of power in Ontario in the face of rising fossil fuel prices (Rosenbloom and Meadowcroft, 2013, p. 674). In fact, as early as 1975 the province made plans for nuclear to meet up to 70 percent of the provinces future electricity demand (McKay, 1983). By the 1980's Ontario had 16 nuclear power plants located in clusters in Clarington, Pickering and Tiverton (Brooks, 2002). Despite the rapid development of nuclear, the public voiced reservations about the technology since the construction costs had noticeably increased consumer electricity rates (Rosenbloom and Meadowcroft, 2013, p. 675). The increase in rates was also a result of the documented reduction in energy consumption growth in Ontario during the 1980s and 1990s (Rosenbloom and Meadowcroft, 2013, p. 675). Both these events would eventually cause the provincial government to reorient energy policy toward conservation and system efficiency principles. The reorientation prefaced the eventual decoupling of energy use from economic growth; an ideological foundation from which decarbonization strategies and programs sprouted.

Feed-in Tariff Program

Following the passing of the ECA and the brief existence of a province-wide wholesale and retail energy market, the Liberal government began to voice support for a campaign advocating a Feed-in Tariff (FiT) program. The Ontario Sustainable Energy Association (OSEA) initiated the campaign in 2004 to pressure the provincial development of policies that would result in the proliferation of affordable renewable energy and the jobs that came with it (OSEA, 2011). The awareness raised by the campaign about the potential environmental and economic benefits of deploying renewable energy technology subsequently influenced the passing of the Green Energy Act (GEA) in 2009 (Winfield et al., 2010). Largely modelled on European renewable energy legislation, the GEA was the first act in Canada to encourage individual, community and company development of renewable energy projects (Weis, 2011). The legislation ushered in a new era of energy policy that emphasized the diversification of the

province's energy system to include environmentally sustainable sources that had the potential to engage communities and become the foundation of a world-class green industrial sector (MaRS, 2010, p. 1).

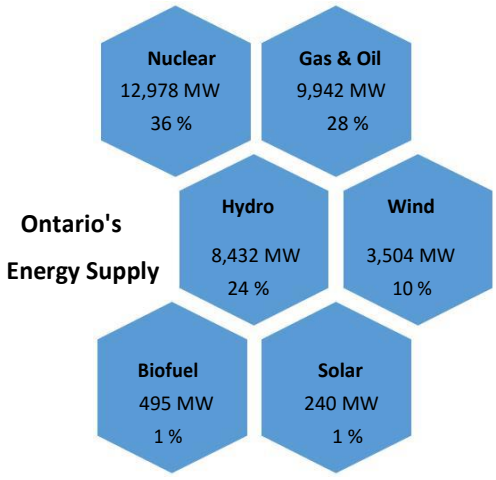
Among other features, the GEA outlined the establishment of a FiT program with varying rates for different renewable sources, the details of the twenty year FiT contract that potential developers would have with the OPA, and the obligation that local electrical distribution companies (LDCs) had to accept generators of various sizes into their system (Green Energy and Green Economy Act, 2009). The FiT program was preceded by the 2006 Renewable Energy Standard Offer Program (RESOP). Under the RESOP, sites that generated 1 to 10 kilowatts of energy from renewable sources received a fixed rate for 20 years. Owners of solar photovoltaic systems for example, were compensated a fixed rate of 42.0 cents per kWh for all energy generated that went directly to the grid (Adachi, 2009, p. 4). The program was frozen in May of 2008 due to transmission issues and the following year the FiT program was launched (OSEA, 2011).

Similar to the RESOP, the FiT program provides set prices for the production of renewable energy and changes the province's energy network from a one-way to a periodically two-way flow of energy (Elston et al., 2012, p. 23). In terms of program structure, the microFiT stream is open to entities procuring systems that are 10 kW or less in size while the traditional FiT program is for the procurement of systems that range from 10 to 500 kW (Ministry of Energy, 2016a). The FiT price rates are designed to help developers cover project costs while also providing them a reasonable return on investment over the contract lifetime (MaRS, 2010, p. 2). Also, the existence of a provincially-supported renewable procurement program reduces risk for investors that develop renewable technology within Ontario's boundaries since there is a guaranteed market as long as the FiT program remains operational. The province's 2012 review of the FiT program revealed that the initiative has attracted more than $27 billion in private-sector investment and has created more than 20,000 jobs, all while encouraging the public to participate in energy generation (Government of Ontario, 2012, p. 2). The program has remained popular since its launch and in April of 2016 a directive was issued by the Ministry of Energy for a fifth FiT program cycle with a procurement target of 150 megawatts, enough energy to power over 25,000 homes (Ministry of Energy 2016b; Government of Ontario, 2013, p. 30). The target represents 16 percent of the total capacity that the government has committed to making available for the FiT program from 2013 to 2018 (Government of Ontario, 2013, p. 30).

The Long-Term Energy Plan and Clean Technology Innovations

The continuation of the FiT program is a central component of Ontario's long-term energy strategy that aims to diversify sources of generation while also advocating a 'Conservation First' policy. Known formally as the Long-Term Energy Plan (LTEP), the strategy outlines Ontario's goal of molding a smart electricity system that affords consumers greater flexibility when it comes to the production and usage of energy (Government of Ontario 2010, p. 3). Much of the 2010 rhetoric reappeared in the 2013 update of the LTEP with some adjustments made to generation source forecasts. These adjustments increased the flexibility of the plan which was necessary in order to avoid the situation of failing to meet specific goals. For example, the 2013 LTEP outlines plans to phase in 10,700 MW of wind, solar and bioenergy by 2021 which is an extension of a time line previously stated in the 2010 LTEP (Government of Ontario, 2013, p. 6).

Solar in particular has a target of producing three percent of Ontario's energy by 2025 (Government of Ontario, 2013, p. 31), but there is potential for this figure and others to change as the province approaches the milestone years. To contextualize this proposed increase, figure 3.0 breaks down generating resources by sources in Ontario as of March 22nd, 2016. In addition to energy generation goals, the LTEP established a conservation target of reducing gross demand for electricity by 16 percent by the year 2032 (Government of Ontario, 2013, p. 27). The provincial government has committed to funding efficiency and retrofit programs, providing energy education resources and increasing access to energy data as these initiatives will all contribute to the achievement of the province's conservation target.



Source: IESO, 2016

Figure 3.0 – The above graphic details the amount each energy source contributes to Ontario's total energy supply as of March 22nd, 2016. The majority of power in the province is sourced from nuclear energy.

In order to track the progress of the goals outlined in the LTEP, the province has committed to releasing annual reports outlining changes in supply, demand, costs and emissions as they relate to energy use in Ontario. Information from the annual reports will impact future updates of the LTEP that occur every 3 years. It is likely that the annual reports outlining yearly shifts in the configuration of the energy system will influence how the province designates the six percent of 'planned flexibility' by 2025 (Government of Ontario, 2013, p. 35). Ideally, the continued development of clean technology will impact the configuration as new innovations will be evaluated in terms of their applicability to the Ontario energy context. This is a likely scenario since Ontario has the fastest growing clean-tech sector in Canada with 36 percent of the country's clean-tech companies within its borders (Government of Ontario, 2015, p. 14).

One type of technology that has emerged as a potential game-changer for Ontario's electricity system is energy storage. In its various forms, energy storage technology allows for the capture and delayed use of energy during periods of high demand. Whether it provides short or long-term storage solutions, the technology improves grid reliability. Storage technology also improves the practicality of renewable technology such as solar since it enables energy produced to be used at times other than peak generation hours (Government of Ontario, 2013, p. 83). Recognizing the potential of the innovation, the IESO launched a procurement process for storage technology in the fall of 2014 that resulted in the approval of five companies for the build-out of 33.54 megawatts of total project capacity (IESO, 2015). This first phase of the energy storage procurement program is expected to come online before the end of 2016. IESO emphasizes that the projects will "optimize the performance of renewable resources by smoothing out natural fluctuations in solar and wind production" (IESO, 2015). Ultimately, the optimization of the distribution and transmission network will have widespread benefits for system operators, private generators, utilities and consumers in Ontario.

Moreover, energy storage is one component of the broad concept of a smart grid. The term smart grid refers to an energy network that is decentralized in form and uses various monitoring technologies to generate real-time producer-consumer data that enhance the efficiency of the system (Hudson, 2014, p. 84). This concept is counter to Ontario's present 'dumb' system that is unresponsive to changes in customer needs or grid congestion and mainly relies on centralized generating stations (Environmental Commissioner of Ontario, 2014, p. 7). The province has welcomed the idea of smart grids with the establishment of the Ontario Smart Grid Forum which produces publications that analyze the potential for the future development of a smart grid that increases the efficiency of decentralized energy sources and eliminate the

possibility of a repeat of the 2003 blackout. The creation of a smart grid will become imperative as more decentralized renewable energy comes online and consumer expectations continue to change and align with 'smart' practices elsewhere in the world. As Ontario moves toward the milestone years of 2021 and 2025, the continued innovation of energy system organization and technology will play a huge role in how the province redefines the details of the Long-Term Energy Plan.

3.3: Ontario's Energy Reality and Solar Opportunities Beyond 2016

As Ontario's moves towards the next decade of the 21st century, a number of temporary and permanent changes will play out in the energy sector. One major change is the refurbishment of two of the province's nuclear plants. In Clarington, the Darlington station operated by Ontario Power Generation (OPG) is scheduled to shut down four of its six units for a refurbishment process that will begin in 2016 and end in 2026 (OPG, 2016). According to the OPG, the $12.8 billion project will add 30 years to the life cycle of the station (OPG, 2016). Additionally, in Tiverton, the Bruce station operated by Bruce Power Limited Partnership is expected to be refurbished in 2020 and will also cost approximately $12 billion (Bruce Power, 2015). Together the two stations account for nearly sixty percent of Ontario's electricity generation when they are operating at optimal capacity (OPG, 2014). The refurbishment processes have been rationalized by the operating entities and the province as being necessary in order to prevent the social and economic risk of future power outages by maintaining a stable source of energy for Ontario's base load needs (OPG, 2015). Moreover, the OPG has suggested to the Ministry of Energy and the IESO that the Pickering station should also be refurbished at some point so that it can continue to operate until 2024 instead of going offline in 2020. (OPG, 2016; Government of Ontario, 2013, p. 5). However, this plan has not yet been approved by the Canadian Nuclear Safety Commission.

While the two refurbishment projects take place, the province has stated that natural gas will fill the void left by the shutdown of the stations (Government of Ontario, 2013, p. 47). Currently, Ontario has roughly 3.5 million natural gas customers that typically use the energy source for water and space heating (Government of Ontario, 2013, p. 74). Though natural gas is

not nearly as harmful a source as coal[9], the planned increased dependence on it is predicted to raise greenhouse gas (GHG) emissions by millions of tonnes (Weis, 2011, p. 16). In fact, the Ontario Power Authority (OPA) predicted that CO_2 in the province will increase by 60 percent between 2020 and 2025 as a result of increased reliance on natural gas during nuclear refurbishment (Environmental Commissioner of Ontario, 2014a, p. 49). Additionally, 30 percent of Ontario's natural gas is projected to originate from shale gas extraction processes by the year 2020 (ICF International, 2010, p. 7). The extraction process of shale gas involves drilling down through hundreds of feet of rocks and then horizontally through shale beds to fracture it and release natural gas (Montgomery, 2010). The process has the potential to leak gas into aquifers, thus posing a major health risk to communities on the surface that use the water (Detrow, 2012).

Unfortunately, the environmental issues associated with natural gas are often overshadowed by the theorized economic benefits of the non-renewable energy source. In early 2016, the overshadowing of environmental considerations by economic ones occurred again when the cost of natural gas dropped by nearly 18 percent in Canada (Blatchford, 2016). As a result, some providers and consumers have been led to believe that increased dependence on the source is economically sustainable during the province's period of transition. However, the price of natural gas has proven in the past to be extremely volatile. One of the best examples of this volatility is The California Energy Crisis that caused a 55 percent increase in residential natural gas prices in Ontario between February of 2000 and May of 2001 (National Energy Board, 2011). For Ontarians with the lowest income the increase strained household finances.

Furthermore, temporarily establishing natural gas as a base load energy source may prove to be a poor decision in the wake of the Cap and Trade system that is expected to be launched in 2017. Under the program the province sets a cap on annual emissions and distributes permits to companies that allow them to produce a certain amount of carbon emissions (Morrow, 2016). Companies that produce more carbon than what is allowable by their permits are required to purchase additional ones from those with a surplus (Morrow, 2016). These additional permits can be purchased from companies in Ontario or the two additional regions participating in the system: California and Quebec. As a result, it is expected that natural gas will pass on some of the costs of purchasing these additional permits to consumers. The price per tonne is predicted to be $16 in 2017 and rise to $95 by 2030, which would result in an estimated increase of home energy costs of $5.88 to $7.88 each month for Ontario households

[9] The U.S Energy Information Administration approximates that for every million British thermal units (Btu) of coal used 214 to 228 pounds of CO_2 are emitted. Natural gas only emits 117 pounds of CO_2 per million Btu.

(Morrow, 2016). These additional costs paid by Ontarians will seldom benefit them in any way since the bulk of additional permits will likely be bought from California-based companies (Morrow, 2016). Therefore, the planned change in the source of our base load energy will result in an exodus of Canadian dollars to the U.S. not only to pay for the importation of the commodity but also to assist natural gas companies purchasing Cap and Trade permits that will rise in cost every year.

In addition to temporarily reducing the supply of nuclear energy, the province will also have to update its aging energy infrastructure that for the most part is over 50 years old (Weis, 2011, p. 3). Both distribution and transmission systems will require extensive updating in order to consistently meet Ontario's energy needs. Transmission systems are responsible for transferring high-voltage electric power from generating sites to customer loads or distribution systems. Relatedly, distribution systems are composed of the wires, poles, breakers, transformers and other related equipment that deliver electricity from a local substation to consumers (Weis, 2011, p. 23). Incidents of blackouts and breaker explosions across the province are the result of equipment that is not serviced or replaced quickly enough when it nears the end of its lifetime (Howlett & Hui, 2010). The lack of maintenance has resulted in cities like Toronto having some of the highest-energy system interruptions per customers anywhere in the world (City of Toronto, 2007, p. 15). Utilities across the province will need to create solutions and initiate actions as soon as possible that reduce instances of blackouts and result in the creation of an innovative and sustainable energy system. In order to efficiently achieve this future innovative system, the Government of Ontario has advocated amalgamation of certain smaller utilities into larger ones to create shoulder-to-shoulder Local Distribution Companies (LDCs). Until such a reform occurs Ontario will continue to have more ill-maintained energy distribution facilities and equipment than is needed to service consumers (Elston et al., 2012, p. 14).

In terms of necessary investment, the Conference Board of Canada has predicted that Ontario will require $5.48 billion for the transmission system and $16.63 billion for the distribution system just to sustain the current network (Baker et al., 2011). In order to expand the system to accommodate growth, and create a smart grid that simplifies the process of integrating new technologies (i.e. decentralized energy systems and smart cars) the system will require additional investment of over $20 billion (Elston et al., 2012, p. 24). When the overhaul of the system eventually picks up momentum, it will provide the option for a larger portion of the province to meet energy needs with technology capable of decentralized and grid-connected energy generation such as solar.

The versatility of solar energy generation systems present unique opportunities for increased deployment of the technologies as Ontario goes through the planned changes to its energy network. One opportunity is the construction of solar energy generation systems with content sourced from the province on suitable structures currently serviced by natural gas that desire to embrace an eco-identity and keep more Canadian dollars in the province. Solar space cooling systems can be of particular use in Ontario during the summer months when the province experiences its highest energy use due to hot weather (Environmental Commissioner of Ontario, 2014a, p. 58). Furthermore, Ontario has locally based solar manufacturers such as Canadian Solar and Samsung that invest billions in communities in Ontario, while natural gas is typically purchased from outside the province (Clean Energy Canada, 2015, p. 14). Additionally, since the launch of the FiT and micro FiT programs, the average costs for new solar PV systems have declined toward grid parity (Government of Ontario, 2013, p. 41). The continued drop in price can be accelerated by households and businesses becoming small-scale decentralized power plants that will not require the future mandatory purchase of Cap and Trade permits in the future. Moreover, solar is an ideal technology for Ontario as the province continues the development of a smart grid. LDCs that have already integrated smart grid technologies that monitor voltage at points along the network can benefit from solar systems that have similar monitoring components to improve the reliability of the broader energy network (Environmental Commissioner of Ontario, 2014b, p. 17). Relatedly, a potential shift in energy generation preferences may occur in response to the reality of consumers paying for GHG emissions under the Cap and Trade program and solar will be a readily available technology.

In order to begin to successfully integrate decentralized energy generating technologies such as solar the province must make some headway on both maintaining and innovating the transmission and distribution networks. The province has acknowledged that innovation cannot occur if the foundational energy system is ill-equipped to maintain its current structure, however acknowledgement is not enough and action to refurbish the system while also innovating its structure is necessary. The lack of action can be blamed in part on the fractured nature of the network with 70 LDCs which service anywhere from one thousand to one million customers, that have yet to unite and develop complimentary strategic plans that all have the goal of making Ontario's energy system world-renowned for its efficiencies and clean technology. However, there may be hope in the future for the development of such plans since the Ontario Government released draft regulations in 2015 that encourage the consolidation of LDCs in Peel, York, Barrie, Durham, Halton and Hamilton (Stevens, 2015). Independent of these planned changes and ideal scenarios, solar technology will continue to be developed and

innovated by both public and private sectors around the world. As the dominant location for solar technology in Canada, Ontario must strive to be among the best countries innovating efficient solar technology that improves the day-to day quality of life at a local and global scale.

CHAPTER 4 – Where Housing Meets Energy

4.1: Introduction

Residential energy consumption encompasses power used for space heating, water heating, air conditioning, lighting and larger appliances which all impact the quality of life experience in a home (National Energy Board, 2013, p. 26). In Canada, housing is responsible for the consumption of over 23 percent of all energy use and relatedly, 20 percent of GHG emissions (Statistics Canada, 2013). In Ontario, a large portion of affordable housing in both its not-for-profit and private forms is older and consequently consumes more energy due to poor insulation (Environmental Commissioner of Ontario, 2014, p. 44). In fact, most of the social housing towers in the province were constructed in the 1960's and 1970's and some can use 25 percent more energy per square meter than a house (MMAH, 2016). The IESO states that the typical household in Ontario uses 800 kWh a month, however energy usage and costs for non-profit housing and private sector multi-unit buildings that have common areas can be significantly higher (Environmental Defence Canada, 2014, p. 2). The increase in cost proves cumbersome for low-income households that annually can spend 10 percent of their income on energy bills while middle and upper-income Ontarians only spend 3 to 4 percent (Sovacool, 2013, p. 141; Ontario Energy Board, 2016). In general, the majority of energy used at the site of the home is for space and hot water heating (Statistics Canada, 2015). In terms of space heating, 73 percent of homes in Ontario are heated by forced air furnaces that burn natural gas (Statistics Canada, 2015). With natural gas temporarily replacing nuclear energy during the refurbishment of the generating plants, it is expected that dependence on it for home energy needs will rise.

As Ontario moves closer toward the target years for emissions reduction and conservation goals it will become increasingly important to standardize sustainable development practices for a larger portion of the province. One component of the process of standardizing sustainable development is ensuring that people of various socioeconomic status are able to engage with available energy efficiency technologies in direct relation to their home so that emission reduction can take place at the scale of the household. Policies and programs that focus on facilitating a link between affordable housing and green technologies contribute to this process of standardization by ensuring those with the least means are able to embrace an ecologically-modern identity. A public sphere that is heavily influenced by people with ecologically-modern identities of various backgrounds has the potential to challenge the political orthodoxy of continued dependence on unsustainable resources (Smith, 2003, p. 125). The

potential result of this movement is the increased valuation of environmental considerations which in turn benefits everyone that calls the Earth home. Therefore, the joint analysis of Ontario's affordable housing and energy systems is important since updating the quality of interaction between the two has the potential to diffuse this identity among a larger population while also creating noticeable environmental, economic and social benefits at a number of scales.

The province's Housing Policy Statement acknowledges that sustainable or green affordable housing typically results in fiscal savings and job creation that strength the economy (Government of Ontario, n.d.). Studies by a number of institutions confirm the positive economic impacts that integrating energy efficient technology with affordable housing can lead to. One 2012 report conducted by Deutsche Bank stated that within the US, every one million dollars invested in energy efficiency retrofits in multi-unit affordable housing generated between $1.3 million and $3.9 million in energy savings and increased gross domestic product (Deutsche Bank, 2012). Though the United States' affordable housing context does differs from Canada's, the two share enough similarities that a similar return on investment could be achieved in Ontario. Additionally, energy-efficient affordable housing reduces the risk of energy poverty among low-income households by lowering utility costs, making them less reliant on emergency funds such as the Ontario Electricity Support Program (OESP)[10]. Furthermore, solar energy systems in particular can add value to properties since systems set-up under the microFiT or FiT program ensure owners of buildings receive payment for all electricity produced, making them a constant source of revenue for the lifetime of the system. Also, the efficient operation of solar photovoltaics and solar hot water heaters is highly dependent on the integrity of the structure on which they sit. Therefore, integrating solar energy with affordable housing can positively influence building owners to perform regular maintenance on their properties which chips away at the stigma of rundown affordable housing in Ontario (Côté, 2013, p. 2).

Along with the economic benefits, green affordable housing inspires positive social change in the surrounding community as a result of emphasis being placed on environmental values. In order to embedded decarbonization and green practices in all facets of society it is important that Ontarians of all socioeconomic backgrounds have the option and ability to engage with

[10] The Ontario Electricity Support Program was launched at the beginning of 2016 by the Ontario Energy Board. Low-income Ontarians that qualify receive an on-bill credit totalling $30 to $50 a month. Program funds come from residential and commercial ratepayers who contribute $1 and $2 to $4 per month respectively. Appendix 'A' details what households are eligible for the OESP based on the number of members and total income (Ontario Energy Board, 2016).

them. The integration of solar technology with affordable housing can inspire residents to engage with an ecologically-modern or eco-identity as a result of gaining insight about the relationship between the environment and energy consumption. The option for low-income individuals to engage with such an identity within their communities is important since it ensures that "going green" is not a class-exclusive movement. Moreover, regularly maintained green affordable housing positively influences residents to take pride in where they live which enhances the sense of place of a community. In turn, changing the attitudes of residents in social, private market and co-op housing can influence individuals in other regions to hold affordable housing in higher esteem, subsequently peeling back the layers of negativity often attached to low-income households and their communities. This chapter will summarize policies and programs that have facilitated the diffusion of solar energy technology as a decarbonization strategy in Ontario's residential communities. Several of these initiatives will later be compared to similar ones in the case study regions of the United Kingdom and California.

4.2: Greening of Residential Building Regulations in Ontario

Ontario has made considerable headway on incorporating decarbonization standards into building regulations. Within the last 20 years, the province has experienced the decoupling of growth in building stock from GHG emissions, largely as a result of amendments to the Ontario Building Code (OBC) in 1990, 2006 and 2012 (Environmental Commissioner of Ontario, 2014, p. 42). The OBC contains regulations that detail uniform construction standards for the province. In 1990, under the leadership of the NDP provincial government, the regulations were amended to mandate improvements to building envelope requirements and smaller units which weakened the correlation between increased residential floor space and GHG emissions (Environmental Commissioner of Ontario, 2014, p. 42). In 1995, the Conservative provincial government briefly contested energy efficiency requirements in the building code, however pressure from a coalition that cited the benefits of the standards halted provincial plans to eliminate the requirements indefinitely (Summerhill Group, 2011, p. 58). The OBC was amended once again in 2006 by the McGuinty government who set some of the highest energy efficiency requirements in North America that came into full effect in 2012 (Summerhill Group, 2011, p. 58). The 2006 OBC required all new homes to be built 35 percent more efficient than those built in 2006 and increased the Energuide rating requirement from 73 to 80 (Summerhill Group, 2011, p. 59). The Energuide rating system measures the energy performance of

individual dwellings (Natural Resources Canada, 2015). The rating is calculated using software that makes assumptions about energy operation in a house based on materials and technology present (Natural Resources Canada, 2015). As Figure 4.0 shows a rating of 80 signifies new energy-efficient housing that is well insulated, with no major air leaks while housing with a rating of 73 only includes some energy efficiency improvements. Ontario was the first province in Canada to mandated Energuide 80 levels for all housing built after 2011 (MMAH, 2010).

TYPE OF HOUSING	RATING
NEW HOUSE BUILT TO BUILDING CODE STANDARDS	65-72
NEW HOUSE WITH SOME ENERGY EFFICIENCY IMPROVEMENTS	73-79
ENERGY-EFFICIENT NEW HOUSE	80-90
HOUSE REQUIRING LITTLE OR NO PURCHASED ENERGY	91-100

Source: Natural Resources Canada, 2015

Figure 4.0 – The table describes what type of housing qualifies for the 4 intervals of the Energuide rating system. A housing rate 100 is well insulated, sufficiently ventilate and requires no purchased energy on an annual basis.

From 1990 to 2011, Ontario experienced a 62 percent increase in residential floor space, but only an 18 percent increase in related GHG emissions, revealing the effectiveness of uniform housing energy efficiency standards (Environmental Commissioner of Ontario, 2014, p. 42). Further amendments to the OBC were made in 2012 that established an objective of limiting GHG emissions from all buildings as well as limiting peak electricity demands. Both objectives will be achieved through the application of a new requirement that will improve energy efficiency of residential structures by 15 percent compared to the 2006 code (Environmental Commissioner of Ontario, 2014, p. 43). The new requirements will come into effect in 2017, the same year that Ontario's Cap and Trade program is scheduled to be rolled out (Environmental Commissioner of Ontario, 2014, p. 43).

In addition to finalized decarbonization standards, the provincial government has voiced interested in mandating new standards in anticipation of a growing market for clean energy. As a renewable energy technology, solar is capable of generating energy used for electricity, space heating and water heating, all of which contribute heavily to month-to-month household costs. Solar has gained momentum over the last several decades as a viable mainstream source of energy, and consequently the federal and Ontario governments have been assessing the

possibility of requiring new houses to be built solar-ready. A solar-ready home refers to dwellings that are initially built to include the necessary piping and equipment[11] needed to install a solar energy system (Ontario Green Homes, 2010). A pilot project developed by Doug Tarry Homes in conjunction with Natural Resources Canada is located in St Thomas, Ontario. The project has revealed that one of the many advantages of solar ready homes is that including the piping for systems at the outset of housing construction is less expensive that adding it in at a later time (Ontario Green Home, 2010). The idea of solar ready requirements for housing came up with the provincial government prior to the release of the 2012 OBC (City of Edmonton, 2014, p. 12). Though no concrete standards have resulted from the discussion or pilot project findings, it is promising that two levels of government have recognized the role solar has the potential to play as a decentralized energy source in a province that has over 20 solar panel manufacturing plants within its borders (Clean Energy Canada, 2015, p. 29).

4.3: Existing Energy Efficiency Initiatives in Ontario

Though additions to provincial legislation called for mandatory energy efficiency requirements for newly constructed buildings, over 70 percent of the province's housing stock was built prior to 1990 (Environmental Commissioner of Ontario, 2014a, p. 44). To reprimand this issue, over the past several decades the province has made services and funding available for residential building owners that wish to retrofit dwelling with energy efficient materials and technology.

The FiT and MicroFiT program

Since their unveiling in 2006, the Ontario FiT and microFiT programs have maintained a high level of interest despite the gradual reduction of prices paid to generators as renewable technology moves closer and closer to grid parity (Environmental Commissioner of Ontario, 2014c, p. 18). The continued popularity of the program can be attributed to a number of factors, including guaranteed payment, a streamlined application process and grid connection priority (MaRS, 2015, p. 5). The microFiT program in particular has continued to grow in popularity

[11] Solar-ready homes include a suitable roof location, labelled conduits from the mechanical room to the attic, extra plumbing valves and labels on the hot water tank indicating a point for solar connection. (Ontario Green Homes, 2010)

among homeowners and other participants with over 19,000 small scale systems that generate over 170 MW of predominately solar energy that is subsequently fed into the grid (McInroy, 2015). With both streams entering their tenth year of operation, Ontario's Feed-in-Tariff programs remains a prime example of a renewable energy deployment initiative that is accessible to homeowners and companies that can afford the upfront costs.

The SHRRP and the Renewable Energy Initiative

Three years after the beginning of the FiT program, the Canadian and Ontario governments announced the launch of the jointly funded Social Housing Renovation and Retrofit Program (SHRRP). The program set out to provide the fiscal means to allow housing providers to create healthy and efficient social housing communities by retrofitting poorly maintained, vacant or abandoned units (Government of Ontario, 2009, p. 1). Under SHRRP, funding was made available to Service Managers, the Ministry of Community and Social Services, Rural and Native Housing, and the Ministry of Health and Long Term Care (Government of Ontario, 2009, p. 2). The program stipulated that all funds had to be spent within two years of the start of the program in 2009 (City of Toronto, 2009). Services Managers received different levels of funding depending on the proportion of social housing in their service area. Service Managers subsequently distributed funds to social housing providers in their jurisdiction under the condition that providers agreed to maintain the tenure of the structure as affordable social housing for a minimum of 10 years (Tsenkova, 2013, p. 33; Government of Ontario, 2009, p. 2). Due to the proportion of social housing in the region, the City of Toronto received over $259 million of the $704 million given to Ontario, which was then allocated to cooperatives and non-profits including the Toronto Community Housing Corporation (TCHC) (Tsenkova, 2013, p. 41). In total the funds contributed to the renovation of over 58,000 social housing units in Toronto (Tsenkova, 2013, p. 38).

Similar to the SHRRP, the $70 million Renewable Energy Initiative (REI) launched in 2010 was jointly funded by the provincial and federal governments (Region of Peel, 2011). The goal of the REI was to further lower operating costs for social housing providers by providing funding that allowed them to install renewable energy technologies such as solar photovoltaic, solar water heater, geothermal and mid-sized wind technologies (City of Toronto, 2010). The initiative is a component of Canada's Economic Action Plan, which outlines a commitment to supporting a green economy in provinces such as Ontario (Region of Peel, 2011). Again, Toronto received a large portion of REI funds, with $30 million goings toward the deployment of renewable energy systems that impacted operational costs for nearly 11,000 social housing units

(Tsenkova, 2013, p. 38). Together, the SHRRP and REI were successful in aiding the redevelopment of desirable and efficient social housing in communities across Ontario from 2009 to 2011. Though the issue of ill-maintained social housing was not fully addressed by the multi-million dollar programs, they both serve as an example of how the federal and provincial governments can work together on issues of housing quality in Ontario.

The Community Energy Partnership Program

In an effort to grow community power in the province, the Ontario Power Authority (OPA) launched the Community Energy Partnerships Program (CEPP) in 2010 (Weis, 2011 p. 79). The goal of the CEPP was to simplify the process of developing community renewable-energy projects in Ontario by providing up to 90 percent of eligible development costs (OPA, 2010). The CEPP overcomes the largest barrier to community energy projects which is access to necessary finances during the development phase. Projects ranging in size from 10 kW to 10 MW are eligible to receive up to $200,000 and those larger than 10 MW have an upper limit of $500,000 (Weis, 2011 p. 79). Funding is provided in 2 phases: the first portion is given to complete project design and development, and the second portion is given to offset the costs for regulatory approvals such as a provincial environmental assessment (OPA, 2010). Participating groups have included charities, not-for-profits, farmers and co-ops that without the funding would be unable to complete a renewable energy project (OPA, 2010). The CEPP ceased to exist in 2015, however the IESO launched a new initiative called the Energy Partnerships Program (EPP) on June 27th, 2016 (IESO, 2016a). The EPP consolidates the Community Energy Partnerships Program, the Municipal and Public Sector Energy Partnerships Program, the Aboriginal Renewable Energy Fund, and the Aboriginal Transmission Fund into one (MaRS, 2010; IESO, 2016a). The program promotes the participation of indigenous communities, cooperatives, municipalities and public sector entities in developing energy projects (IESO, 2016a).

The program is composed of two funding streams: the Partnership Stream and the Project Development Stream. The Partnership stream assists indigenous communities who require support and guidance in their pursuit of partners to develop renewable energy projects under both the FiT and Large Renewable Procurement programs. The stream provides the same support to co-ops, municipalities and public sector entities, but only for the development of Ontario FiT projects (IESO, 2016). The maximum amount of funding for the Partnership stream is $50,000 (IESO, 2016b, p. 16). The Project Development Stream supports eligible community groups with funding for the soft costs associated with developing renewable energy projects

under the FiT program (IESO, 2016a). Applicant to this stream can apply for $75,000 per FiT project if a community group's portfolio contains 1-3 separate sites or up to $250,000 for 4 or more FiT projects (IESO, EPP Project Development Rules, 2016c, p. 6-7). Among other requirements, all applicants to the EPP must detail how the proposed projects will create jobs, offer education and training opportunities and enhance economic wellbeing in the community (IESO, 2016b, p. 17). Moving forward, the EPP will allow a larger portion of Ontarians to overcome the largest barrier to community-owned energy projects by assisting in the acquisition of partners and providing funding for projects that generate local clean energy.

Net Metering

Aside from program providing funding for the redevelopment of dilapidated affordable housing into green affordable housing, the province of Ontario has also discussed the idea of net metering. Net metering refers to the process of monitoring energy use at the site of consumption by comparing the output of an at-site energy generation system to the electricity consumed by the household (O. Reg 541/05; Environmental Commissioner of Ontario, 2014b, p. 33). Eligible structures with generation facilities can reduce their energy costs by exporting surplus energy to the grid for credit from their utility provider. In 2006, the provincial government introduced the net metering regulations which allow generators of electricity from systems smaller than 500 kW to have a meter installed that monitors consumption relative to generation, and compensates owners with credits that reduce their bill when excess electricity is exported to the grid (Adachi and Rowlands, 2009 p. 4; Toronto Hydro, n.d.). Net metering is an important element of the province's culture of conservation, one that rightly endorses reduced consumption as the primary way to lower energy costs provincially (City of Toronto, 2009, p. 2). This link was reflected in the 2013 LTEP that mentioned the evolution of the microFiT program into a net metering program, a concept that was subsequently explored by a working group formulated by the Ministry of Energy (Government of Ontario, 2013, p. 6; Environmental Commissioner of Ontario, 2014 p. 33).

In December of 2013, the working group began to examine the feasibility of turning Ontario's microFiT program into a net metering program as early as 2018 in order to significantly grow the number of renewable energy systems connect to the grid (Environmental Commissioner of Ontario, 2014 p. 33). In February of 2016, the Ministry of Energy issued an update which outlined that local distributing companies, the IESO, industry professionals and the Ontario Energy Board were collaborating on a proposal that will be subsequently posted for public comment before the end of the year (Ministry of Energy, 2016). The directive went on to

state that the microFiT program will stop accepting application by December 31st, 2017 in preparation for the launch of the net metering program the following year (Ministry of Energy, 2016).

It is undeniable that this initiative is a step in the right direction, however currently the majority of participants in the microFiT program that serve to benefit from net metering are households in least need of reduced energy costs. A 2009 report by the City of Toronto highlighted the future inequity of failing to afford tenants living in rental and social housing access to renewable energy and smart metering when it stated: "Vulnerable groups will be hurt by smart-metering and rising energy costs because they [are not] shielded from sudden increases [in non-renewable energy prices]" (City of Toronto, 2009, p.6). The vulnerability to fluctuating energy prices is likely to become a reality for a greater portion of low-income Ontarians since the province has committed to increased natural gas dependence in the wake of both nuclear plant refurbishments. Thus, in order to not only reduce the projected impacts of heightened non-renewable energy dependence for low-income Ontarians, but also allow low-income groups to adopt an eco-identity, it makes sense now more than ever to implement solutions such as solar energy system integration with affordable housing in the province of Ontario. Elsewhere in the world, these solutions have been implemented with various policies and programs that serve as prime examples of how Ontario can establish a necessary relationship between renewables, particularly solar energy, and the affordable housing system.

CHAPTER 5 – Residential Solar-Integration Program Case Studies

5.1: Introduction

The United Kingdom (UK) and California are two regions that similar to Ontario are considered to be part of the geopolitical 'West'. Both have histories of ecologically-damaging industrialization practices that have contributed to climate change and consequently have enacted changes that separate economic growth from environmental degradation. The 'West' collectively faces the harsh reality of the energy 'trilemma', a concept explained by Andy Boston in his 2013 article *Delivering a secure electricity supply on low carbon pathway*. The term refers to the combination of three competing issues that governments at all scales continue to attempt to address:

1) The unstable economy
2) Creating incentives for carbon reduction
3) Maintaining a secure and affordable energy supply

One strategy that public institutions and private actors in both contexts have recognized as a potential blanket solution for the trilemma is increased deployment of solar energy technology in residential communities. The continued innovation of solar technology in its various forms has contributed to its status as a tool that is typically successful in solving economic, environmental and social issues that all spring from the central problem of energy production and consumption. The truth of this statement is backed by global growth rates of 35 to 40 percent for solar photovoltaics, making the technology the fastest growing renewable energy source in the world (Reinsberger et al., 2015, p. 179). The UK and California in particular have pushed for the increased deployment of renewable technologies with ecological modernization-based policies in order to successfully meet clean energy and emission reduction targets by the year 2020.

As a member of the European Union (EU), the United Kingdom is obliged to meet the region's 20-20-20 targets that were formally adopted in 2008 (Smith et al., 2014, p. 123). The strategy aims to reduce CO_2 emissions by 20 percent compared to 1990 levels, source 20 percent of energy from renewables, and increase energy efficiency by 20 percent (European Commission, 2016). In order to plan the successful achievement of these goals, the European Commission directed all members of the union to produce a road map describing how they

would contribute to achieving the second target (The European Parliament, 2009). The UK subsequently released its National Renewable Energy Action Plan (NREAP) which bound the region to obtain 15 percent of energy from renewable sources by 2020 (DECC, 2010). Additionally, the Parliament of the United Kingdom released the Climate Change Act that legally bound the region to reduce greenhouse gas emissions by 80 percent by 2050 relative to 1990 levels, representing a commitment to go above and beyond the GHG reduction targets for the European Union (Bolton and Foxon, 2015a, p. 167; Bolton and Foxon, 2015b, p. 541).

Moreover, in California, following a decade of enhanced support for renewable energy, Governor Schwarzenegger announced the expansion of financial support for solar generation technologies in 2004 under the Million Solar Roofs initiative (CPUC, 2016, p. 1). The initiative presents solar energy technology as a strategy that addresses climate change by introducing one million rooftop solar power systems that are hypothesized to reduce greenhouse gas emissions by three million metric tons (Zahran et al., 2008, p. 433). The initiative was formally enacted two years later in 2006 with the ultimate goal of installing three thousand megawatts of new solar over a ten year period with $3.3 billion in funding from ratepayers to be used for program administration, evaluation and incentives (Hallock, 2015, p. 4).

In order to successfully achieve their decarbonization targets both regions have established dedicated programs that encourage the deployment of solar energy technology in affordable housing communities. This chapter will examine the social and institutional dimensions of solar integrating programs in the United Kingdom and California that contribute to a broader understanding of how green affordable housing is not only an important decarbonization strategy, but also a huge component of socioeconomic equity as many Western nations restructure all elements of society around an eco-identity.

5.2: The United Kingdom

Residential Energy Context

Similar to Ontario, the United Kingdom is facing the related issues of fossil fuel dependence and greenhouse gas emissions. In the region, 70 percent of domestic, commercial and industrial buildings are heated with natural gas (Bolton and Foxon, 2015, p. 538). The residential sector alone has 18 to 20 million individual gas boilers installed in dwellings (Bolton and Foxon, 2015, p. 538). The dominance of the non-renewable energy source is a result of cheap gas being readily available from the conveniently located North Sea reserves that resulted in the development of a gas distribution network from the 1960's onwards (Bolton and Foxon,

2015, p. 542). However, in 2004 the region became a net energy importer following a steep decline in North Sea-sourced oil and gas after production peaked in 1999 (Office for National Statistics, 2015). In 2013, the region imported 47 percent of its energy, a level that had only previously been reached in 1974 following the 1973 oil embargo (Office for National Statistics, 2015). In addition to being vulnerable to fossil fuel dependence, the UK is scheduled to undergo closures of all coal fired plants by 2025, a feat achieved by Ontario in 2014 (Mason, 2015). Some estimates point to approximately £110 billion in investments in generation, transmission and distribution in order to just maintain current levels of consumption (Foxon and Pearson, 2013, p. 5). The threat of fossil fuel depletion has generated consistent discussion regarding regional energy security and has influenced energy policy to take on an ecologically modern perspective that ideally will smoothly guide a transition to a low-carbon energy system.

Energy policy has also stressed the evolution of energy systems within residential communities as an important component of the low-carbon transition. In 2003 the Parliament of the United Kingdom released the Energy White Paper which promoted "the development of homes and communities that combine energy efficient technologies and renewable energy to radically reduce their demand for energy from the grid" (DTI, 2003, p. 15). One of the four primary goals of the policy was to reduce fuel poverty, an issue that affects 2.34 million households in the region (DECC, 2014a). According to the UK government, a household is considered to be affected by fuel poverty if they spend more than 10 percent of their annual income on fuel costs (DECC, 2015a, p. 10). The rise of wholesale gas prices in 2005 drastically increased household energy bills, which effectively created an affordability crisis that peaked in 2009 with 6 million households being impacted by fuel poverty (Foxon and Pearson, 2013, p. 5; DECC, 2015a). Though this figure has declined since 2010, it remains an issue for millions of families. Fuel poverty adds to the problem of housing affordability which is exasperated by the United Kingdom having the third highest score for housing prices in the European Union and tenant households spending more than 40 percent of their income on rent[12] (Cuellar, 2014; Bachelor, 2015). In order to reprimand the related issues of energy and housing affordability, the UK government introduced a number of institutions and programs that aim to improve the existing housing stock not only through conservation education, but also renewable energy system deployment that eliminates some of the transmission and distribution costs associated with centralized energy production.

[12] In the UK, owner-occupied dwelling have the lowest rate of fuel poverty while rented dwellings have the highest. (DECC, 2015a, p.7).

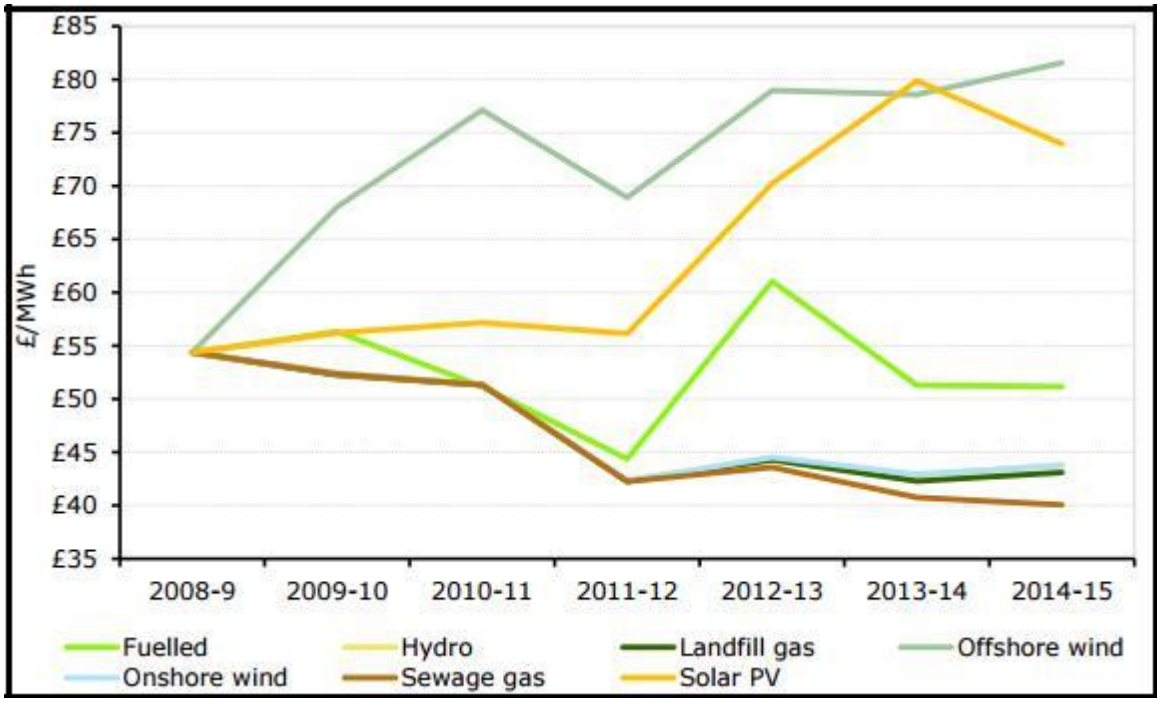
The Renewables Obligation and the FiT Program

The Renewables Obligation (RO) was an initiative that was active prior to the region committing to decarbonization targets set by the European Union and UK Parliament. The initiative was gradually introduced in 2002 and placed an obligation on electricity suppliers to source a growing portion of energy from renewables (Ofgem, 2016a; DECC, 2015b, p. 172). In order to meet the obligations of the program suppliers are required to apply for Renewables Obligation Certificates (ROCs) from the Office of Gas and Electricity Markets (Ofgem) for eligible renewable generating stations (Ofgem, 2016a). If licensed electricity suppliers are unsuccessful in obtaining ROCs, then they are subsequently required to contribute to a buy-out fund for each megawatt of renewable energy they failed to generate[13] (Keirstead, 2007, p. 4130; Ofgem, 2016a). The by-out fund covers all administrative costs and the residual money is distributed back to suppliers in proportion to the amount of renewable energy they produce (Ofgem, 2016b). The program was designed as the main government-run financial mechanism that provided incentives for large-scale renewable generation (DECC, 2012a, p. 7). Subsequently, many hopeful micro-generators had a difficult time navigating the administration process of the RO (Keirstead, 2007, p. 4130).

In October of 2008, the Department of Energy and Climate Change (DECC) was set up by Prime Minster Gordon Brown (Foxon and Pearson, 2013, p. 4). The UK Parliament recognized that climate change targets would be difficult to achieve without developing shared discourse between the conflicting departments of business and regulatory reform (Rogers-Hayden, 2011, p. 139). Subsequently, the DECC became responsible for functions previously run by three separate departments: Business, Enterprise and Regulatory Reform, and Environment, Food and Rural Affairs (Foxon and Pearson, 2013, p. 4). The department collaborated on a white paper released in 2009 that articulated its vision of guiding the transitioning of the region to a low carbon economy by 2020 (DECC, 2009, p. 4). Ofgem reviewed the RO in 2009 to bring it into closer compliance with the transitional plans of the white paper by instituting changes to the ROC process (DECC, 2015b, p. 172). The changes replaced the practice of providing a single rate of one ROC per megawatt hour with 'banding' (DECC, 2015b, p. 172). Banding permitted Ofgem to offer different amounts of ROCs depending on what renewable technology was used (DECC, 2012a). The changes resulted in a decline in popularity of the program among large-

[13] Generators can also buy ROCs from suppliers that have already met their renewable obligation. ROC can be purchased for less than the mandatory buyout price per megawatt hour. As of April 1st, 2016, the buyout price per megawatt hour is £44.77 which is equal to around $80 CAD (DECC, 2016).

scale onshore wind generators, however, there was a subsequent increase in popularity among micro generators since residentially-friendly renewables such as solar had higher banding levels as figure 5.0 illustrates (Finney et al., 2012, p. 293; DECC 2012b).

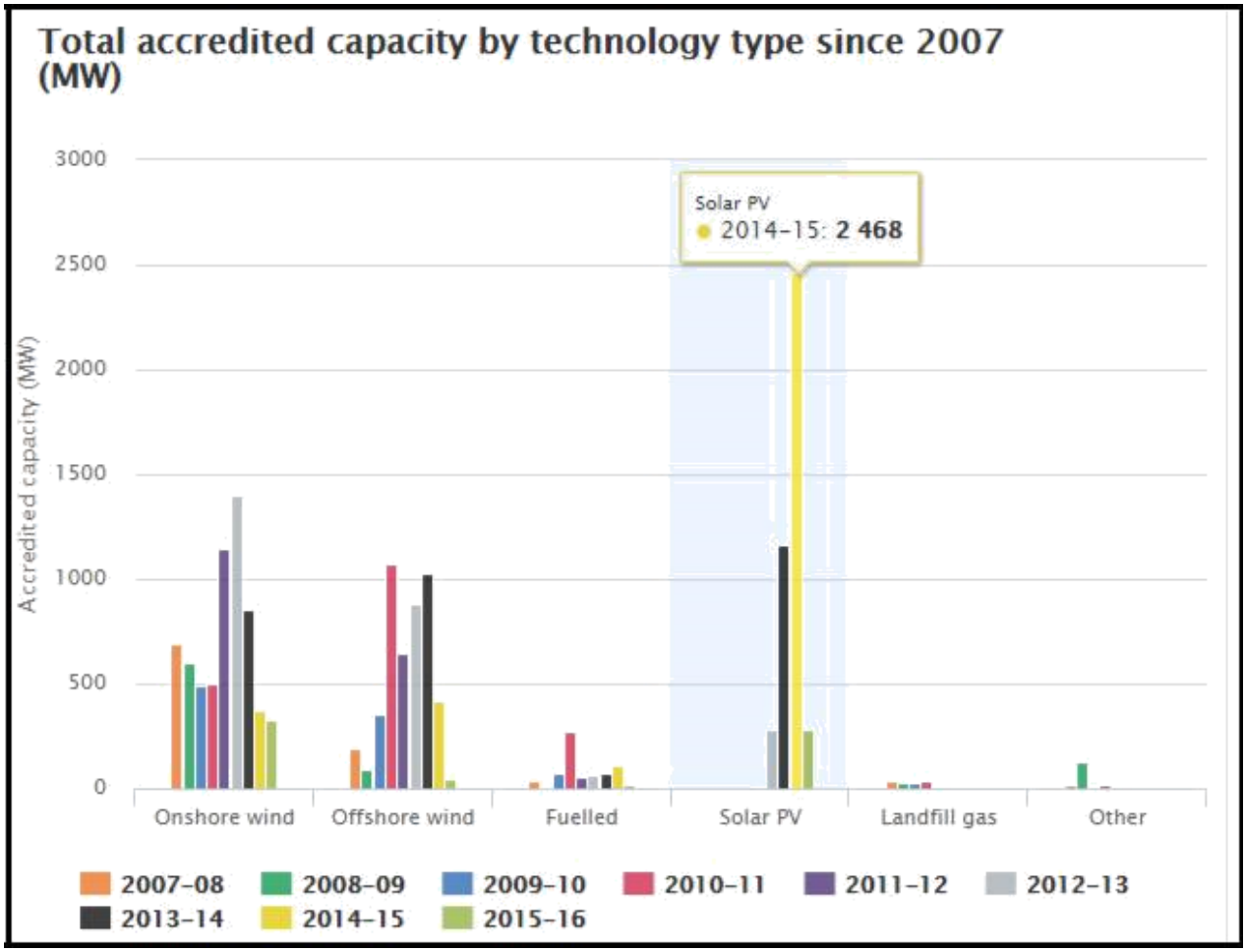


Source: Ofgem, 2016c

Figure 5.0 – The graph above shows the amount of support in £ per MWh for various eligible Renewable Obligation technologies from 2008 to 2015. Following a review of the program in 2009 all technologies were assigned different banding rates. In particular, solar peaked from 2013-2014 but declined from 2014-2015 due to a drop in banding rates related to the general decline in cost of PV technology.

The RO program's 2015 annual report states that since inception the program has resulted in the procurement of 55.7 TWh of renewable energy, representing 18.6 percent of the UK's total electricity supply (Ofgem, 2016d, p. 6). Solar photovoltaics represent 73 percent of capacity procured under the RO program from 2014 to 2015 and 3.8 percent of total capacity procured since 2007 as figure 5.1 shows (Ofgem, 2016c).

The report went on to explain the continued subtle move away from large-scale generation with the closure of the program for solar photovoltaics projects that were 5 MW or greater in size as of April 1st 2015 (DECC, 2015b, p. 172; Ofgem, 2016d, p. 6). The program also closed to small scale solar and onshore wind on April 1st of 2016 (Ofgem, 2016d, p. 50). The Renewables Obligation program remains open until March of 2017 at which point the UK government expects the region's feed-in-tariff program to replace it as the central support mechanism for renewable generation (DECC, 2012c, p. 22).



Source: Ofgem, 2016c

Figure 5.1 – The above graph summarizes the amount of capacity procured under the Renewable Obligation program from 2007 to 2016. Solar photovoltaics were particularly popular from 2014-2015 despite the reduction in banding rates shown in figure 5.0.

The United Kingdom established a feed-in-tariff (FiT) program in April of 2010 that had the goal of incentivizing the deployment of systems smaller than 5 MW for households and organizations that had not engaged with the Renewables Obligation scheme (Finney, 2012, p. 294). Similar to the Ontario FiT program, owners of structures that installed small-scale solar photovoltaics were compensated for the energy generated and exported back to the grid. However, the program differs from Ontario's in that licensed energy suppliers in the UK are required to administrate the program and pay tariffs to generators instead of an entity of the UK government (Ofgem, 2016e). In some instances, suppliers have to make two tariff payments to system owners; one for generation of energy and another for exporting renewable electricity to the grid (Ofgem, 2016e). All licensed electricity suppliers with more than 250,000 customers are

required to participate in the FiT scheme (Ofgem, 2016e). There are two ways that a system can be financed. The first requires the household to pay for all upfront investment costs of a system which allows them to receive the full value of FiT income while also saving on electricity bills (Saunders et al., 2012, p. 80). In some instance, housing associations or social housing landlords take out a loan for the cost of materials and installation and use the FiT tariffs to pay off the loan charges (Saunders et al., 2012, p. 80). In such a scenario the association or landlord makes the equivalent of 472 Canadian dollars per year for every 2 kW of capacity installed (Saunders et al., 2012, p. 80). Once the system is paid off the annual income from the system can be reinvested in the community, contributing to the eradication of fuel poverty among those with the lowest incomes.

Though the upfront payment scheme allows for full retention of FiT income, it is not accessible to individual low-income households that live in private market housing that seek to participate in decarbonization practices. Subsequently the PAYGen scheme is offered to remedy issues of cash-flow access experienced by low-income communities. A third party company unaffiliated with the licensed electricity providers will install a photovoltaic system or any other renewable energy system free of charge. The household receives the energy bill savings that come with at-site solar generation, and the third party company receives the generation and export tariffs over the lifetime of the system (20-25 year for solar photovoltaics) as payment (Saunders et al., 2012, p. 80). Under the PAYGen scheme, a household saves the equivalent of 180 to 220 Canadian dollars that is a notable boost to total income for simply deciding to engage directly with renewable energy technology (DWP, 2010).

Within the first two years of the FiT program the number of PV installations rose drastically, which triggered the initiation of a comprehensive review from 2011-2012 led by acting Energy Secretary Chris Huhne (DECC, 2015b, p. 173; Smith et al., 2014, p. 125). The review resulted in the enactment of a cost control mechanism that reduced tariffs every 3 months in order to compensate for the steady decline of the costs associated with solar photovoltaics (DECC, 2015b, p. 173). Figure 5.2 shows historical, present and future FiT rates for solar photovoltaic systems ranging in size from 4 kW to 1 MW.

FiT Year	Generation Tariff Rate (pence* per kilowatt hour)	Export Tariff Rate
2010-2011	35.07 - 49.43	3.48
2011-2012	9.69 - 49.43	3.48
2012-2013	7.50 - 22.86	4.91
2013-2014	7.23 - 16.30	4.91
2014-2015	6.46 - 14.79	4.91
2015-2016	3.08 - 13.55	4.91
2016-2017	0.74 - 7.68	4.91
2017-2018	0.41 - 7.61	4.91
2018-2019	0.15 - 7.55	4.91

*10 pence is equivalent to 18 to 20 Canadian cents. Source: Ofgem, 2016

Figure 5.2 – The table summarizes FiT rates from 2010 to 2019. Rates differ depending on the size of the solar photovoltaic system and if the system is stand alone. A significant decrease in generation tariff occurred in 2011 due to the popularity of the program and a decline of the cost of solar in the UK and the European Union.

Moreover, the review also spawned the creation of a multi-installation tariff. The tariff is given to generators who own more than twenty-five PV installations located on different sites (DECC, 2012d). Many social landlords with multiple properties fall into this category of tariffs which subsequently reduces the amount of tariffs they receive by 20 percent for every property procured through the program after the twenty-fifth site (DECC, 2012d). The impacts of the reduction were felt by the social housing sector that not only lost long-term revenue, but also the eco-economic benefits of projects that were abandoned when the reduced tariff was announced (Clark and Hay, 2012). Thus, the reduction is an example of an economically-guided decision that is counter to the broader eco-modern goal of engaging populations that have previously been excluded from renewable generation and decarbonization program.

Additionally, the Electricity Market Reform (EMR) introduced formally by the 2013 Energy Act projects the launch of a Contracts for Difference (CfD) FiT program that will replace the Renewables Obligation when it is phased out in 2017 (Ofgem, 2016f). A Contract for Difference is a formal agreement between a renewable energy generator and the Low Carbon Contracts Company (LCCC) that mandates the generator be paid the difference between the strike price and the reference price (DECC, 2015c). The strike price is the cost of investing in a low carbon technology and the reference price is the average market price for electricity in the region (DECC, 2015 EMR CfD). The benefits of CfD are that it removes the volatility of

wholesale prices from the renewable energy generation equation (DECC, 2015c), and protects consumers engaging with renewable technologies from electricity price spikes. This scheme will likely attract social housing providers that previously have been hesitant to engage with renewables for fear of drastic tariff drops as was the case in the past. Overall, the Renewables Obligation and FiT programs represent an important origin point for the pairing of housing and solar energy systems and their continued redevelopment ensures that domestic renewable energy is an important part of decarbonization and affordability goals.

The Renewable Heat Premium Payment Scheme and the Renewable Heat Initiative

The Renewable Heat Premium Payment Scheme (RHPP) and the Domestic Renewable Heat Initiative (RHI) are two related programs that also facilitated the integration of solar technology with affordable housing in the UK. Launched in August of 2011 by the DECC, the RHPP had the goal of accelerating the deployment of renewable heating technologies in the UK's social housing sector (DECC, 2012e). Eligible providers would bid for a one-time grant that could be claimed after they installed a renewable heating project that sourced its energy from biomass, air, the sun or ground source heat (DECC, 2012e; Ofgem, 2016g). The Energy Savings Trust administered grants to successful applicants during the three phases of the program that spanned from August of 2011 to March of 2014.

During the first phase, 37 social landlords were granted the equivalent of 6.9 million Canadian dollars which allowed them to install just under 1000 renewable heating systems for lower-income households (DECC, 2012e). By the third phase of the program funding for social housing-sited projects tripled to the equivalent of 18.2 million Canadian dollars (DECC, 2012f), illustrating the undeniable popularity and success of the program among those that served to benefit from it the most. The DECC interviewed tenants throughout each phase of the program and the majority had a positive reaction to the upgrades and became engaged with learning about the performance of the systems (DECC, 2012e). Similarly, social landlords were more than willing to participate in the RHPP scheme because it allowed them to offer tenants a solution to fuel poverty while also lowering maintenance costs (DECC, 2015d p. 7). The DECC's RHPP summary report revealed that the two main motivating factors for participation were reducing dependence on fossil fuels and cost savings (DECC, 2015d, p. 9), a fact that revealed how decisions at residential scale are increasingly guided by eco-economic rationale. However, some smaller social landlords highlighted barriers to participation, such as a lack of tenant engagement throughout the process and a lack of clarity of information about renewable technology and their suppliers (DECC, 2015d, p. 7). The DECC acknowledged that social housing

represented a significant share of the sites of RHPP-funded projects, and sees value in remedying barriers by developing a more effective administrative process that has an educational component. The summary report highlighted that community groups should be recruited to play a support role in the process of tenant engagement and educate participating communities about the renewable technology and its resultant benefits (DECC, 2015d, p. 11).

The RHPP was eventually closed in March of 2014 and replaced by the Domestic Renewable Heat Initiative in April[14]. Similar to the RHPP, the RHI promotes household to switch from fossil fuel to renewable-sourced heating systems (DECC, 2015b, p. 173). The DECC administers the program to eligible homeowners, private landlords and social landlords on or off the grid who wanted to install renewable technologies such as solar hot water heaters on domestic structures (UK Parliament, 2016). Participants receive RHI payments for seven years that vary depending on the type of system and the amount of energy produced (DECC, 2013, p. 13). For example a mid-floor flat with a solar thermal heater would receive approximately 600 Canadian dollars a year if they are paid the 2016 rate of 19.74 pence per kilowatt hour guaranteed by the RHI[15]. Since the program's inception over 16,000 renewable heating systems have been installed, 23 percent of which are solar hot water heaters (Wilson, 2015). In terms of eligible group participation, private and social properties owned by landlords account for 8.9 percent of all RHI-funded projects (Wilson, 2015) showing a potential regression in engagement of low-income households. Unfortunately, the DECC has not yet released a summary report highlighting the opinions of participants in a way that replicates the RHPP 2015 report, so it is unclear exactly why social and private landlords have backed away from renewable heating despite yearly increases in tariffs. It is likely that low fossil fuel prices in 2015 and 2016 have contributed to this drop-off in interest (Elliot, 2015) and consequently have slowed down the decarbonization transition. However, a potential future price spike in fossil fuels could influence a resurgence of popularity of domestically-focused affordable renewable heating programs in the UK.

[14] The RHI program is split into 2 streams: non-domestic and domestic. The non-domestic RHI was launched in 2011. This chapter exclusively talks about the domestic stream.

[15] These rates were calculated using the DECC's Renewable Heat Initiative Calculator. The interface prompts users to input where they live and in what type of housing in order to generate an estimate of annual savings achieved if they were to deploying renewable energy technologies. The calculator is available at https://renewable-heat-calculator.service.gov.uk/Default.aspx

The Urban Community Energy Fund

Outside of DECC and Ofgem administered programs, several non-profits and charities have funds set up that help low-income households with energy bills and retrofits; the Centre for Sustainable Energy (CSE) is one such charity. CSE is a national charity that has been active since 1979 with a mission to empower people to change the way they think about energy (CSE, 2016). The charity currently has 60 separately-funded projects that help communities "meet real needs for both environmentally sound and affordable energy services" (CSE, 2016). In November 2014 the DECC gave the CSE the responsibility to administer the Urban Community Energy Fund (UCEF) in partnership with another community energy charity, Pure Leapfrog (CSE, 2014). The £10 million fund provides community groups[16] in England the opportunity to apply for grants or loans that provide financial support through the development phase of energy projects (DECC, 2014b). Eligible technologies included wind turbines, hydro power, solar PV, solar thermal, biomass and anaerobic digestion and project can range in size from 0.5 to 3 gigawatts (DECC, 2014b, p. 4). The maximum funding for a grant is £20,000 while loans have a ceiling of £130,000 (CSE, 2014). The program only requires the repayment of loans and a 45 percent premium[17] if the community is successful in completing a project and makes a profit from it (DECC, 2014b, p. 4). The premium helps cover the costs of loans that are never repaid due to unsuccessful projects and also allows the program to continue to offer support to new communities (DECC, 2014b).

The UCEF website shows a map of the location of 30 successful applications in England, including 5 groups in London (CSE, 2016). One of these 5 projects is run by South East London Community Energy (SELCE), a group awarded a grant to assist with the cost of a feasibility study and public consultation (CSE, 2016). SELCE aims to help reduce fuel poverty in London among Greenwich and Lewisham residents who also share the vision of contributing to the UK's transition to a low carbon society (SELCE, 2016). The group was successful in raising £250,000 in investment from the surrounding community in 2015 that financed the installation of solar PV on four schools (SELCE, 2016). The system prevents over 94 tonnes of CO_2 emissions from being released each year, saves the school £358,000 in electricity costs over 20 years and will produce £90,000 of surplus clean energy that is available to locals who participate in the community share offer by contributing a minimum of £250 to initial

[16] In order to be eligible a group must be located in an urban area recognized by the Office of National Statistics (DECC, 2014b).

[17] The 45 percent premium is not the same as interest since it does not accumulate over time. For example, if a group borrows £100,000 they would have to repay £145,000 regardless of how long the loan lasts (CSE, 2014).

investment costs that subsequently is repaid with four percent interest (SELCE, 2016). Overall, the UCEF initiative is a great example of a flexible program that places a majority of control and responsibility for affordable decarbonization in the hands of locals seeking to improve quality of life and the communal relationship with the environment.

Stagnation of Decarbonization Progress in the UK

The UCEF was established during the middle of a larger scheme known as the Green Deal. Launched, in 2013 alongside the Energy Company Obligation[18] (ECO), the Green Deal (GD) sought to create an energy efficiency market that did not require ongoing public support and reduced barriers to uptake of domestic energy retrofits (Gillich et al., 2016, p. 3). The general GD provided loans to owners of domestic buildings seeking to increase energy efficiency with updated insulation (Daikin, 2012, p. 4). Though it was not an enforced regulation of the program, the ideal situation was for loan repayment to be less than monthly savings in energy costs. Participants could also pair savings from the FiT program and the Green Deal that led to thousands of pounds being saved over the lifetime of a renewable energy system (DECC, 2013, p. 17). Additional sub-programs such as GD Cashback, the Home Improvement Fund and the GD Communities scheme were eventually added in order to increase program flexibility (Gillich et al., 2016, p. 3).

Though the GD was marketed as the "biggest home improvement program since the Second World War" (Vaughan, 2015), participation in the scheme was relatively low with just over 15,000 loans issued two years into the program (DECC, 2015e, p. 17). Furthermore, several academic reports were released criticizing the Green Deal for neglecting to address barriers to uptake besides upfront costs and placing too much attention on 'low priority' energy issues (Eyre et al., 2013; Rosenow and Eyre, 2013). On July 23, 2015 the DECC halted funding to the Green Deal Finance Company and cited low uptake as the reason for closing the program (Gillich et al., 2016, p. 3). No successor program is scheduled to be launched in place of the Green Deal so homeowners no longer have the extra source of support for energy efficiency retrofits. However, the Energy Company Obligation remains active and continues to service lower income households with poor energy efficiency.

[18] The Energy Company Obligation is a ratepayer-funded scheme also introduced in January of 2013 that required energy supplier's to deliver domestic energy efficiency measures to low-income consumers in particular. The program explicitly states a goal of targeting hard-to-treat properties in order to reduce the percentage of UK households with insufficiently insulated housing. The Green Deal and ECO are separate programs but a GD assessment is a perquisite for accessing ECO funding (DECC, 2012)

The end of the Green Deal was one of several changes made by the Conservative government elected in 2015 that stagnated the pace of progress toward emission reduction goals. The Conservatives also ended all subsidies for onshore wind, stunted fiT small-scale solar subsides by 87 percent and axed future plans for new built zero-carbon homes (Vaughan, 2015; Carrington, 2015). The provided rationale behind the slashing of support for renewable energy was that subsidies were rising too fast, particularly for solar, which conservative ministers believed was costing energy consumers too much; the Conservative government later admitted that the reduction in small-scale solar subsidies will only save energy consumers 50 pence a year (Macalister, 2015). All of these changes were made the same year that wind, solar and bioenergy surpassed coal and became responsible for generating 25 percent of electricity in the UK (Carrington, 2015). Rather than continuing the trend of increased clean energy, the Conservative government has opted to turn back to fossil fuel with a £20 million fund for oil and gas seismic surveys on the UK Continental Shelf (DECC, 2016). Numerous renewable energy advocates have spoken out about the damage the cuts will cause to the renewable energy industry and decarbonization progress including former chairman of Shell, Lord Oxburgh. The ex-chairman highlighted that in order for the North Sea oil industry to gain traction, consistent aid from the UK government was integral, therefore the same long-term government support is necessary for the clean energy industry to establish itself as a stable and thriving sector (Macalister, 2015). Despite widespread opposite to their decisions, the Conservative government remains steadfast on draining funds from clean energy initiatives and pumping them into the environmentally-damaging and economically volatile fossil fuel industry. Only time will tell if this decision is beneficial or damaging to the wellbeing of the region.

Benefits of Policies and Programs

Despite the 2015 political shift, the UK has gained a number of benefits from the existence of domestic energy efficiency retrofit programs. One obvious benefit of these programs is the increased deployment of sustainable energy. With solar photovoltaic generation accounting for 4.1 TWh and solar thermal producing 52 kites of renewable heat, sun-powered technologies continue to dominate growth in the clean energy sector from year to year due to the ease of integration with existing structures (DECC, 2015b, p. 1-11). In particular, the FiT program has resulted in the deployment of 2,540,110 kW of domestic and 54,966 kW of community renewable energy capacity, representing 57 and 1.2 percent of the programs total installed capacity (Ofgem, 2016h). Solar photovoltaics are the dominant technology for both domestic and community projects with over 361,000 separate projects that on average are 4kW

in size currently receiving FiT tariffs (Ofgem, 2016h). Projects installed in 2014 alone saved 2 million tonnes of CO_2 from being produced (Ofgem, 2015).

Moreover, at least 5,000 community groups have commenced or completed a renewable energy project, many of which received Renewables Obligation, UCEF or ECO funding (DECC, 2014c, p. 16). Prior to subsidy cuts, the DECC hypothesized that community energy generation schemes such as solar panel installations on social housing could supply enough electricity for one million homes by 2020 (DECC, 2014d). The potential to achieve such a milestone still exists, but the UK Government must support energy efficiency initiatives in a variety of communities so that they are not just present on owner-occupied dwellings with households capable of financing upfront costs. In fact, a study on the impacts of small scale renewable energy on fuel poverty in the UK revealed that renewable installations on low income households are more likely to be completed when they are facilitated by third party local energy organizations, since these groups remove the risks associated with energy projects by coordinating funding and negotiating the best deals possible from material and labour suppliers (Saunders, 2012, p.9). Also, encouraging community-led renewable energy projects saves participants money, which in turn can be fed back into the community through local purchases (DECC, 2014c, p. 47). The increased economic investment in the local community contributes to another benefit which is the development of communal pride. Participants in a community energy scheme rally around the idea of being a part of projects that brings positive attention to areas that otherwise may often be regarded as run-down. This sense of pride is driven by and reinforces an eco-identity that influences households engaging with renewable energy to put additional thought into how else they can improve their solar-powered community to ensure the feeling is a lifelong sentiment. Ultimately, replicating the cost savings, engagement and communal pride within various neighbourhoods will continue to contribute to traditionalizing decarbonization pathways in the United Kingdom that are accessible and affordable to a diversity of households.

5.3: California

Residential Energy Context

Though on the opposite side of the Continent, the state of California shares a number of North-American socioeconomic experiences with Ontario that have resulted in parallels between the two regions. The most obvious of these parallels is that both are their nation's most populous regions, placing greater responsibility on the shoulders of service providers within their borders. Home to 13 percent of the US population, California consumes more energy than its four

neighbouring states combined and has one of the largest electricity use profiles in the United States (Izadian et al., 2013, p.23; Langlois-Bertrand et al., 2012, p. 11). Just years prior to Ontario taking the same action, California deregulated wholesale electricity and began operating a spot market in 1998 (Reis and White, 2003, p. 1). Between 1999 and 2000 wholesale electricity market prices increased by 500 percent, causing the state two largest utilities - Pacific Gas & Electric and Southern California Edison - to pay more for wholesale power than what they were able to resell it for (Joskow, 2001, p. 365). The spike in price was caused by a number of factors, including rising natural gas prices, a drought in the Northwest that impacted hydroelectric imports and companies, such as Enron, that took advantage of congestion relief payments and transmission charges built into the newly restructured energy system (Weare, 2003; Joskow, 2001, p. 377). Unable to keep up with the costs, both utilities stopped paying their debts to energy companies who in turn stopped selling power to them, leading to the California energy crisis (Reis and White, 2003, p. 1). As a result, several state-ordered rolling blackouts occurred during the first half of 2001, the largest one impacting 1.5 million customers for two days in March (PBS, 2001).

Though a retail price cap regulation insulated residential consumers from the economic costs of energy, the state is still afflicted by an unaffordable housing system. California has some of the nation's highest housing costs with median home prices 2.5 times the national level and low-to-moderate tenant households using on average 35 percent of their income to pay rent (Kroll and Singa, 2008, p. 28). The issue has continued to worsen with 90 percent of all low-income households (those earning less than $35,000), and 53 percent of middle income households spending 30 percent or more of their total income on housing (Christopher, 2016). Recognizing the havoc that natural gas dependence among other factors had caused it, the state began establishing new energy regulations and programs under the Million Solar Roofs Initiative that would further reduce energy costs, several of which made a point of emphasizing a relationship between solar energy technology and low-to-moderate income housing.

The Renewables Portfolio Standard and the California Solar Initiative

Initially established in 2002, the Renewables Portfolio Standard (RPS) Program was expanded in 2011 to required energy service providers in the state to increase renewable energy resources to 33 percent of total procurement by 2020[19] (Centre for Sustainable Energy, 2015, p. 5). The program is a very ambitious environmental undertaking and a declaration to the rest of

[19] The RPS has intermittent goals of 20 percent by the end of 2013 and 25 percent by the end of 2016

the country that California is committed to transforming its previously weak, import-dependent energy system into a flexible heterogeneous one that equally values the environmental and economic benefits of energy generation sources. In order to establish a self-sustaining solar industry that contributes to this transformation, the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) established a $3.3 billion USD 'Million Solar Roofs' fund in 2007 (Bichkoff et al., 2015, p. 7). Over ten years the fund aims to install 3000 megawatts of new solar (Bichkoff et al., 2015p. 8) The California Solar Initiative (CSI) is a sub-program authorized by Governor Schwarzenegger in 2006 and administrated by the CPUC with a $2.167 billion USD budget that funds the installation of 1,940 megawatts of new solar capacity (CPUC, 2014, p. 7). The CSI only provides funding in the form of cash rebates or tariffs for the installation of solar energy systems on existing buildings (Langlois-Betrand, 2012, p. 18). It should be noted that the program is separate from the RPS, however the initiative's ultimate goal of creating a solar-industry free from ratepayer subsidies by 2017 will ideally make achievement of the 2020 RPS target easier. The CSI is made up of five sub-programs:

- The General Market Program
- The Single-Family Affordable Solar Homes (SASH) Program
- The Multifamily Affordable Solar Housing (MASH) Program
- The CSI Thermal Program
- The Research Development and Demonstration Program (RD&D)

The next section will look at the SASH, MASH and thermal programs since they specifically shine a light on solar integration practices that target low-to-moderate income housing.

The SASH and MASH and CSI Solar Thermal Programs

Ten percent of the CSI budget is designated for use by low-income affordable housing communities as the initiative has an explicit goal of enabling those with the least means to become solar adopters (CPUC, 2014, p. 5). Two sub-programs of the CSI split the $216 million USD set aside for these communities; the first was the Single-family Affordable Solar Homes (SASH) program. The SASH program had an initial budget of $108 million USD and was administrated by the non-profit renewable service provider GRID Alternatives (Navigant Consulting, 2011a, p. 9). The program sought to reduce energy bills for low-income households, decreasing the overall cost of solar ownership and ultimately "provide energy solutions that are environmentally and economically sustainable" (Navigant Consulting, 2015a, p. 2). In May of

2009, GRID Alternatives began accepting applications from low-income Californians living in single-family housing for SASH 1.0 (Bichkoff et al., P. 30). Households were eligible to apply for full subsidization of a 1 to 1.2 kW system if they owned their home and the total household income is 50 percent of the average median income (AMI) or lower (U.S. Department of Energy, 2016). Those making more than 50 but less than 80 percent of the AMI are eligible for partial subsidization for a system sized to make the home a net zero dwelling (U.S. Department of Energy, 2016; Navigant Consulting, 2011a). When they apply for SASH program incentives, applicants are also required to apply to an additional energy efficiency initiative called the LIEE program[20] that helps participants update energy efficiency measures before the solar system is installed (CPUC, 2014 p. 192). The provided subsidies for households making more than 50 percent of the AMI varied depending on the applicant household's income and eligibility for the California Alternative Rate for Energy (CARE) program which subsidizes the cost of gas bills (Bichkoff et al., 2015, p. 32; U.S. Department of Energy, 2016). GRID Alternatives also provides green job training opportunities, and actively engages with the communities of participants to increase awareness and knowledge about the environmental and economic benefits of solar energy (Bichkoff et al., 2015 p. 31).

The second program that received $108 million USD of dedicated funds for low-income communities is the Multifamily Affordable Solar Housing (MASH) program also launched in 2009. The program provides financial incentives for retrofits of multi-unit affordable housing and has three program administrators: Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and the Centre for Sustainable Energy (CSE) (Navigant Consulting, 2011b, p. 1). Similar to the SASH program, the MASH program strives to decrease electricity costs, increase solar adoption in the affordable housing sector and increase awareness about the benefits of solar in low-income communities (Bichkoff et al., 2015, p. 34). The program originally provided two different tracks of incentives to successful applicants, however, in 2011 one track was eliminated due to a stronger demand for the other (CPUC, 2015, p. 5). The remaining incentive is composed of two categories: 1A and 1B. 1A incentives are given to building owners who have installed solar PV systems that offset common area load[21], while 1B incentives are given to

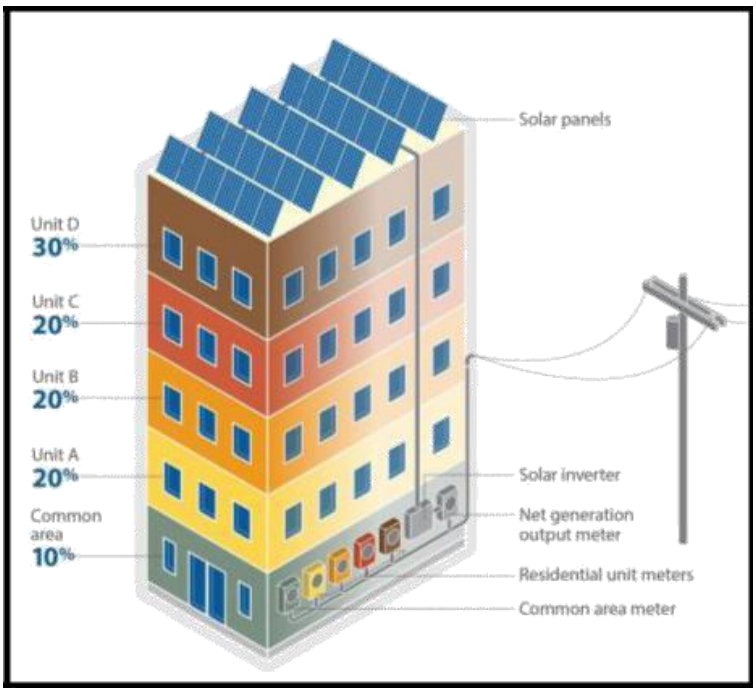
[20] The Low-Income Energy Efficiency (LIEE) Program has been run by the CPUC since the 1980's. The program has a goal of reducing the number of low-income households burdened by energy costs and establishing energy efficiency as the states most important energy resource. The LIEE program requires utilities to connect with community-based organizations and provide low-income Californians with energy education programs, energy efficient appliances and weatherization services at no charge. (CPUC, 2014).

[21] Common area load includes all energy used to power hallways, security lighting, parking lots and recreational centers in multi-unit residential buildings

tenants for systems that offset individual unit electrical load (CPUC, 2014, p. 5; CPUC, 2015). In some instances, one property can receive both 1A and 1B incentives for a project that offsets common area and tenant load (CPUC, 2014, p. 63). The 2015 California Solar Initiative Annual Report provided an example of such a scenario:

> If a 100 kW solar installation offsets both common area and tenant load, and 60 percent of the electricity output of the system is dedicated to common area load and 40 percent of the electricity output is dedicated to tenant load, the Applicant will receive Track 1A incentives for 60 kW and Track 1B incentives for 40 kW.
>
> (Bichkoff et al., 2015)

For a system to receive both these incentives it would need to be integrated with virtual net metering (VNM). Virtual net metering measures the electrical usage for each unit that belongs to a single low-income housing enterprise and compares it to the electricity generate by the system in kilowatts per hour when it is fed into the grid (CPUC, 2015, p. 7). As Figure 5.3 shows, each unit is allocated a share of the renewable energy based on the size of their unit and electricity load which in turn is used to calculate the level of incentives they receive from the MASH program (CPUC, 2015, p. 7). In California, virtual net metering was first adopted as a pilot program for MASH program participants, and in 2011 the CPUC made the tariff available to all multi-tenant properties, thereby making solar increasingly accessible to rental complexes, cooperatives and condominiums in the state (Bichkoff et al., 2015 p. 39). The MASH program also offers a third-party financing model in the form of power purchase agreements (PPAs). Each PPA provider finances all costs associated with installing, operating and maintaining the system, and sells the power produced to the customer on a per kWh basis for an agreed upon period (McCutchan et al., 2011, p. i).



Source: CSE, 2015a

Figure 5.3 – The diagram illustrates the process of virtual net metering in multifamily housing. The energy used by each residential unit is monitored in order to virtually allocate energy produced by the solar PV system to each household on their energy bill.

When the SASH 1.0 and MASH 1.0 program funding neared exhaustion, the California legislature passed AB-217 in 2013 which established an additional $108 million in funding to be split between both initiatives (Bichkoff et al., 2015 p. 31). In 2015, both programs began their second phase, each with $54 million USD in new funds and a combined capacity target of 50 megawatts of solar PV (Navigant Consulting, 2015a, p. xi). Since SASH 2.0 received less funding than the first phase, the CPUC authorized GRID Alternatives to use a third-party ownership model to assist in financing the installation of projects at no additional cost to low-income participants (Bichkoff et al., 2015, p. 32). Also, under SASH 2.0, subsidies no longer vary depending on a household's income as they are set at $3.00 USD per watt for all participating households making more than 50 but less than 80 percent of California's average median income (Bichkoff et al., 2015, p. 31). Since program inception in 2009, 5,186 SASH-funded projects have been installed across California and over 100 are scheduled to be interconnected (GRID Alternatives, 2016 p. 3). Moreover, as of June 2015, 349 projects totalling 23 megawatts have been completed with the help of MASH program funds and an additional 40 are in progress (Bichkoff et al., 2015 p. 10).

Another initiative that grants low-income households access to cost-saving solar technologies is the CSI Thermal program. Established in January of 2010, the CSI Thermal

program offers incentives to businesses and households that install solar water heating (SWH) technologies to displace natural gas use (Bichkoff et al., 2015, p. 38). The $250 million USD program has the goal of promoting the installation of 200,000 SWH systems by the end of 2017 as a method of reducing California's natural gas dependence (Bichkoff et al., 2015, p. 38). Three of the four program administrators[22] are Independent Operating Utilities (IOUs) that receive a percentage of incentive funding proportionate to the amount of customers they service. In March of 2012 the CSI Thermal low-income program was launched and received ten percent of the initial program funds to be used exclusively to promote the installation of SWH systems on single and multifamily low-income housing (Bichkoff et al., 2015, p. 41). In order to be eligible for the general program incentives, participants must already have a SWH system installed by certified contractors (Bichkoff et al., 2015, p. 41). Moreover, low-income participants must meet the same requirements of the general program as well as living in a home that is financed with low-income housing tax credits or a residential complex where at least 20 percent of the units are sold or rented to lower income households (Bichkoff et al., 2015, p. 42).

All incentives are paid based on the expected amount of displaced natural-gas generated energy in the first year and incentive levels decline as the CSI Thermal program meets certain total installation benchmarks (CPUC, 2016b). Participating low-income single-family and multifamily projects receive incentives 200 and 150 percent higher than the general program incentives but do have upper limit caps as the program progresses and rates decline (Bichkoff et al., 2015, p. 43). In terms of participation, the program has approved over 2,500 applications and administered $33.7 million USD in incentives since it began in 2010 (Bichkoff et al., 2015, p. 45). Overall, each of the three discussed CSI sub-programs have been designed to maximize the use of funds sourced from ratepayers, while also providing acceptable incentives that encourage continued solar adoption within low-to-moderate income communities.

The New Solar Housing Program

Outside of incentives aiding the retrofit process of existing housing, the state of California also offers a program that encourages developers to integrate solar photovoltaics into their new residential projects. The New Solar Housing Program (NSHP) is an initiative separate from the CSI established in 2007 that seeks to install 360 megawatts of new solar PV in ten years and simultaneously create a self-sustaining residential solar market in California (CESA,

[22] The program administrators for the CSI Thermal program are Pacific Gas and Electric (PG&E), SoCalGas, San Diego Gas & Electric (SDG&E) and Centre for Sustainable Energy (CSE). SoCalGas received 51 percent of program funds allocated for incentives. (Bichkoff et al., 2015).

2015 p. 1; Langlois-Betrand et al., 2012, p. 18). The NSHP provides funding for four types of projects: subdivisions, custom homes, affordable housing and common areas for multifamily housing (CESA, 2015, p. 11). All project incentives are taken directly from the California Energy Commission's Renewable Resource Trust Fund (CEC, 2015 p. 3).

NSHP rebates are issued once the solar energy system is operational and vary not only based on project type, but also depending on if the property is or is not owned by a tax-exempt entity (CEC, 2015, p. 2; CESA, 2015, p. 3). Full subsidization for the cost of systems is not provided, however affordable housing projects receive rebates for 75 percent of the total system costs, while all other projects receive a 50 percent rebate (CEC, 2015, p. 31). New residential housing and building owners can finance the purchase and installation of the solar PV system out of pocket, through a lease arrangement, or using third-party agreements that are the same as those used to complete SASH and MASH program installations (CESA, 2015, p. 16). As the NSHP program comes closer to achieving its megawatt goal, incentive levels will gradually decline. As of March 2015, the NSHP has offered rebates for over 14,000 solar PV systems totalling 45 megawatts and 19,000 additional homes with a solar capacity of over 55 megawatts are under construction (CESA, 2015, p. 2). Though owners of new production homes have received a majority of the issued rebates, the average amount they are given is only twenty percent of the average rebate provided to affordable housing participants (CESA, 2015, p. 13). The enhanced funding given to low-income Californians is an example of how the state acknowledges that issues of equity can and should be partially remedied with ecologically modern policy and programs that increasingly will shape the development of urban areas.

The GTSR and ECR Programs

The state of California recognized that certain households could not benefit from the CSI and New Solar Housing incentive programs due to the inability of the structure they live in to support a renewable energy system. To reprimand this gap in access, the state established two solar share programs: the Green Tariff Shared Renewables (GTSR) program and the Enhanced Community Renewables (ECR) program. Both programs were the result of action taken by Pacific Gas & Electric and San Diego Gas & Electric to create a statewide voluntary solar access program in 2012 (CSE, 2015, p. 10). Applications submitted by both utilities to create the program were consolidated in July of 2013, and in October Senate Bill 43 was passed establishing the GTSR and ECR programs (Sen. Bill 43, 2013). Senate Bill 43 places a cap on renewable energy project sources for both the GTSR and ECR program at 600 megawatts. The bill goes on to state that 100 MW of shared solar capacity must be located within communities identified by the California Environmental Protection Agency (EPA) as the most

disadvantaged[23] in order to allow these communities the environmental benefits of renewable systems and the green jobs they create (Sen. Bill 43, 2013; CSE, 2015, p. 13). Additionally the bill reserves 100 MW for residential customer participation (Sen. Bill 43, 2013).

The GTSR program allows Californian's living in structures unsuitable for on-site renewable systems to apply for a green rate offered by their utility which enables them to have 50 to 100 percent of their electrical load sourced from off-site renewable electrical generation facilities (CSE 2015, p. 7). Furthermore, upon being granted a green rate from their utilities, customers lock in their energy costs for a year, insulating them from energy price spikes (CSE, 2015). The green rate is made possible by a separate agreement between the utilities and solar developers that requires the former to pay the latter for a particular project's energy output.

The ECR program differs from the GTSR in that customers establish an agreement with a solar developer of their choice that enables them to buy the rights to a specific portion of a solar project's output and receive payment for the energy produced per month or year by it (CSE, 2015, p. 7). A customer's respective utility has a separate agreement with the solar developer that enables them to receive the selected arrays output and credit the customer's bill with the energy produced from the portion of the array they purchased for however long a period the customer-developer agreement specifies. Though both programs were established in 2013, they were not approved by the CPUC until February of 2015 (CSE, 2015, p. 11). As of June 2016 the CPUC website states that both programs are still in their implementation phases. Despite this, the GTSR and ECR are innovative yet simple programs that will grant more households access to the environmental and economic benefits of off-site solar energy generation.

Benefits of Policies and Programs

Similar to the UK, California has gained a number of benefits[24] as a result of policies and programs that aim to increase solar deployment in low-to-moderate income communities. As of June 8th 2016, the California Solar Initiative has provided funding for the installation of just over 4,100 megawatts of solar projects[25], a figure that surpasses the initial 1,940 megawatt goal of the program (State of California, 2016). Furthermore, in 2014 two-thirds of on-site solar

[23] SB 43 mandates that 100 MW of the GTSR shared solar capacity must be located within the top 20 percent of areas identified as being disproportionately affect by environmental pollution, environmental degradation or socioeconomic vulnerability (CSE, 2015a)

[24] Navigant consulting developed a list of non-energy benefits that was used in their evaluation of CSI's SASH and MASH programs. The entire list can be found in Appendix

[25] Solar projects procured with CSI funding account for approximately 31 percent of the state total installed solar capacity (State of California 2016; SEIA, 2016).

projects did not receive funding from any CSI sub-programs and most were installed in residential communities (Bichkoff et al., 2015 p. 26). The willingness of Californian's to engage with solar technology when funds for the program setup specifically for that purpose were temporarily exhausted, is a good sign that the state will eventually achieve its goal of creating a self-sustaining industry that is accessible to both the residential and commercial sectors. Relatedly, the surge of solar deployment driven by CSI, NSHP, GTSR and ECR programs has had a positive impact on the costs per watt for solar generated energy. According to CEC and CPUC, the price of solar energy across all sectors has dropped 43 percent from $10.56 per watt in 2007 to $4.57 per watt in 2015 (State of California, 2016). A GTM research report partially attributes the drastic drop in the price of solar in California to the strong level of residential uptake in the state (Roselund, 2016). The report goes on to predict that the continued integration of solar will push the technology to reach grid parity in 22 states by 2020 (Roselund, 2016). Since grid parity is the ultimate end goal for solar integration on a global scale and the reality of achieving it does partially depend on steady residential uptake, it becomes paramount for other regions like Ontario to take lessons from California's successes.

In particular, the Single-family Affordable Solar Homes and Multi-family Solar Housing programs have contributed greatly to California's solar-driven environmental, economic and social successes. As figure 5.4 shows between 2011 and 2013, the SASH and MASH programs reduced GHG emissions by 10, 922 tons and 27, 452 tons respectively (Navigant Consulting, 2015a).

Program	**Year**	**GHG Reduction (tons CO_2)**
SASH	2011	618
	2012	3,663
	2013	6,641
MASH	2011	2,857
	2012	10,261
	2013	14,334
TOTAL		38,374

Source: (Navigant Consulting 2015a)

Figure 5.4– The above table summarizes total GHG emission savings resulting from the deployment of solar photovoltaics systems entirely or partially funded by the SASH and MASH programs.

The reduction of GHG emissions is closely linked to a decline in peak demand that was estimated by Navigant Consulting to have dropped by 13,859 kilowatts in 2013 as a result of the

installed capacity of both CSI affordable housing-specific programs (Navigant Consulting, 2015a, p. xiv). In terms of monetary savings, SASH participants on average saved $876 USD annually between 2011 and 2013; for the same time period, the average savings for a tenant with virtual net metering participating in the MASH program was $484 USD a year (Navigant Consulting, 2015a, p. 65). 71 percent of SASH program participants have an income less than $40,000 a year (Navigant Consulting, 2015b, p. 37). As is the case in the United Kingdom, the savings resulting from solar integration with affordable housing provide greater financial stability to low-to-moderate income households. Additionally, one interviewed building owner highlighted that along with saving households money, the MASH program also safeguards tenants from rent increases initiated by price spikes in the energy market (Navigant Consulting, 2015b, p. xxii).

Moreover, as administrator of the SASH program, GRID Alternatives regularly facilitates outreach between initial adopters of the SASH program and residents in their community to increase participation (GRID Alternatives, 2016, p. 9). The trust-based marketing strategy is necessary in low-income communities that can sometimes be skeptical of government programs that seem too good to be true. GRID Alternatives also requires each sub-contracted installation to have at least one paid trainee - typically from the surrounding community - on-site, learning from the licensed professionals (GRID Alternatives, 2016, p. 4). This requirement has resulted in the growth of skilled labour sourced from low-income communities, which subsequently contributes to the upward socioeconomic mobility of low-income households by making them employable in California's lucrative solar market sector (GRID Alternatives, 2016, p. 4).

As the part of the evaluation phase, a survey conducted by Navigant Consulting was issued to SASH and MASH program participants. When asked what the top benefit of the initiative were, over 60 percent selected 'reduced utility bills' or 'environmental benefits' as their top choice (Navigant Consulting, 2015a, p. xiii). Additionally, 65 percent of participants responding to the survey noted that they had adopted new energy efficiency behaviours as a result of having a residential solar energy system; half of MASH respondents made similar energy efficiency behavioural changes (Navigant Consulting, 2011b, p. 4; Navigant Consulting, 2015b, p. xix). Urban energy researcher James Keirstead notes that on-site generation projects often illicit this change in energy consumer behaviour since the process of procuring a renewable energy system influences them to be more cognizant of the impacts of their energy use, thereby inspiring demand management (2007, p.4129). Furthermore, 86 percent of

surveyed tenant MASH program participants stated that if they were to move to another building, they would encourage their new property manager to participate in the initiative (Navigant Consulting, 2015b, p. xxii). This detail about the majority of participants endorsing solar integration in any housing they live in illustrates the ultimate benefit of any domestic solar integration initiative: influencing low-income households to recognize and educate others about the environmental, economic and social benefits that stem from the integration of solar energy with affordable housing.

CHAPTER 6: Increasing the Potential for Solar-Equipped Green Affordable Housing in Toronto

6.1: Introduction

The examination of domestic solar integration programs in two socio-political contexts similar to Ontario's offer a number of lessons to be put to use in the province's capital city. Since adopting its Climate Change Action Plan in 2007, the City of Toronto has continuously sought to green facilities it owns and operates. In total, the action plan set aside $42 million dollars for energy retrofits and renewable energy projects located on City facilities (Climate Change Action Plan, 2007). However, discussion of domestic energy efficiency was absent from the plan with the exception of a brief mention about the creation of a framework for the Towerwise initiative which focused on renewing high-rise residential buildings. More recently, the City has made an effort to link households to energy efficiency services with initiatives such as the Home Energy Loan Program (HELP) which began in 2014. The recent municipal engagement with residential energy efficiency is a necessary next step that must be taken in order to successfully achieve carbon emission reduction targets outlined in the 2007 Action Plan[26].

Similar to other urban centers, Toronto is home to a large portion of low and moderate income individuals and families that like everyone else desire access to tools and services that make living in the city healthy and affordable. Therefore, it is incredibly important that Toronto enhances the energy efficiency of rental housing in both its public and private forms since the result is significant to both decarbonization and socioeconomic equity goals. With a median income of $14,930, low-income Torontonians cannot afford the average private market 1-bedroom rental unit at $1,110 a month, illustrating the necessity of not only lowering the operational costs of private market dwellings but more importantly increasing the amount of habitable social housing units (RentSeeker Inc., 2016; Mangione, 2015). Over the long-run, improving energy efficiency in existing social housing complexes will save funds that can be used to develop additional social housing by providers such as the Toronto Community Housing Corporation (TCHC). In order to become "the most sustainable city in North America" (City of Toronto, 2016), Toronto will have to offer those with the lowest incomes access to energy efficient materials and technologies that go hand in hand with creating a regional eco-identity.

[26] The City of Toronto aims to reduce greenhouse gas emissions from 1990 levels by 30 percent by 2020 and 80 percent by 2050.

Residential properties operated by TCHC - the largest housing provider in the city - are ideal places to cultivate a regional eco-identity that is not exclusive.

Created by the City of Toronto on January 1st, 2002, TCHC has a mandate to provide safe and affordable quality housing for low and moderate income households (TCHC, 2016). The Corporation maintains 2,100 buildings for 110,000 residents, 75 percent of which make less than $20,000 a year (TCHC, 2014). The majority of buildings are over 50 years old and collectively require upwards of $2.6 billion in repairs (TCHC, 2014, p. 12). The Toronto Community Housing 2014 Annual report revealed that one-third of the necessary funds had been secured, but federal and provincial contributions for the remaining two-thirds is needed. The most frequent repair requests are for plumbing, door and electrical issues, which have major impacts on the quality of life experienced by residents (TCHC, 2014, p. 19).

The rent for TCHC tenants includes utilities and is capped at a certain rate, however the utility rates that TCHC pays have no corresponding cap (TCHC, 2009, p. 3). Provincial legislation mandates that social housing providers cannot share higher costs for energy with tenants (Côté, 2013, p. 6). Consequently, as utility rates have risen in tandem with the age of the buildings, Toronto Community Housing has had to allocate a larger portion of their budget to energy consumed by residents (TCHC, 2009, p. 3; Canadian Centre for Economic Analysis, 2015, p. 55). In addition to the monetary costs of aged and inefficient TCHC residences, many of the older apartment towers constructed in the mid- to late 20th century are some of the largest contributors to residential greenhouse gas emissions[27] (Stewart and Thorne, 2009). One solution to the related issues of increased residential energy costs and high residential GHG emissions acknowledged by Toronto Community Housing in a 2009 report is the integration of solar energy with existing buildings (TCHC, 2009, p. 4). This chapter will examine past and present energy efficiency programs in Toronto that endorse the use of solar energy technology and subsequently analyze what lessons they can take from similar programs in the United Kingdom and California.

[27] Compared to a single detached house, apartment towers constructed between 1945 and 1984 require 25 percent more energy per square meter for operation. (Canadian Centre for Economic Analysis, 2015).

6.2: Past and Present Energy Efficiency and Domestic Solar Integration Programs in Toronto

The Social Housing Renovation and Retrofit Program and the Building Energy Retrofit Program

The Social Housing Renovation and Retrofit Program (SHRRP) was a capital grant program initiated in 2009 that required $704 million to be spent on rehabilitating certain social housing complexes in Ontario by 2011 (Government of Ontario, 2009, p. 2). Funds for the program originated from the federal and provincial governments who both contributed $352 million (Tsenkova, 2013, p. 36). Each of the provinces 47 municipal service managers received funding relative to the number of social housing units within their service area; in total the City of Toronto received $259 million (Tsenkova, 2013, p. 41). Service managers allocated funds to cooperatives and housing providers who utilized it to complete capital repairs that improved the energy efficiency of social housing units in the city (Tsenkova, 2013, p. 37). In particular, Toronto Community Housing used a portion of the $150 million it received to carry out an initiative called the Building Energy Retrofit Program (BERP) (Tsenkova, 2013, p. 41; City of Toronto, 2012, p. 2). Beginning on August 7th, 2009, the BERP was run by TCHC in partnership with the energy services company Ameresco (TCHC, 2009). The program facilitated energy efficiency upgrades such as fluorescent lighting in common areas and units, replacement of hot water boilers, roof waterproofing, HVAC upgrades, window refurbishments, building envelope repairs and the installation of energy-saving automation systems (TCHC, 2009; Gee and Chiappetta, 2012, p. 5). Additionally the program provided energy education, retrofit training and mentorship opportunities for tenants of Toronto Community Housing that gave them employable skills (TCHC, 2009).

Ameresco was responsible for administrating the BERP in 20 TCHC communities with social housing units in low, mid or high-rise structures (City of Toronto, 2012, p. 2). By the end of 2012, $40 million originating from the SHRRP fund was used by the Building Energy Retrofit Program to upgrade 6,158 units and simultaneously create 400 direct jobs (City of Toronto, 2012, p. 2). A 2012 City of Toronto staff report hypothesized that the BERP upgrades to Toronto Community Housing properties will annually save $1 million as a result of improved efficiency from the implemented measures and reduced overall consumption as a result of tenants being educated about the impacts of their energy use (City of Toronto, 2012, p. 2). Overall, the SHRRP funds contributed to the renovation of over 58,000 social housing units in Toronto (Tsenkova, 2013, p. 38).

The Renewable Energy Initiative

Another program that provided funding for energy retrofits in Toronto was the Renewable Energy Initiative (REI). The REI was launched in 2010 and jointly funded by the federal and provincial governments. The program delivered one-time funding to housing providers installing renewable energy technologies that heat, cool or generate electricity for social housing complexes[28] (Tsenkova, 2013, p. 38). Since Toronto has a large portion of the province's social housing, the city received $30,672,243 of REI funds (City of Toronto, 2010, p. 2). Toronto Community Housing received nearly 70 percent of REI funds allocated to the city that went toward the development of 59 renewable energy projects; the other 40 percent of funding was used by other non-profit and cooperative housing providers for the development of 33 projects (Tsenkova, 2013, p. 40). Figure 6.1 illustrates one of two notable SolarWall© projects completed on TCHC buildings in Moss Park on Shuter Street.

(Source: Conserval Engineering, Inc.)

Figure 6.1 - Pictured is a SolarWall© located at 272 Shuter Street in Toronto's Moss Park neighbourhood. The system provides solar heated air to residents of the building which reduces the uses of natural gas.

[28] The REI program supported investment in rooftop solar photovoltaics systems, solar water heating, solar air heating, geothermal and mid-sized wind technologies (City of Toronto, 2010).

A SolarWall© is a metal wall overlaid with perforated solar collectors 6 to 12 inches from its surface in order to create an air cavity that is heated by the collectors and releases the warm air into the buildings through the HVAC system (Tsenkova, 2013, p. 49). This particular solar energy system reduces the demand placed on conventional heating systems often sourced from natural gas, by generating warm air from the sun and recovering heat from suites through the ventilation system. The systems in Moss Park have reduced energy consumption costs by $15,000 a year and offset over 85 tonnes of CO_2 emissions annually since they became operational in 2012 (Tsenkova, 2013, p. 49). Overall, the Renewable Energy Initiative had positive energy efficiency impacts for 10,997 separate units in the City of Toronto (Tsenkova, 2013, p. 41) illustrating the potential for success if more programs promoting green affordable housing are created and sustained with funding.

Towerwise

In December of 2014 TCHC and Toronto Atmospheric Fund (TAF) signed an agreement to complete energy retrofits for over 1,200 units in seven Toronto Community Housing buildings (Leach, 2015). Known as the Towerwise retrofit project, the ongoing initiative has $4.2 million in funding sourced from loans, grants and utility incentives. The finances of the project are organized through an Energy Savings Performance Agreement that requires TAF to provide all funding for the upgrades upfront and share the utility costs savings with Toronto Community Housing over 10 years (Leach, 2015). The first phase of the initiative required energy-use data to be gathered in order to determine what retrofit designs will improve air quality, provide temperature control and conserve water and energy in seven TCHC buildings (TCHC, 2016). On average, each building is 45 years old and subsequently requires a number of energy efficiency upgrades to lower operational costs and improve the quality of living for tenants (TCHC, 2015). The Towerwise retrofit project will implement upgrades such as new low-flow bathroom hardware, double-glazed windows and high-efficiency refrigerators and lighting (Leach, 2015). Toronto Community Housing anticipates using the funds from energy cost savings to further support the corporation's 10-year capital repair plan (TCHC, 2015). When TCHC follows through with this action it will serve as an example of the far-reaching positive impacts of funding the development of ecologically modern social housing. An informational video released by the Toronto Atmospheric Fund in June 2016 details that the retrofit process has begun and residents welcome the changes (Toronto Atmospheric Fund, 2016). In addition to improving the efficiency of TCHC buildings, the Towerwise retrofit projects seeks to act as an

example for other municipalities desiring to upgrade the energy efficiency of affordable housing.

The Home Energy Loan Program and the High-rise Retrofit Improvement Support Program

Two additional residential energy efficiency initiatives launched in Toronto in 2014 were the Home Energy Loan Program (HELP) and the High-rise Retrofit Improvement Support (Hi-RIS) Program. Both were pilot programs launched by the City of Toronto in collaboration with Toronto Hydro and Enbridge Gas to fill a gap left by the conclusion of federal energy efficiency programs like SHRRP and the REI (FCM, 2016). The goal of the HELP and Hi-RIS programs is to reduce the amount of emissions in the City originating from existing building stock by offering single-family and multi-unit residential owners access to $20 million in funding for energy efficiency upgrades (Spears, 2014; Hamilton, 2013). Retrofit processes eligible for funding include upgrades to furnaces, water heaters, insulation, windows and drain water heat recovery systems[29] (Spears, 2014). The process begins with interested single and multi-unit homeowners having their homes evaluated by an energy advisor certified by the city who decides whether or not the residential structure can benefit from energy efficiency improvements. The programs use a Local Improvement Charge[30] financing mechanism that mandates all upfront costs to be covered by the City of Toronto and paid back by each participating owner. Participating single-family homeowners have a five to fifteen year payback period while multi-unit building owners are allowed five to twenty (Hamilton, 2013). If approved by the energy advisor, owners become eligible for a loan from the City with a 2.5 or 4.25 percent interest rate depending on the payback period selected (Spears, 2014). Once the upgrades are completed, loan payments are added to the property tax bill of participants so if the property is sold during the payback period, the new owners become responsible to repay the loan to the City of Toronto (City of Toronto, 2016). The HELP and Hi-RIS Program are designed to result in the ideal situation in which annual payments of the loans are less than the cost of the energy and water that the improvements are saving (Hoicka, 2014, p. 595).

[29] The pilot phase of the program did not offer the option of active solar systems for electricity or heat generation however they may become eligible HELP technologies in the future.

[30] A Local Improvement Charge (LIC) is a financing mechanism typically used by municipalities to cover the cost of constructing local infrastructure such as sidewalks or sewer extensions. The municipality pays outright for the upgrades and recoups the costs from special charges put on the property tax bill of households that directly benefit from the investment. Provincial regulatory changes in 2012 expanded LIC use to include energy efficiency upgrades including renewable energy systems to existing housing. The mechanism poses little to no financial risk to the province or the municipalities that implement energy efficient upgrade programs, and overcomes two barriers that often discourage homeowners from green retrofits: upfront access to capital and a realistic way to pay back loans (Persram, 2013).

In early 2016 The Federation of Canadian Municipalities presented the FCM Sustainable Communities Award to the City's Toronto's for both the Home Energy Loan Program and High Rise Retrofit Improvement Support Program (FCM, 2016). FCM recognized the programs since they are the first of their kind in Ontario to use an LIC financing mechanism to support energy and water upgrades to privately-owned residential buildings. The HELP has reduced the energy used by participating households by 25 percent on average. Relatedly, the Hi-RIS program has reduced energy used by participating tenants in buildings by 28 percent (FCM, 2016). In addition to lowering energy bills and improve residential comfort, the revenue-neutral programs have also reduced annual CO_2 emissions by 4,900 tonnes (FCM, 2016), illustrating the economic, social and environmental benefits that can result from simply offering equitable access to financing for residential 'greening'. The pilot program will run until December of 2016 at which point the City of Toronto may decide to offer the program permanently.

6.3: Re-imagining Domestic Solar Integration Programs in Ontario

The analysis of solar integration initiatives in the United Kingdom and California offers a number of lessons for similar programs in Ontario. In this section, the components of programs in the two case studies regions will be applied to the Ontario context and used to re-imagine programs that have ended, are currently ongoing, or are anticipated to be launched in the future.

Ontario's microFiT program has facilitated the development of over 19,000 small scale renewable energy systems generating over 170 MW of predominately solar energy that is fed into the grid (McInroy, 2015). In 2013 the Ministry of Energy, the IESO and industry professionals collaborated on a proposal to reconfigure the microFiT program into a Net Energy Metering (NEM) program by 2018 (Environmental Commissioner of Ontario, 2014, p. 33). Net metering refers to the process of monitoring energy use at the site of consumption by comparing the output of an at-site energy generation system to the electricity consumed by the household (O. Reg 541/05; Environmental Commissioner of Ontario, 2014b, p. 33). Eligible structures with generation facilities can reduce their energy costs by exporting surplus energy to the grid for credit on their energy bills from their utility provider. A 2016 update issued by the Ministry of Energy stated that this reconfiguration will occur and that all applications for the microFiT program will no longer be accepted as of December 31st, 2017 in preparation for the re-launch (Ministry of Energy, 2016). Though the creation of a dedicated net energy metering program is a great way to encourage solar integration and reduced consumption, issues of access to the future

initiative have been highlighted. A report published by the City of Toronto stated that unless they are financially assisted to participate in renewable integration and net metering programs, low income households will be excluded and vulnerable to rising non-renewable energy costs (City of Toronto, 2009, p. 6).

In California the CPUC eliminated the potential for this vulnerability by initially offering NEM as a sub-program of the Multi-Affordable Solar Housing Initiative. The MASH program uses a third-party financing model known as a power purchase agreement (PPA) that requires each PPA provider to finance all upfront and system maintenance costs and subsequently sell the power produced by a rooftop solar system to each unit on a per kWh basis for an agreed upon period (McCutchan et al., 2011, p. i). Since the MASH program targets low-income tenant properties, these communities were able to benefit from net energy metering before it became a state-wide program accessible to people of all socioeconomic backgrounds. In Ontario, microFiT participants typically have higher incomes since these households are able to afford the upfront costs of renewable technologies such as rooftop solar photovoltaics. Thus, in order to enhance access to Ontario's microFiT turned NEM program the Ministry of Energy, IESO and leading renewable energy industry professionals should entertain the thought of establishing a separate MASH-replica program for communities where a portion of residents receive monthly support for energy bills from the Ontario Electricity Support Program. Promoting power purchase agreements that pair residential renewable energy integration with net energy metering for clusters of social, cooperative and private-market rental housing would eliminate the pending issue of these communities being excluded from the province-wide decarbonization solution of net energy meter. Towerwise resembles a PPA in that the Toronto Atmospheric Fund pays for the energy efficiency upgrades and pass on some of the energy savings to Toronto Community Housing. Developing a separate program that like MASH pairs the financing of renewable energy systems with net energy metering equipment would likely be popular in high density regions of Ontario such as Toronto.

Moreover, though the federally and provincial-funded Renewable Energy Initiative was successful in lowering operating costs for social housing providers and tenants, it did not reach as broad an audience as it could have since it only took place over two years. If the federal and provincial government choose to relaunch the program they should take lessons from the California Solar Initiative and open the program for a decade, in order to afford it the same period of maturity and popularity as Ontario's FiT program that has gradually reduced tariffs over the years but maintains a steady rate of participation. Additionally lengthening the active period of REI 2.0 would allow interested housing providers to organize more residential

renewable energy projects and potentially develop economies of scale that give more low-income Ontarians access to clean energy. Toward the end of the ten-year Renewable Energy Initiative 2.0 as funding nears depletion, similar to the extension of the SASH program, third-party participation by utilities such as Enbridge Gas who will be faced with rising Cap and Trade rates should be endorsed by both senior levels of government. In such a scenario a smaller portion of REI 2.0 funds would be presented to cover the costs of the development phase of projects like the UK's Urban Community Energy Fund and the third-party would be responsible for construction and maintenance costs for the life of a system.

Creating third-party Power Purchase Agreements or PAYGen[31] schemes similar to those used in California and the UK between utilities and housing providers will offer the same benefits of cash-flow access for upfront costs and consequent energy cost savings to low-income Ontario communities. The PAYGen scheme used in the UK in particular would be a good fit in Ontario since the general FiT program continues to reduce tariffs, and existing solar developers that have traditionally focused on large scale rural ground mounts and commercial rooftop projects may show interest in tackling large scale residential solar procurement. Additionally, throughout the revamped REI program incentives granted to applicants should vary depending on the average income of residents in an affordable housing building or complex. For example, the first phase of the SASH program only fully subsidized the cost of solar photovoltaics systems installed on homes that had a total household income 50 percent or lower than California's average median income (U.S. Department of Energy, 2016). All households making less than 80 percent but more than 50 percent of the average median income were only eligible for partial subsidization of a system sized to make the home a net zero dwelling (U.S. Department of Energy, 2016; Navigant Consulting, 2011). The differences in incentives based on income affords those with truly the least means the greatest amount of support in their pursuit of lower energy costs, while still offering substantial funding to those that may only be a few paychecks above households who are financially strained.

The province could also adapt aspects of California's New Solar Homes Program (NSHP). Though it has only been implemented as a pilot project, in the future the province may formally mandate that all new residential structures must be built solar-ready. A solar-ready home refers to a dwelling that is initially built to include the necessary piping and equipment

[31] A third party company unaffiliated with the licensed electricity providers will install a photovoltaic system or any other renewable energy system free of charge. The household receives the energy bill savings that come with at-site solar generation, and the third party company receives the generation and export tariffs over the lifetime of the system (20-25 year for solar photovoltaics) as payment (Saunders et al., 2012, p.80).

needed to install a solar energy system (Ontario Green Homes, 2010). When solar-readiness becomes a reality for new residential buildings, cooperative, social and purpose-built rental housing will require a program like the NSHP that provides a variety of types of homes full or partial subsidization for the costs to install the system (CEC, 2015, p. 2). Similar to the re-imagined REI program, residential building owners can finance the initial purchase and installation of the solar PV system using third-party agreements (CESA, 2015, p. 16). Additionally, funding could come from the province's Green Investment Fund (GIF). In April of 2016 the GIF set aside $82 million to be used by social housing providers to complete energy retrofits that contribute to provincial decarbonization targets (Ministry of Municipal Affairs, 2016). The City of Toronto will receive $42.9 million of these funds and allocate them based on a competitive application process (Ministry of Municipal Affairs, 2016). Again like REI 2.0, participants would receive funding based on the average income of residents of a building or complex in order to promote 'just sustainability'.

Additionally, the new streamlined community renewable energy initiative in Ontario could eventually incorporate aspects of the UK's Urban Community Energy Fund (UCEF). Ontario's Energy Partnerships Program (EPP) consolidated four separate community energy programs[32] into one in order to improve the ability of various communities and organization to develop renewable energy projects on or off-site. The window for the new Energy Partnerships Program opened on June 27th, 2016 and provides indigenous communities, cooperatives, municipalities and public sector entities access to funding to develop energy projects (IESO, 2016). Similar to the UCEF program, funds are distributed exclusively for the development phase of community renewable energy projects. In the context of Ontario, the development phase of these projects encompasses a majority of the legal, technical and financial due-diligence and costs that precede the submission of applications to the FiT or Large Renewable Procurement programs. Presently the Energy Partnerships Program will be accessible to groups regardless of their average income. In the future the program could adapt a premium similar the UCEF which requires successfully implemented projects that generate a profit to repay the issued loan with a premium; the premium funds would then be used to expand access of the program to more communities (DECC, 2014, p. 4). It is important to note that the EPP program is a grant program, and participants are not expected to repay the IESO. However, a re-imagined EPP would have both a grant and loan stream, with the latter ideally mandating a

[32] the Energy Partnerships Program (EPP) that consolidates the Community Energy Partnerships Program, the Municipal and Public Sector Energy Partnerships Program, the Aboriginal Renewable Energy Fund, and the Aboriginal Transmission Fund into one (MaRS, 2010; IESO, 2016)

premium for projects that will mainly benefit households classified as anything other than low-to-moderate income. Like the UCEF the premium would only be imposed if the project is successfully executed. All premium funds would be used specifically for renewable energy projects that benefit low-to moderate income Ontarians.

Furthermore, in the future the EPP could also adapt aspects of California's Green Tariff Shared Renewables Program (GTSR) that emphasize the importance of the participation of low-income communities in decarbonization programs. The GTSR is an innovative solar share program that allows Californian's living in structures unsuitable for on-site renewable systems to apply for a green rate offered by their utility which enables them to have 50 to 100 percent of their electrical load sourced from off-site renewable electrical generation facilities (CSE, 2015, p. 7). The program stipulates that 100 MW of the 600 MW cap for the two California solar shares programs[33] must be located in environmentally or socio-economically disadvantages communities in order to provide residents that live there access to the economic, social and environmental benefits of solar energy systems (Sen. Bill 43, 2013; CSE, 2015, p. 13). Since the EPP does not have the ability to mandating a portion of MW for low-to-moderate income communities, instead it could establish that a certain portion of total funding must be used to assist in the development of renewable energy projects in regions of the province with the least means.

Ultimately, active and archived domestic solar integration programs in Ontario should be habitually evaluated and analyzed in order to identify how they can further be innovated to reflect both ecologically-modern ideology and 'just sustainability'. Successfully innovating programs that pairs these two ideologies together would reflect a provincial mindset that green housing and affordable housing are not, and should not be treated as mutually exclusive concepts in the 21st century.

[33] The second California solar Share program is the Enhanced Community Renewables (ECR) program.

6.4: Potential Residential Solar Energy System Locations in Toronto

In addition to re-imagining programs in the province that encourage a relationship between solar energy systems and affordable housing, it is beneficial to think through where potential projects should be located. Toronto Community Housing owns and operates 63 percent of the social housing stock in the most populous city in Ontario (Tsenkova, 2013). If solar energy systems were successfully integrated with a large portion of residential properties owned by the most well-known housing provider in Ontario, it is not far-fetched to imagine that housing providers elsewhere in the province would follow suit.

In order to identify potential locations for residential solar energy systems on Toronto Community Housing-owned buildings, several factors were examined. The first, pictured in Figure 6.2 is the density of TCHC Rent-Geared-to-Income (RGI) units in each Toronto Neighbourhood[34].

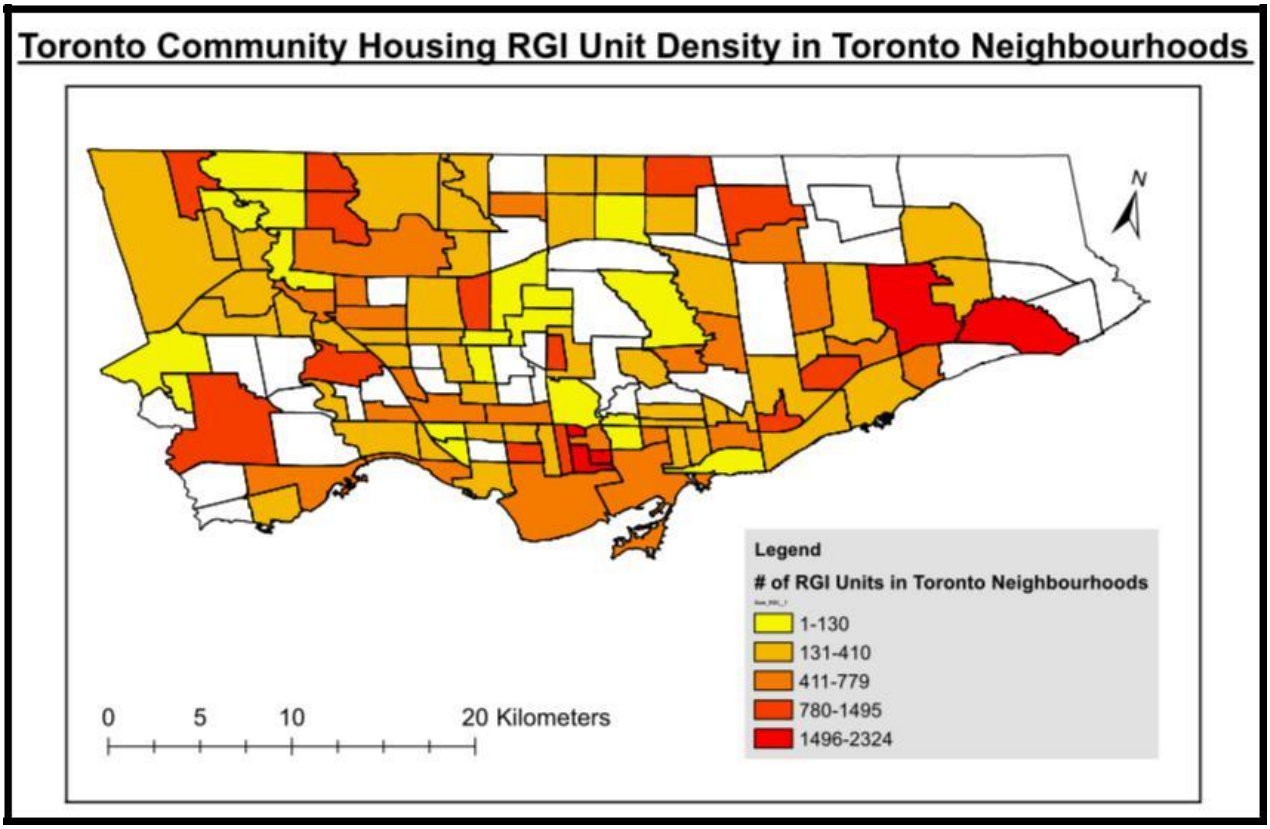


Figure 6.2 - A map of Toronto's 140 neighbourhoods illustrating the density of Toronto Community Housing rent-geared-to-income units in each.

[34] The Data set used to illustrate density only summarizes RGI data for TCHC properties with six or more units in 2013. (TCHC, 2013)

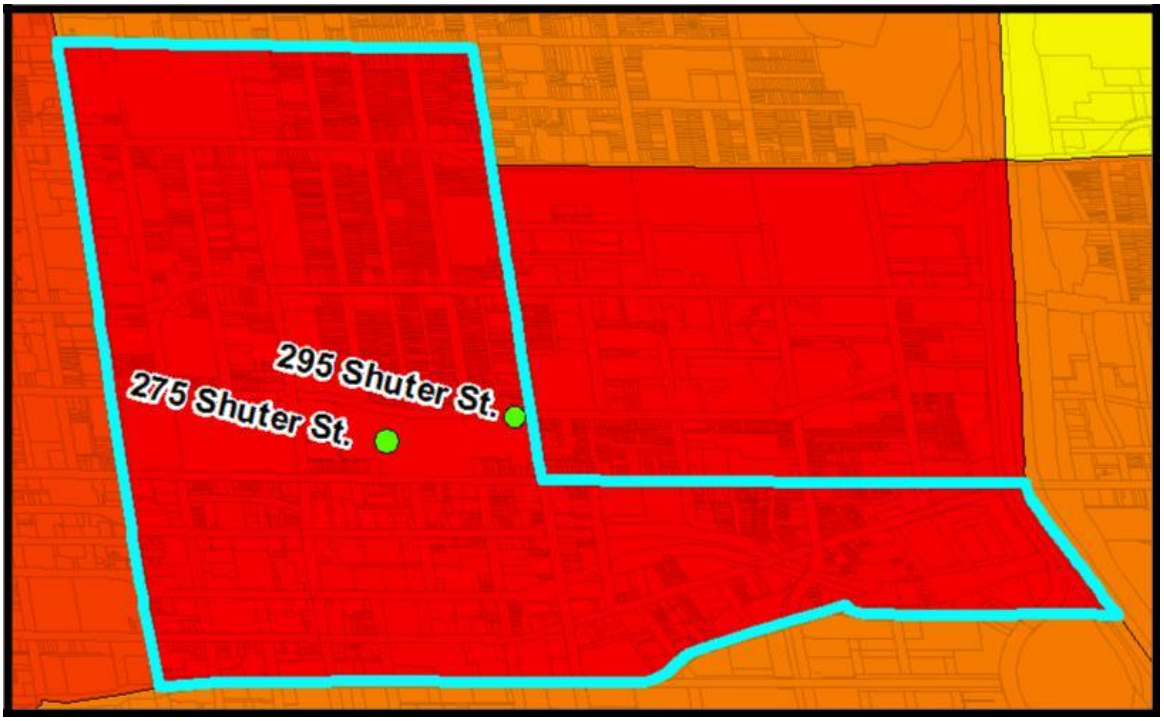


Figure 6.3 – The image outlines the boundaries of Moss Park, the Toronto neighbourhood with the highest density of RGI units in Toronto. Also pictured are the location of two SolarWall© systems on Toronto Community Housing high-rise buildings at 275 and 295 Shuter Street.

Moss Park (outlined in Figure 6.3), has the highest density of RGI units in TCHC properties at 2,324 (TCHC, 2013). The neighbourhood is also home to SolarWall© projects located on 275 and 295 Shuter Street also identified in Figure 6.2. Since the SolarWall© projects were developed with REI funding that had to be spent within a certain time frame, Moss Park was likely selected since the systems would benefit so many TCHC households. Collectively, the two buildings have 600 RGI units combined. Ideally, this should be the mindset for Toronto Community Housing when they develop new residentially integrated solar energy systems in order to offer as many low-income residents the benefits experienced by civilians with similar socioeconomic status in the United Kingdom and California. As such, RGI unit density is one factor that should inform the selection of future solar energy system sites on Toronto Community Housing properties.

A second characteristic examined was the age of Toronto Community Housing properties. The majority of residences with existing RGI units were built in the 1950's and 1960's. In fact, over 100 separate TCHC properties were built in 1962 alone (TCHC, 2016). Existing microFiT solar energy systems on Toronto Community Housing Properties pictured in Figure 6.4 are predominantly located on residences built less than 60 years ago, alluding to the corporation's preference for placing systems on structure of this age. It is safe to assume that TCHC rationalizes a building-age cut-off point for residentially integrated solar projects since

older buildings are more likely to require a number of structural repairs such as plumbing, roof or electrical improvements before they are suitable for on-site renewable energy systems. Furthermore, properties 60 year or older – such as the original 1949 Regent Park complex - are more likely to be entirely redeveloped during the 20 year microFiT contract period.

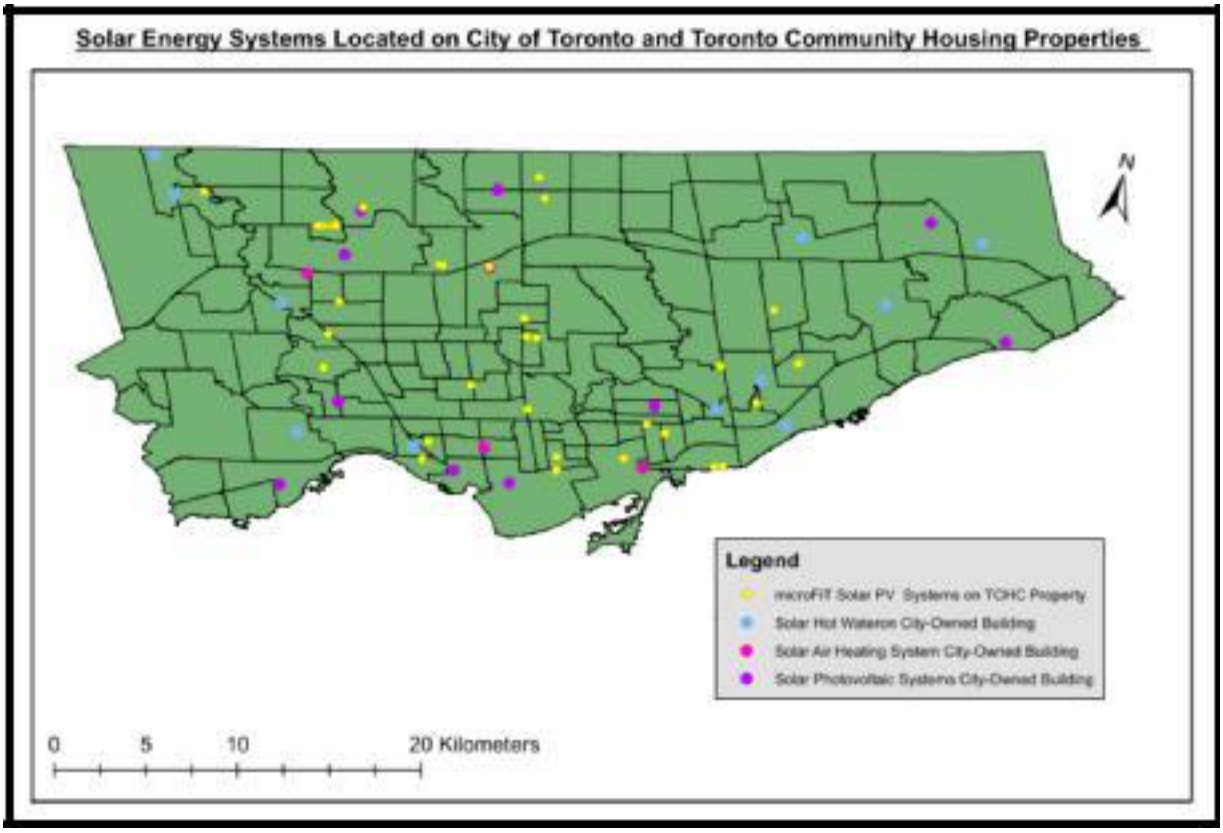


Figure 6.4 – The pictured map highlights the location of existing solar energy systems on TCHC and City of Toronto-owned buildings. The marked Toronto Community housing microFiT systems range in size from 1 to 140 kW AC and were connected to the grid between June of 2010 and September of 2014.

Combining the requirements of high RGI unit density[35] and buildings no older than 60 years, produces the twelve Toronto neighbourhoods shown in Figure 6.5. With total RGI densities ranging from 445 to 1,803 these neighbourhoods are home to a sizeable portion of Toronto Community Housing residents in high-rises, townhouse multiplexes and mid-rise apartments all built in the second half of the 20th century.

[35] For the purpose of this cartographic analysis, a neighbourhoods was considered to have high RGI unit density if it had more than 410 units in its borders.

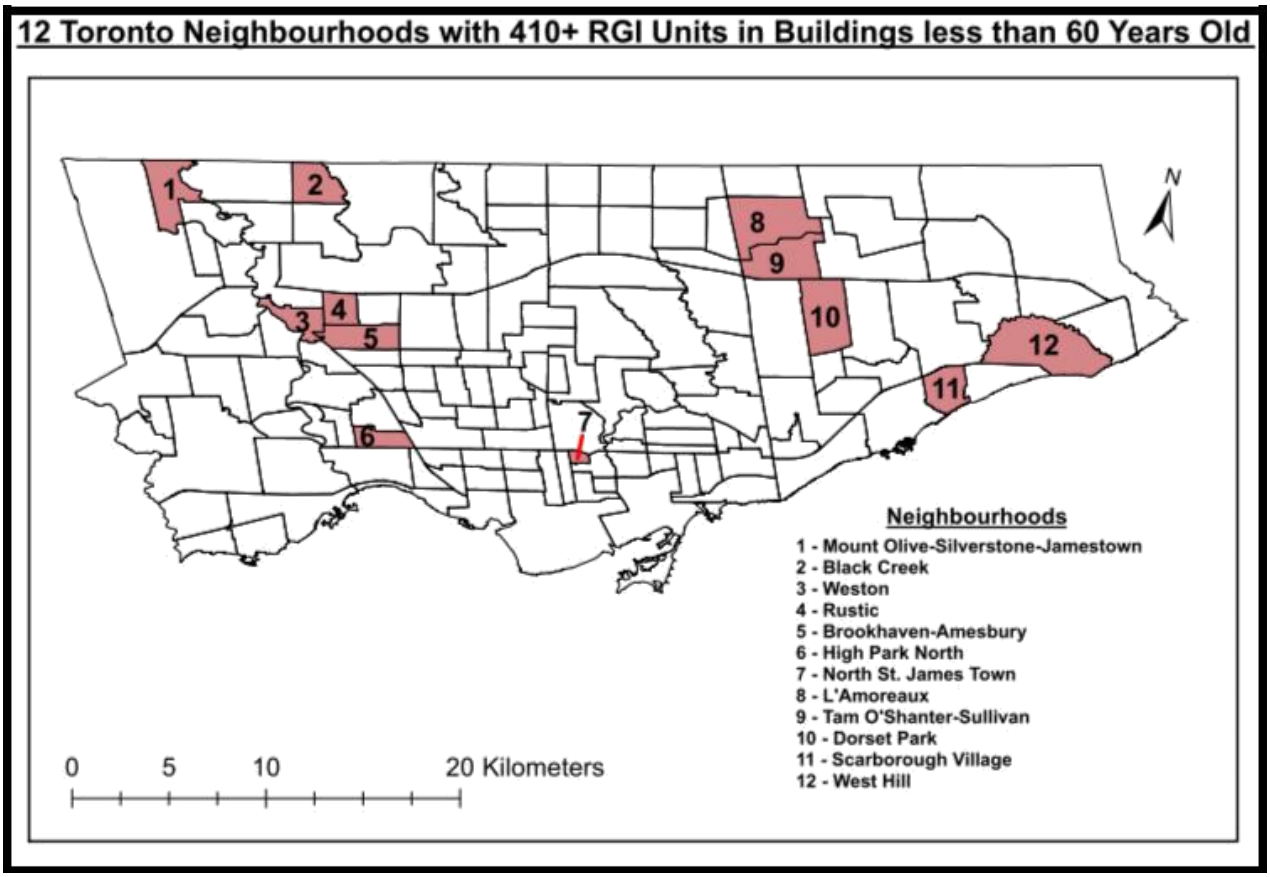


Figure 6.5 – In red are the twelve Toronto neighbourhoods with more than 410 RGI units in buildings built less than 60 years ago.

In order to narrow in further on ideal locations for residential solar energy systems, twelve neighbourhoods that adhered to the density and age criteria were cross referenced with the City of Toronto's Neighbourhood Improvement Areas in order to determine which regions suffers from the highest levels of housing unaffordability. Figure 6.6 identifies the location of the 31 Neighbourhood Improvement Areas (NIAs) established by the City of Toronto in 2014.

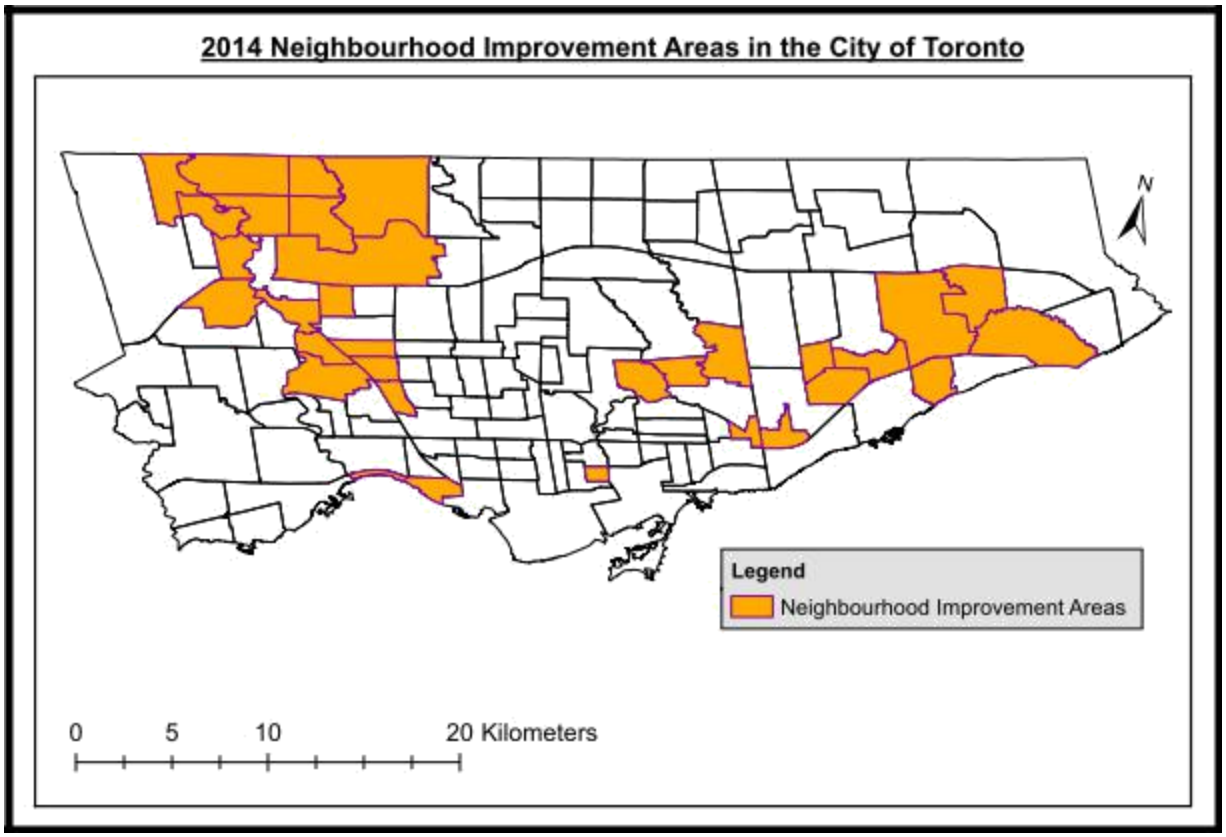


Figure 6.6 – The map highlights in orange the 31 Neighbourhood Improvement Areas identified by the City of Toronto in 2014.

As part of the 'Toronto Strong Neighbourhoods Strategy 2020', the city analyzed all 140 neighbourhoods and those that failed to meet the Neighbourhood Equity score were classified as NIAs (City of Toronto, 2016). The measure scores each neighbourhood out of 100 points; the lower the score, the higher the level of inequalities present in the neighbourhood (Ontario Energy Board, 2015). The scores for each neighbourhood varied depending on the presence, absence and intensity of fifteen indicators that examined residents' economic opportunities, social development, participation in decision-making, quality of physical surroundings and health (City of Toronto, 2014 March). Neighbourhoods with scores lower than the equity benchmark (42.89) were identified as needing immediate action and subsequently designated NIAs. Six of the twelve neighbourhoods (pictured in Figure 6.7) previously identified in figure 6.5 were recognized by the City of Toronto as Neighbourhood Improvement Areas in 2014.

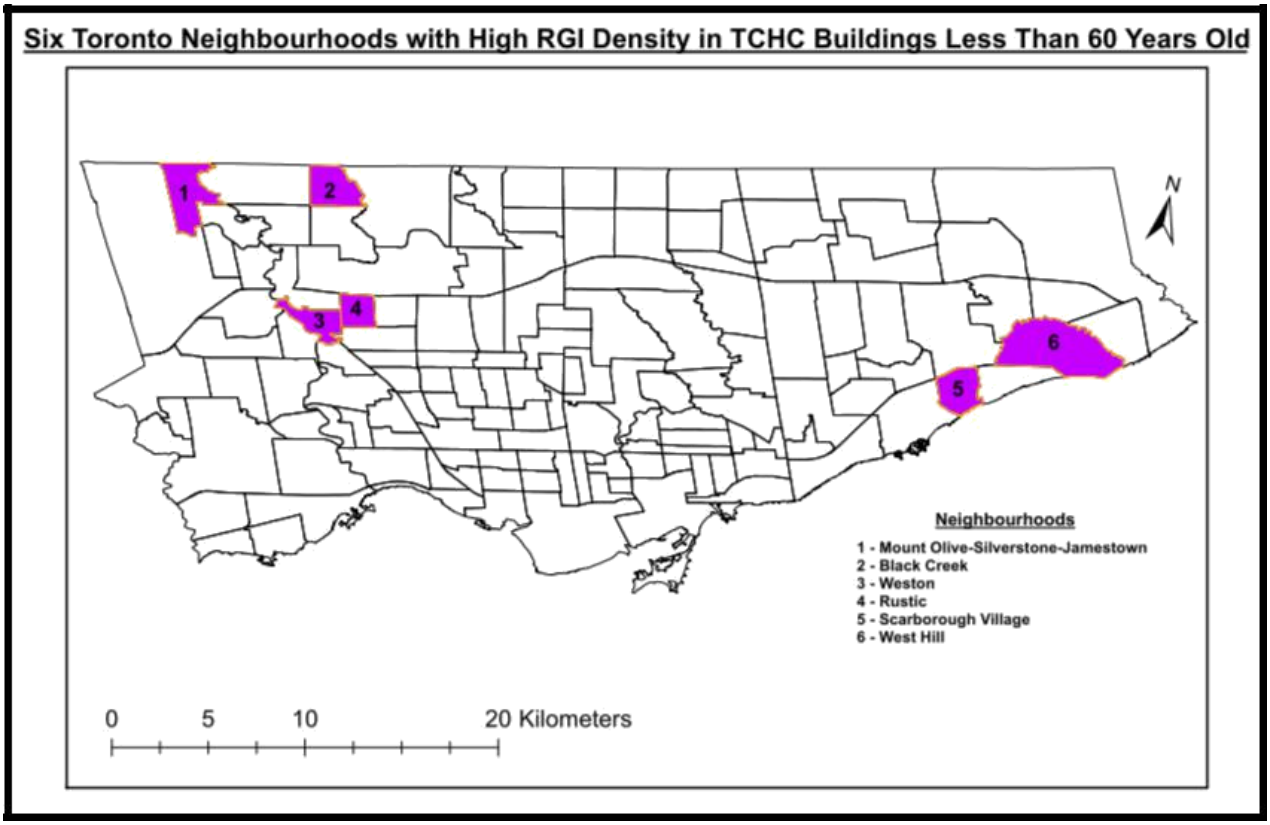


Figure 6.7 - The map highlights in purple the six Toronto Neighbourhood Improvement Areas with high RGI density built less than 60 years ago.

The City of Toronto has created an NIA profile for each of the neighbourhoods outlining the details of their equity scores along with housing and demographic information. Figure 6.8 summarizes several of the measurements from each neighbourhood profile in order to further develop clarity about where potential residential solar energy systems should be located.

Neighbourhood	Total Population (2011)	% of Population Spending 30 percent or more of household income on shelter costs	Percent of Population in Low-Income (after tax)	# of RGI Units*
Mount Olive-Silverstone-Jamestown	32,788	38%	27%	983
Black Creek	22,057	34%	28%	1424
Weston	18,170	42%	24%	704
Rustic	9,951	29%	25%	724
Scarborough Village	16,609	42%	33%	566
West Hill	26,547	29%	24%	1803

Source: City of Toronto, 2014

*Number of RGI is based on a 2013 City of Toronto data that only compiled data for TCHC properties with 6 or more units.

Figure 6.8 – The table summarizes statistics taken from the neighbourhood profiles for each of the six neighbourhoods. Though Black Creek and West Hill have the greatest amount of RGI units, the Mount-Olive-Silverstone-Jamestown, Weston and Scarborough Village neighbourhoods have more households living in unaffordable housing.

With relatively similar total and low-income populations, the 6 neighbourhoods can be split into two groups when it comes to housing affordability. The Mount Olive-Silverstone-Jamestown, Weston and Scarborough Village Neighbourhoods all have over 35 percent of their total population spending more than 30 percent of their income on shelter costs. These three neighbourhoods were selected as ideal areas to begin to integrate solar energy systems that taken advantage of the re-imagined and hypothetical programs discussed in chapter 6.3. Subsequently, cluster of TCHC properties in the 3 neighbourhoods were surveyed using satellite imagery to identify buildings with substantial solar access that were well suited for on-site solar energy generation systems.

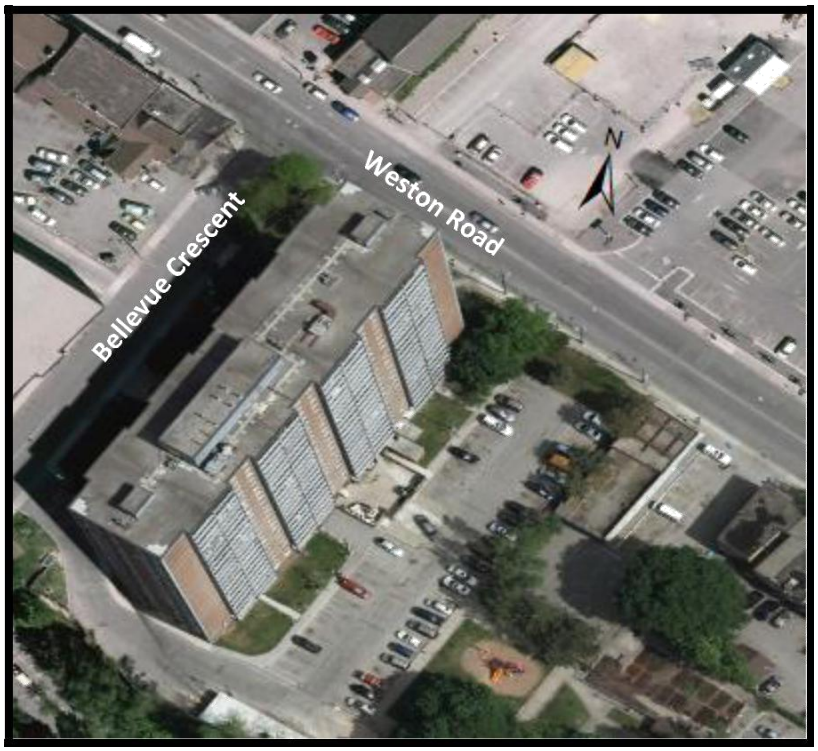
One potential site is a Toronto Community Housing complex located southeast of the intersection of Silverstone Drive and Mount Olive Drive identified in Figure 6.9. Known as the Kipling/Mount Olive development, the complex is composed of fourteen buildings originally built in 1967 (TCHC, 2013). The multiplex has 144 rent-geared-to-income units in 2-storey townhouses (TCHC, 2013). Collectively the community has over 80,000 square feet of unshaded rooftop space that could support multiple solar photovoltaic systems. Moreover, installing net metering equipment along with the solar photovoltaic panels could incentivize reduced consumption and ultimately result in energy cost savings for Toronto Community Housing.

Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 6.9 – Toronto Community Housing's Kipling/Mount Olive Townhouse Multiplex located southeast of the intersection of Silverstone Drive and Mount Olive Drive. The development is located in Toronto's Mount Olive-Silverstone-Jamestown neighbourhood.

In turn, the saving could be used to update other components of the Kipling/Mount Olive development. Through the re-imagined Renewable Energy Initiative, youth or unemployed residents living in the multiplex that are interested in gaining technical skills would be partnered with licensed solar contracts and given hands-on education about not only the installation but continued maintenance of solar energy systems.

Another potential residential solar energy system could be located in Toronto's Weston neighbourhood on a high-rise apartment building south of the intersection of Weston Road and Bellevue Crescent (Figure 6.10). 5 Bellevue Crescent was originally constructed in 1971 and contains 325 RGI units (TCHC, 2013). Similar to the high-rise buildings in Moss Park, Bellevue has a large southeast facing exterior wall with large brick-only sections. Thus, like Moss Park a SolarWall© could be constructed on one or several sections of the wall to provide solar air heating to building occupants, subsequently reducing the use of natural gas as a heating source.



Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 6.10 – Pictured is Toronto Community Housing's 5 Bellevue Crescent property. Locate south of the intersection of Weston Road and Bellevue Crescent the high-rise contains 325 RGI units.

Finally, a mid-rise apartment building in the Scarborough Village neighbourhood is well suited for a rooftop solar photovoltaic system. Originally constructed in 1965, 3181 Eglinton Ave East is a seven-floor apartment building with 103 rent-geared-to-income units (TCHC, 2013). As figure 6.11 shows the property has a relatively clear rooftop measuring approximately 23,500 square feet capable of housing a 150 to 200 kW tilted-array system[36].

[36] The 200 kW estimate was derived from comparing the square foot size of an existing 10 kW system on a TCHC property. The reference project is located at 30 Denarda Street in Toronto and tilted array occupies approximately 1000 square feet of the rooftop.

Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 6.11 – Picture is a mid-rise Toronto Community Housing building located at 3181 Eglinton Avenue East. The seven-floor building has 103 RGI units and a total roof that is approximately 23,500 square feet.

Even if programs such as the re-imagined Renewable Energy Initiative become a reality, impediments to the successful procurement of residential solar energy systems on the three potential sites identified in this chapter are likely to occur, especially issues of grid capacity and connectivity. Regardless, it is important to think through how all affordable housing structures can adapt energy efficient materials and technologies; doing so has the potential to prompt private and non-profit housing providers such as Toronto Community Housing to evaluate the potential economic, social and environmental benefits of technologies such as solar. Housing provider can subsequently voice an interest in greening the existing residential built form to institutions, who ideally would consider the creation of a dedicated program for residential solar integration. The idea of housing provider mobilization at the municipal scale will be discussed further in the final chapter of the paper along with recommended actions at the provincial levels.

Chapter 7: Recommended Actions to Incite Solar-equipped Green Affordable Housing in Ontario

7.1: Municipal Actions

The six chapters of analysis in this work have revealed a number of actions that should take place at either the municipal or provincial level in order to make solar-equipped green affordable housing a reality for a larger portion of Ontarians. As the lowest level of government, municipalities are responsible for a majority of components that impact the day to day quality of life of Ontarians. The paired discussion of energy efficiency and housing affordability has revealed the importance of coordinating the parallel evolution of two components of the built form that historically have been examined and innovated independently. Based on the discussion that has taken place in this work, the following actions are recommended to be taken by all municipal governments in Ontario.

1) **Offer administrative and technical support to non-profit and private housing providers who wish to evaluate the qualitative and quantitative feasibility of integrating solar energy systems with suitable properties.**

Municipalities have a responsibility to play a part in rectifying the current unequal distribution of solar decarbonization technologies among socioeconomic classes. In order to achieve a reality of equitable distribution of reduced energy costs, GHG emissions and improved comfort of dwellings, cost-benefit and non-energy benefit analyses need to be completed by housing providers and owners to gauge where systems can be placed to create the largest impact. The municipal action of assisting housing providers and owners with solar suitability analysis was inspired by the federal 1998 home energy audit program[37]. The program offered free energy audits across Canada and focused on targeting housing built earlier than 1980 (Gamtessa, 2013, p. 157). The energy audits were performed by independent professionals certified by the Office of Energy Efficiency, who were obligated to provide residential property owners detailed information about the ideal energy efficiency improvements they should make to the dwelling in order to achieve a higher EnerGuide for Homes rating (Gamtessa, 2013, p.

[37] The home energy audit program was known formally as the EnerGuide for Homes initiative. It was developed by the Office of Energy Efficiency of Natural Resources Canada in cooperation with Canada Mortgage and Housing Corporation. The goal of the program was to reduce greenhouse gas emissions through investment in upgrades that improved the energy efficiency of the building envelope, windows, doors, heating systems and hot water systems (Hoicka, 2014).

157). In order to incite residential solar adoption, the home energy audit program should be revived and reconfigured at the municipal level.

The municipal adaptation of the program would require auditors to be certified by a city planning department and a specific section of their report would assess the technical feasibility of integrating solar technology with the dwelling. Moreover, in order to offer the program at no cost to housing providers, auditors would be paid from a city Decarbonization Strategies Trust derived from funds permitted by zoning by-law to be given to the city by private developers seeking height or density bonuses. Each municipalities' 'bonusing' by-law[38] would include 'decarbonization strategies' as an eligible matter that private developers would financially contribute to in exchange for municipal authorization of increases in height and density that are otherwise unpermitted by the zoning by-law. With this free technical feedback from certified auditors, housing providers could assess feasibility and arrive at a decision (after consulting with residents), to declare an interest in procuring a solar energy system to their governing municipality. If Ontario continues to lack a provincial program dedicated to financially assisting affordable housing providers with solar integration projects, municipalities should connect housing providers with third party solar developers interested in forming community energy partnerships and utilizing the IESO Energy Partnerships Program. The municipal action of simultaneously offering housing providers support for energy efficiency improvement analysis and mandating inclusionary zoning would certainly result in considerable progress to be made on decarbonization targets and affordable housing availability goals.

2) Compile details of residential community interest in solar integration programs and advocate the demand for funding programs to the provincial government.

As entities responsible for the provision of affordable housing, municipalities have a vested interested in physical changes to dwellings that improve the quality of life experienced by residents. In order to prevent future instances of Ontario dwellings degrading and consequently lowering the quality of life of occupants, affordable housing and sustainable housing must become synonymous concepts. Solar-powered green affordable housing is one of many ways to create a link between the two concepts, but in order for it to become a reality, dedicated funding programs that offer grants, loans or both must exist. In order to advocate a need for these programs by residents in their jurisdiction, municipalities should summarize details of feasible residential solar integration projects.

[38] Section 37 of Ontario's Planning Act states "The council of a local municipality may, in a by-law passed under section 34, authorize increases in the height and density of development otherwise permitted by the by-law that will be permitted in return for the provision of such facilities, services or matters as are set out in the by-law."

To attract the attention of the provincial government, municipalities should unite through the existing CHEERIO initiative and compile a database of potential sites for residential solar integration projects. The Collaboration on Home Energy Efficiency in Ontario[39] (CHEERIO) is an initiative launched in 2012 with over twenty municipalities as members. The members seek to develop a multi-municipality pilot[40] that analyzes the effectiveness of the Local Improvement Charge (LIC) in accelerating residential energy retrofits on single and multi-unit dwellings (Clean Air Partnership, n.d.). The identification of properties suited for solar technology, among other energy efficiency measures, aligns with the objectives of CHEERIO. Therefore, action should be taken by current member municipalities to develop a database of potential sites for energy retrofits. The creation of a 'potential site' database through CHEERIO would oblige the province to acknowledge a union of municipalities that have identified the need for residential energy retrofits at specific locations. Ideally, the province would be inclined to provide funding while also requesting federal contributions to facilitate the launch of programs that administratively and financially resemble the former REI, the UK's Renewable Heat Initiative and the collection of California Solar Initiative programs that facilitate solar procurement in low-to-moderate income communities.

7.2: Provincial Actions

Managing over 40 percent of Canada's total population, the Government of Ontario has a duty to diffuse ideas with actions that improve the livability and global reputation of the region. One such idea is the treatment of sustainability and affordability as equally important factors in decarbonization strategies. The following actions are recommended to be taken by the Government of Ontario.

1) **Clear articulation of the benefits stemming from a relationship between renewable energy systems and the construction and redevelopment of affordable housing.**

The full environmental, economic and social potential of solar energy technology cannot be realized without detailed policy and programs in place that incentivize engagement with these technologies by people of all socioeconomic backgrounds living a variety of dwellings. The idea of coordinating energy and housing is not lost on the Government of Ontario, which has

[39] CHEERIO is administrated by both Toronto Atmospheric Fund and the Clean Air Partnership and receives funding from federal, provincial and private entities

[40] The Toronto Home Energy Loan Program (HELP) is the first of several initiatives anticipated to be launched to evaluate the effectiveness of the LIC in accelerating residential energy retrofits in Ontario.

articulated in several documents the importance of bridging sustainable practices and housing. The Housing Service Act outlines that the interests of the province are furthered by housing "delivered in a manner that promotes environmental sustainability and energy conservation" (Housing Services Acts, R.S.O. 2011). Additionally, the Ontario Housing Policy Statement acknowledges that across the province, there is an "increased awareness of the importance of developing sustainable and energy efficient housing" and the province strives to be a leader in renewable energy procurement and green job creation (Government of Ontario, n.d., p. 7-8).

Thus, it is recognized that the action of articulating the positive relationship that can exist between renewable energy and affordable housing has partially been taken by the provincial government. However, the next phase of this action requires the province to emphasize the importance of integrating all existing housing along with newly developed residences with energy efficiency technology. Put another way, it is important to be forward thinking about the future development of newly constructed sustainable, energy efficient housing; but it is even more important to pull existing housing into the future with technology located at the site of residential consumption. The action of endorsing integration of decarbonization materials and technologies with existing housing ideally will contribute to the creation of a society where innovation and integration of green practices and technologies inspires a total reconfiguration of short-sighted, and harmful practices like fossil fuel dependence.

2) The creation of a residential solar-integration initiative that identifies affordable housing properties as target sites and has clear participation, installed capacity and emission reduction targets.

Affordable housing is extremely important to the evolution of the socioeconomic culture of urbanizing regions like Ontario. Programs that facilitate the incorporation of solar energy technology with affordable housing can facilitate the continued evolution of Ontario's socioeconomic culture. This evolution would move the province in a direction where processes of development are increasingly driven by public support that is subsequently mobilized by an identity that places environmental health and socioeconomic equity ahead of initial monetary costs. Additionally, creating programs that facilitate the integration of solar energy systems with affordable housing ensures that residents do not have to wait for the technology to trickle down to their communities. The provincial government should finance and administer a residential-solar integration initiative with a similar format as the California Solar Initiative that has an overarching installed capacity goal and participation targets for sub-programs that differ based on the type of dwelling, type of solar technology and whether the system is located on or off-site. A certain portion of total initiative funds should be set aside for households currently

eligible for the funding from the Ontario Electricity Support Program. Similar to the MASH program, multi-unit buildings operated by non-profit or private housing providers would be eligible to receive incentives for solar-generated energy that offsets the common areas load as well as net-metered individual unit electrical loads.

A regionally-administered residential solar integration initiative offers a host of potential benefits to Ontarians currently experienced by residents in the United Kingdom and California. As a decarbonization strategy, solar energy system integration reduces reliance on non-renewable sources of energy that release emissions, and in the near future will cost consumers more money when the Cap and Trade program is introduced. Another benefit made particularly clear by the UK case study is that the existence of energy-efficient affordable housing reduces the risk of energy poverty among low-income households by lowering energy costs, and reducing reliance on emergency energy funds like the OESP. Additionally, the efficient operation of solar technology is highly dependent on the integrity of the structure on which it sits. Therefore, integrating solar energy systems with affordable housing can positively influence housing providers to perform regular maintenance on their properties, which slowly eliminates the notion of rundown affordable housing in the province. Moreover, an Ontario residential solar initiative that mandates resident mentorships with licensed solar contractors like the SASH program will produce the economic benefit of providing residents the opportunity to gain labour skills that subsequently enhance their employability.

Along with the economic benefits, solar-powered green affordable housing inspires positive social change in the surrounding community as a result of emphasis being placed on environmental values. One particular change noted by James Keirstead is that on-site generation projects often illicit a change in energy consumer behaviour since the process of procuring a renewable energy system influences many residents to be more cognisant of the impacts of their energy consumption (2007, p.4129). Becoming aware of the environmental and economic impacts of individual consumption contributes to the materialization of an eco-identity that becomes embedded in a community when multiple households possess it. Relatedly, well-maintained solar-powered green affordable housing positively influences the community to take more pride in where they live. Changing the attitudes of residents in social, private market and co-op housing in Ontario can influence individuals in other regions to hold affordable housing in higher-esteem, subsequently peeling back the layers of negativity often attached to low-income households and their communities. Also, the California case study revealed that even when solar-powered households move they are inclined to recreate all the benefits by educating and encouraging their new housing providers to procure residential solar

energy systems. Ultimately, the creation of a residential solar integration initiative by the provincial government is an important and worthwhile undertaking that would contribute to the achievement of three inextricably linked notions: environmental health, inter-generational equity and intra-generational equity.

3) Continue to fund research examining how Ontario's energy system can efficiently adapt green technologies like solar energy systems and storage technology.

It is important that Ontario's existing energy system is capable of adapting green technology innovations of the present and the future. In the past, Ontario's Renewable Energy Standard Offer Program (RESOP) had a high participation rate, but operation of solar photovoltaic systems was slowed by transmission issues two years into the program in 2008 (OSEA, 2011). Consistent funding of research examining how the province's energy system can efficiently adapt green technological innovations is central to ensuring that the system rigidity associated with centralized energy generation does not stand in the way of energy innovations that are decentralized. For example, energy storage technology will in the coming decades become more mainstream[41] since it improves the practicality of renewable technologies such as solar that contribute to decarbonization targets. It is important that the provincial energy system is able to adapt the technology without major delays due to the rigidity of an energy system built with centralized production and distribution in mind. Therefore, in addition to funding research about future adaptation of green technology this action must be complimented by the province making headway on maintaining and innovating the transmission and distribution networks.

Together the three recommended provincial actions contribute to the creation of a strong region-wide effort that connects processes central to the creation of a stable socioeconomic environment for residential solar. The full benefits of solar-powered green affordable housing in Ontario can only be realized if educated households and housing providers exist parallel to a regional residential program and a government-supported green technology industry that obliges them to innovate the existing energy system. Successfully carrying out these actions will bring Ontario closer to a reality in which the guaranteed growth of residential development is

[41]The IESO launched a procurement process for storage technology in the fall of 2014 that resulted in the approval of 5 companies for the build-out of 33.54 megawatts of total project capacity (IESO, 2015). This first phase of energy storage procurement program is expected to come online before the end of 2016. IESO emphasizes that the projects will "optimize the performance of renewable resources by smoothing out natural fluctuations in solar and wind production" (IESO, 2015).

shadowed by green development practices that make sustainability a lived reality for a majority of the population, instead of aloof ideal only achieved by the privileged minority.

7.3: Conclusion

This work has discussed the environmental, social and economic harmonies that result from the equitable and sustainable practice of integrating solar technologies with affordable housing communities. Through analysis of low-to-moderate income households and residential energy consumption in multiple contexts, this paper has emphasized the role solar energy generation technology can play in bridging urban planning and energy planning. Solar-equipped housing is one of many solutions that ensures that energy affordability, social equity, and environmentalism are reflected in affordable housing. Additionally, in order to eliminate the socioeconomic exclusivity of green practices, Ontario must become indoctrinated with the idea that sustainability and affordability should be treated as equally important factors in decarbonization strategies so that eco-identities can materialize anywhere. The deployment of solar energy systems is capital-intensive, thus financing support options for low- income interested customers are an essential part of ensuring the creation and maintenance of an equitable solar market in Ontario. Programs in both case study regions acknowledged this reality by offering both grants and low interest finance mechanisms. Furthermore, several of the analyzed programs had higher rebate structures for low-income participants in order to make the front end economics of solar development work for these households. In order to develop solar-powered green affordable housing, the province of Ontario needs to establish similar inclusive policies and regulations that allow low-income households to participate in decarbonization strategies.

The analyzed programs also emphasized how important good information sharing and marketing are to getting low-to-moderate income households to participate. In particular, California's SASH program used a strategy of trust-based marketing that allowed potential participants to consult with existing low-to-moderate income solar adopters in order to see firsthand the benefits of residential solar energy system integration (GRID Alternatives, 2016, p. 9). The ideal scenario is the creation of policy and programs that spawn satisfied participants who advocate the benefits to others. This contributes to processes of decarbonization being valued and implemented in communities where improving the energy efficiency of housing benefits those with the least means; A scenario that embodies the related ideals of ecological modernity and 'just sustainability'. As more cities begin to adopt sustainable living principles,

the existence of quality green affordable housing will become an indicator of what regions are serious about integrating decarbonization strategies as a way of life for everyone.

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APPENDIX A - Ontario households recognized as low-income by the Ontario Electricity Support Program and for the purposes of this paper.

Level of Household Income ($)	**Number of people living in home**						
	1	**2**	**3**	**4**	**5**	**6**	7
28,000 or less	✓	✓	✓	✓	✓	✓	✓
28,001-39,000			✓	✓	✓	✓	✓
39,001-48,000					✓	✓	✓
48,000-52,000							✓

Source: Ontario Energy Board, 2016

APPENDIX B – Non-Energy Benefits identified by Navigant Consulting

Beneficiary	Non-Energy Benefit
Utility	Reduced carrying cost on arrearages (interest)*
Utility	Lower bad debt written off*
Utility	Fewer shutoffs*
Utility	Fewer reconnects*
Utility	Fewer notices*
Utility	Fewer customer calls*
Utility	Lower collection costs*
Utility	Reduction in emergency gas service calls
Utility	Utility health and safety - insurance savings only
Utility	Transmission and/or distribution savings (distribution only)
Utility	Utility rate subsidy avoided (CARE) payments*
Societal	Economic impact (direct and indirect employment)**
Societal	Emissions/environmental**
Societal	Health and safety equipment (CO and Other health and safety)
Societal	Water and wastewater (avoided)
Participant	Water/sewer savings
Participant	Fewer shutoffs*
Participant	Fewer calls to the utility*
Participant	Fewer reconnects*
Participant	Property value benefits*
Participant	Fewer fires
Participant	Indoor air quality (CO-related)
Participant	Moving costs/mobility*
Participant	Fewer illnesses and lost days from work/school
Participant	Reduced transactions costs (limited measures)
Participant	Net household benefits from comfort, noise
Participant	Net household benefits from additional hardship benefits*

Source: Navigant Consulting Inc., 2015a

*Indicates NEBs that apply to low-income solar PV programs.

**Indicates NEBs that could apply to low-income solar PV programs but were not considered in this analysis because the LIPPT report conservatively estimated the value to be zero in order to avoid double counting with other avoided cost values.