Residential Solar Energy Adoption in a Community Context: Perceptions and Characteristics of Potential Adopters in a West Toronto Neighbourhood

by

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Author’s Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Theodore Sherk

Abstract

In the summer of 2007, a single neighbourhood in downtown Toronto contributed at least 13 percent of all residential grid-tie solar photovoltaic (PV) systems sold in the Canadian province of Ontario. On average, PV purchaser households produced 37 percent as much electricity as they consumed.

This research investigates solar energy adoption in a community case study. Specifically, it investigates why some residents who sign up for a solar resource assessment through a community solar energy initiative (CSEI) decide to purchase, and others decide not to purchase in the short-term. Characteristics and perceptions of potential adopters are analyzed to better understand their motivations and barriers to adoption.

Community energy projects became an official public policy goal in Ontario, with the passing of the *Green Energy and Green Economy Act* in 2009. Approximately 80 percent of Ontario's anticipated generation capacity will need to be built, replaced or refurbished within 15 years. In this context, the Ontario Ministry of Energy, Ontario Power Authority, and Deloitte (one of Canada's leading professional services firms), have partnered with a 'green benefit' fund, the Community Power Fund, to help local community groups access resources to develop and establish renewable energy projects. Understanding solar energy adoption in a community context is therefore important to improve the effectiveness of such policies, including the disbursement of multi-million dollar grant funds.

Differences between purchasers and non-purchasers in respect of adoption behaviour were found in this study to cluster around two general themes. The first theme concerns differences in compatibility of both the concept of solar energy systems, and their physical attributes, with characteristics of potential adopter households. Some compatibility issues are straightforward, e.g. availability of roof space with a southern orientation. Others are more complex, involving several interrelated perceptual and socio-demographic factors. For instance, while both purchasers and non-purchasers rated cost as a very important barrier, purchasers rated the motivation of solar energy systems to reduce climate change higher relative to the barrier of high financial costs than did non-purchasers. Purchasers were also more likely to possess a graduate degree, while non-purchasers were more likely to hold a professional degree.

The second general theme relates to potential adopters' trust and stake in the ability of the community-based initiative to reduce barriers in the adoption process. Since two types of solar energy systems are considered in the case study—PV and thermal (hot water)—differences are explored between each of three respondent groups: solar PV purchasers, solar hot water (SHW) purchasers, and non-purchasers.

Surveys were used to gather data on adopter perceptions and characteristics. A participatory research design helped identify the research topic. Two main bodies of literature—community-based social marketing (CBSM) and diffusion of innovations theory—were drawn upon to conceptualize the adoption process and interpret the survey findings. These include five models of human behaviour that can be used to guide the design of CBSM campaigns. Diffusion theory was used as a basis for discussing 'perceived innovation attributes'. The study takes an integrated approach by considering both social and technical aspects of solar energy adoption, together with the issues of fuel substitution and household electricity demand.

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Thanks to my friends, family and various others who have pushed me along the way. You have taught me firsthand about what it means to live in community, through our shared struggles and successes to foster more humane and sustainable energy systems.

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List of Acronyms

CBSM	-	community-based social marketing
CDD	-	cooling degree days
CSEI	-	community solar energy initiative
DoI	-	diffusion of innovations
DSHW	-	domestic solar hot water
FIT	-	feed-in tariff
GTA	-	Greater Toronto Area
HDD	-	heating degree days
IPSP	-	Integrated Power System Plan
kW	-	kilowatt
kWh	-	kilowatt-hour
MW	-	megawatt
OPA	-	Ontario Power Authority
OSEA	-	Ontario Sustainable Energy Association
PV	-	photovoltaic(s)
REEP	-	Residential Energy Efficiency Project
RESOP	-	Renewable Energy Standard Offer Program
SHW	-	solar hot water
TREC	-	Toronto Renewable Energy Cooperative
WISE	-	West Toronto Initiative for Solar Energy

1 Introduction

Greenhouse gas concentrations in Earth's atmosphere are arguably the most pressing of today's global challenges. Many individuals, communities, firms, and governments have a choice—to accept the need to respond to global challenges, such as mitigating greenhouse gas emissions by replacing fossil fuel sources of energy with renewable sources, and align their interests with these, or to continue pursuing narrower interests at the expense of the common good.

This research focuses on an exemplar case study of cooperation among citizens, industry, and government, to overcome barriers to solar energy adoption in the context of concern over climate change as a result of greenhouse gas emissions. The West Toronto Initiative for Solar Energy (WISE) was one of several community-led efforts to expand the residential solar market. Citizens and civil society organizations took innovative action to incentivize industry to lower costs, find efficiencies, and improve their overall value proposition. These civil society efforts converged in the founding of *Our Power*, a project to connect community-oriented solar energy enthusiasts around the Greater Toronto Area (GTA), and later beyond the GTA.[1] Meanwhile, the Ontario provincial government had created an innovative incentive program to build capacity for renewable energy procurement, the *Renewable Energy Standard Offer Program* (RESOP). Industry responded by lowering costs and working closely with civil society and local governments to address regulatory and technical barriers to their systems.

The success of the WISE, measured in terms of systems sold, was exceptional in Canada. This can be inferred partly from circumstantial evidence—local and national media coverage[2], a CSEI organizer (Ken Traynor) being awarded the Canadian Solar Industry Association's *Solar Leader Award* in 2008, and Our Power's claim to have been responsible for 31 percent of residential solar PV systems installed in Ontario under the RESOP. This claim is supported by the author's conservative estimates based on industry and government sources (Section 1.1).

[1] The current website of the Our Power Network describes its history as follows: "The Our Power project grew out of efforts in the Riverdale and Bathurst-St.Clair neighbourhoods of Toronto, where neighbours got together to gather information, evaluate installers and simplify the solar investment decision together. With an overwhelming demand for the information gathered by these groups and a gap in the market for a strong customer service offering identified, [Our Power became a program of the Toronto Renewable Energy Cooperative (TREC)] to expand the program's reach. Our Power is governed by the TREC Board of Directors and advised by a Steering Committee made up of volunteer professionals with engineering, small business, marketing, website development and solar development experience as well as the TREC Executive Director." The website further states that Our Power possesses Canada's largest database of "homeowner solar enthusiasts", and a membership of 3200 individuals. (Our Power, 2010)

[2] Eye Weekly, 2007; Canadian Geographic, 2008

This success offers an opportunity to better understand what factors contributed to this rapid and proportionately high adoption of solar energy systems by residents of a small Canadian community. Further background on the case study is provided in Section 3.2.1.

This research provides evidence of capacity building, or what Hirschman (1980) calls "consumer creativity", at the community level pushing up to high levels of government and industry to overcome barriers to renewable energy technologies. In synergy with removing barriers to renewable energy adoption is deploying the technology in a way that addresses the "three pillars of sustainability": society, environment, and economy.[3] It has been argued that when communities participate directly in procuring the energy they use, not only can barriers be identified and potentially removed/overcome, but ultimately the type of energy system that emerges is more in the public interest than were it designed with minimal public input. As will be discussed, the graveyard of infrastructure proposals is full of projects that were acceptable to planners and engineers, but died in the court of public opinion. Recently, opposition from residents in Oakville and Mississauga led the Government of Ontario to cancel plans that had already been approved for a new 975 MW gas-fired generator (CTV, 2010; Toronto Star, 2010). Nuclear reactor construction has been at a "very low ebb in much of the world" (Bodansky, 2004) in the wake of strong public opposition following the nuclear meltdown at Chernobyl and partial core meltdown at Three Mile Island (Kahn, 2007). Of course, renewable energy technologies are not immune to not-in-my-backyard (NIMBY) opposition. A proposed wind farm to be built two kilometers off the shores of Lake Ontario east of Toronto met with strong opposition from both residents and municipal councillors (ReNew, 2010). Together, they petitioned the City to place a moratorium on all new wind turbine agreements (ReNew, 2010). Hence, there are lessons to be learned about the importance of including communities in the design of energy systems that affect them.

The influence of communities on improving power system design is certainly not limited to NIMBYism. There is evidence of socio-technical interactions that occur as communities become stakeholders in electricity generation (Verbong and Geels, 2007). In this research, energy consumers who voluntarily engage in a process of community-facilitated education, evaluation and adoption of rooftop solar energy systems also show a lower level of electricity consumption. In some cases, the expression of a desire to conserve energy appears as a direct result of going through the solar technology adoption process.

[3] Alternatively referred to as "the triple bottom line": people, planet, and profit.

1.1 Advantages and Potential of Distributed Solar Energy

In determining which energy options will prevail, Bradford (2006) argues that a reasonable analysis must look beyond preconceptions about which one "should" succeed or which one would be "the best" solution for society. Instead, responsible analysis should determine how, in the course of day-to-day life and trillions of coordinated and uncoordinated decisions, energy solutions will unfold. Placing energy systems in this greater context aids our ability to understand and predict energy trends. For example, consider the transition from whale oil for lighting to coal derivatives in the 19^{th} Century. Lovins (2004) reports that 5/6ths of the whalers' market evaporated in the 1850s due to fatal competition from a burgeoning oil and gas industry. As Lovins amusingly points out, the remaining whale populations were ultimately saved by "technological innovators and profit-maximizing capitalists" (p. 5).

There are two major schools of thought around the future of electricity supply in Ontario. Some stakeholders favour a centralized electricity system, while others favour a distributed model. Traditionally, Ontario has had a centralized power system, since the predominant forms of generation have been large hydro, nuclear and fossil-fueled generators. After the Second World War, nuclear power was embraced as a preferred long-term energy source, and became a mainstay of Ontario's electricity system (OPG, 2010). Many commentators point to problems with transmission capacity limits and large environmental impacts associated with large, industrial generators (Duncan, 2006; OEB, 2005; Love, 2007; Lovins, 2004; Valocchi et al, 2007). However, a new trend is developing toward distributed energy generation, which means that energy conversion units are situated closer to energy consumers, and large units are supplemented or substituted by smaller ones. A distributed energy system is an efficient, reliable and environmentally friendly alternative to the traditional energy system (Alanne and Saari, 2006). It has been argued that distributed power systems offer greater flexibility along with reduced environmental impacts as they can incorporate a diverse mix of forms of generation (Lovins, 2004). Centralized and distributed systems are not mutually exclusive and can be integrated at the transmission level (CERTS, 2002).

An attractive example of distributed generation is rooftop solar PV applications. Rooftop solar technology avoids many of the transmission capacity issues and environmental impacts of centralized generators, because each building, itself a load on the electricity grid, is also generating some portion of its consumption. In the residential context, this portion is usually 25-50% of its electricity needs (Fisher, 2006). Solar energy is an abundant and nearly ubiquitous resource around the globe. The amount of sunlight that falls on the earth every day is equivalent to the total energy that is used by the earth's current population in twenty-seven years (DOE, 2004). The total area required to meet U.S. electricity needs using today's PV technology is 0.4 percent of the total land area of the United States (Bradford, 2006). This is only seven percent of the area currently covered by cities and residences, many of which offer viable locations for integrating PV systems and are unavailable to centralized electricity generators (ibid.). Unlike other technologies that require the use of rotating turbines, PV has no moving parts. Once installed, PV produces no emissions, virtually no noise, and is warranted to derate[4] at less than 1% per year for the first 20 years of operation.

Distributed solar energy systems also offer some intriguing potential socio-technical benefits. Currently, energy and power are not terms within the natural language of mainstream householders (Dobbyn and Thomas, 2005).[5] Gas and electricity operate at the level of the subconscious within most households. There is some latent cultural guilt about the notion of waste, however, many consumers feel unable to actively and significantly reduce energy consumption in their households (Dobbyn and Thomas, 2005, cited in Darby, 2006). In a centrally-planned energy system managed by techno-elites, individual homeowners have little direct control over how their energy is produced. The deregulation of the retail electricity markets and emergence of 'green' energy retailers has gone some way to expand consumer choice. *The Green Energy and Green Economy Act, 2009*, by allowing individuals and communities to invest directly in distributed renewable energy generation, further increases consumer choice.

CSEIs, as an approach to distributed energy generation, avoid a number of significant environmental impacts that are associated with centralized electricity systems.

1. reduces ecological disturbance by utilizing rooftops instead of natural or agricultural lands
2. reduces pressure on delivery infrastructure by tending to produce electricity at load and during periods of peak demand (Rowlands, 2004)
3. reduces the amount of land used for transmission line right-of-ways, and strip mining of metal ore to supply grid infrastructure
4. offers indirect benefits such as not adversely affecting rural aesthetics[6] and increasing energy awareness in urban areas (Hondo and Baba, 2010)

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[4] This term refers to a gradual reduction in a solar panel's rated electrical production capability over time.

[5] In a technological, rather than social sense.

[6] Windfarms have been criticized on aesthetic grounds by some rural residents. The reader is referred to the case of the Cape Wind project in Nantucket Sound. In Ontario, the Provincial government passed a moratorium on off-shore wind farms partly in response to legal challenges from anti-wind energy citizens groups (Toronto Star, 2011).

The separation between consumers and suppliers is argued to be a fundamental barrier to fostering more responsible energy behaviour. Literature on attitudes and behaviour has established that knowledge is often a requisite for action (Faiers and Neame, 2006; McKenzie-Mohr, 2000). When consumers participate in the generation or distribution of electricity, as happens with community solar energy projects, a knowledge gap can be bridged and awareness start to grow about the true costs and complexities of electricity supply (Sherk and Parker, 2008). Whether consumers on the whole are interested in such complexities, or regard them as a burden better delegated to techno-elites, e.g. professional energy system planners, is a question beyond the scope of the thesis. However, distributed energy projects have been shown to improve morale around energy and environmental issues within the communities in which the projects are built (Sherk and Parker, 2008). Bradford (2006: 213) writes, "Solar energy can improve people's expectations for the future if they appreciate its potential to transform energy industry economics. As more people understand the inevitability of the shift to solar, they will be less inclined to bet on marginal or deteriorating solutions". "Community energy offers a 'serious alternative to the current energy system' (Hoffman and High-Pippert (2005:387)) which incorporates participation of locals and hence offers a system concurrent with local needs, values and resources" (St. Denis and Parker, 2008:2). Conversely, a lack of stakeholder/community participation in energy choices has been identified as a barrier to the use of renewable energy (Margolis, 2006).

1.2 CSEIs in the Ontario Policy Context

There has been a groundswell of general support in Ontario over the last decade for "clean" technologies and technology deployment strategies to reduce environmental impacts. An example is support for the decision to close coal fired power stations in the province (MOE, 2010). Approximately 80 percent of Ontario's generation facilities will need to be replaced or refurbished by 2025 (Ontario Power Authority, 2005 cited in Robinson, 2007). In this context, governments and industry are looking to renewable energy as an alternative to traditional sources.[7] While the financial proposition of several renewable energy technologies has been improved through effective policy, namely a feed-in-tariff program that is the centerpiece of Ontario's *Green Energy and Green Economy Act, 2009*, much more needs to be done to promote sustainable energy practices in the province.

[7] More than half of Ontario's power generation currently comes from nuclear power plants that operate at a supercritical level and produce radioactive wastes with half-lives of more than 200,000 years (IESO, 2011; Nature, 1996).

Diverse communities across Ontario are concerned about the environment and the future of our energy supply.[8] We have much to share and learn from each other about how to address imminent environmental catastrophes--species loss, climate change, food security, and global resource conflicts. Some believe that technology and expert-driven decision-making are our only real hope to address these challenges. However, there is compelling evidence that precisely this form of delegated, technocratic governance is at the root of our sustainability woes.[9]

The Ontario Power Authority (2006a) has stated that its consideration of sustainability in the Integrated Power System Plan is based on Robert Gibson's, *Sustainability Assessment: Criteria and Processes*. In this book, Gibson explains, "the present concept of sustainability is a response to evidence that current conditions and trends are not viable in the long run, and that the reasons for this are as much social and economic as they are biophysical or ecological. This means that current sustainability efforts are not merely integrative and forward looking. They are also attempts to push us onto a different and more hopeful path, and as such they are an attack on entrenched habits and structures of decision-making" (Gibson, 2006: 2).

Community-based energy initiatives offer an opportunity for direct public decision-making concerning where their energy is sourced, how it is produced, and who receives the benefits/impacts of production. At the same time, community initiatives as presented here are intended to spur market growth of sustainable energy technologies. The WISE contributed at least 13 percent of all residential grid-tie solar energy systems sold in Ontario between March

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[8] The website of the Ontario Sustainable Energy Association (OSEA) lists member communities ranging from faith communities, to aboriginal communities, to community power groups, rural energy cooperatives, and civic associations.

[9] An extensive body of literature has linked environmental and economic mismanagement to the disconnect between resource managers and resource users: Chomitz et al., 1999; Cox, 2001; Geller, 1992; Folke et al., 2007; Goldman, 2003; Thompkins and Adger, 2004. Relevant research disciplines include Complexity Theory (Van der Brugge, 2007), Integrated Resource Management (e.g., using Traditional Knowledge to inform Scientific Management, Molnar et al. 2004), Participatory Development (Fabricius and Collins, 2007; Maarleveld and Dangbégnon, 1999), and Systems Theory (Hollick, 1993; Reed, 1984).

2006 (when the RESOP program was announced) and August 2007,[10] despite the ward having only a tiny fraction (0.37 percent) of Ontario's population.

1.3 Research Gap

The academic literature has limited examinations of the phenomenon labelled in this study as community-based solar energy initiatives (CSEIs). A small body of literature has emerged from the United Kingdom, mostly since 2007, exploring the more general topic of community-based renewable energy. Very few references were found exploring the topic in a North American, let alone, Canadian or Ontario context. Despite the remarkable outcomes surrounding some of the Our Power initiatives (highlighted above), the lack of academic attention is understandable, not so much because CSEIs are a new type of initiative[11] (and hence have not had time to attract scholarly interest), but because their importance is only beginning to be recognized in relation to broader issues such as public participation in the energy sector, fuel substitution to reduce dependence on fossil fuels, and distributed generation.

A substantial body of literature exists on community energy management and planning (Jaccard et al., 1997; Jaccard, 2001; CMHC, 2003; Hiremath et al., 2007; St. Denis and Parker, 2008). However, planned and managed approaches to community energy are quite different from the grass roots, market-based approach explored in this study. While there is significant experience in Europe with community energy initiatives, (initially with wind energy and more recently with solar energy), the nature of such initiatives is not well understood (Hoffman and High-Pippert, 2005). Hence, this research fills a gap in the literature by providing rich insights into one type of community energy initiative, including developing a conceptual framework for solar energy adoption in a community context.

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[10] At least 16-22 RESOP applications had been submitted by the WISE PV vendor on behalf of purchasers by the end of August 2007. The total number of executed RESOP contracts was 140, with another 104 in process (OPA, 2007). Using a conservative estimate that none of the WISE systems were among the 140 executed contracts, but rather were included in the 104 "applications in process", WISE's 16-22 systems constituted at least 16/(140+104) to 22/(140+104) = 6.6 to 9 percent of the RESOP contracts in either executed or in process in August 2007. This calculation is based on all RESOP contracts, i.e., for all technologies. A breakdown could not be found of executed PV contracts vs. those in process. However, the total number of PV contracts executed by the end of August 2007 was 72, or 51 percent of the total of 140. Assuming that this proportion of PV contacts to total RESOP contracts holds for contracts "in process" as well as those that had been executed, the above percentages nearly double, giving the estimate of 13 percent.

[11] Parker Rowlands and Scott (2003: 179) briefly mention a "solar pioneers" program, which "facilitates the establishment of solar panels on peoples' houses". This describes in general terms the case study from which data for this thesis has been drawn.

CSEIs are defined here as the phenomenon of grass roots mutual facilitation directed towards increasing solar energy adoption in one geographic community by pooling information and issuing a bulk purchase tender to reduce costs and risks associated with adoption. The emergence of CSEIs in Toronto over the past 15 years, beginning with Greenpeace's Solar Pioneers program in the late 1990s, and then again in 2006 with the Riverdale Initiative for Solar Energy (RISE), and other projects based on the Our Power model[12] appears to be a new phenomenon worthy of study.

This thesis also adds to the growing body of literature exploring drivers and barriers to solar energy adoption through a diffusion of innovations (DoI) framework (LaBay and Kinnear, 1981; Jacobsson and Johnson, 2000; Painully, 2001; Duke et al., 2005; Faiers and Neame, 2006). The sun provides a virtually limitless supply of energy, which can be converted into heat and electricity with little-to-no emission of greenhouse gas. One ten-thousandth of the solar energy that falls on the Earth each day would be sufficient to meet global (metered) energy demand,[13] and unlike hydrocarbons, this energy source is theorized to be available and undiminished for at least the next five billion years (NASA, 2009). To relate the sheer scale of solar energy's sustainability and abundance to the present study context, consider the case of the cancelled 975 MW gas turbine plant in Oakville, (a suburb of Toronto), mentioned above. The annual electricity production (kWh/yr) from this gas plant could be provided by installing solar photovoltaic (PV) panels on just 0.6 percent of the surface area of the GTA.[14] Consider also that the price per unit of energy generated by these solar panels is roughly one order of magnitude higher than energy from the gas plant (using the standard utility metric of $/kWh).[15] With such powerful drivers and barriers at play, there is a need to understand the perceptions of both solar energy adopters and those who seek information but decide not to adopt a system in the short term. Knowing the differences between adopters vs. non-adopters, with respect to their perception and characteristics, offers a basis for assessing how likely a particular individual or household is to purchase a solar energy system, and more importantly,

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[12] These projects include the project highlighted in this study (WISE), as well as a Mennonite Initiative for Solar Energy (MISE), Valley Initiative for Solar Energy (VISE), and Community Renewable Energy Waterloo's Solar Initiative for Distributed Energy (CREW's SIDE), which was a CSEI based in the Regional Municipality of Waterloo, Ontario.

[13] Derived from a finding of the United States Dept. of Energy (2004), that the amount of sunlight that falls on the earth every day is equivalent to the total energy that is used by the earth's current population in twenty-seven years (DOE, 2004).

[14] The reader is referred to section 2.5.2 for the calculation on which this is based.

*While a difference of 90 vs. 12 percent might be interpreted to favour the gas plant, note that O&M costs (such as the cost of fuel) and depreciation mean that the difference in capacity factor is only one of several important considerations in a broader cost-benefit analysis.

[15] Operators of solar PV facilities were paid 42 cents per kWh under the RESOP program, while operators of natural gas generators were paid approximately five cents/kWh (OPA, 2007; Toronto Hydro, 2007).

what aspects of solar energy market need to change to move more homeowners to the point of purchase.

A third contribution of this research concerns socio-technical aspects of solar energy and household energy demand. Keirstead (2007) found the present study design to be infeasible, given data access issues around paired monitoring data with social surveys. However, the eagerness of CSEI participants to provide data to the present study allowed these data access issues to be overcome. Further, while Keirstead (2007) measured solar energy adopters' self-assessment of electricity savings, the present study measures actual household electricity performance—generation and consumption--acquired from the local utility company. Ontario households consume one-third of the province's electricity (Ontario Energy Board, 2005 cited in Robinson, 2007). By comparing the electricity consumption and production of WISE PV-adopting households, this research provides an objective measure of net[16] electricity performance of homes in the study.

1.4 Research Purpose

A wide range of literature spanning sociology to power system engineering could be drawn upon to better understand the nature and role of community energy initiatives within what Hoffman and High-Pippert (2005: 387) call, "socially and technologically decentralized energy systems". Partly due to this lack of a single academic paradigm to orient the research, this study took a participatory approach to define its purpose, inviting input from members of the community of CSEI stakeholders to suggest questions whose answers would be useful to their work. These stakeholders comprised civil society and industry leaders (further described in Chapter 3). Based on this input and a review of relevant literature, two areas of study were identified to help conceptualize the CSEI phenomenon. These are community-based social marketing (CBSM) and diffusion of innovations (DoI) theory.

The key question identified by CSEI stakeholders was how to increase the diffusion of solar energy systems within a community context. Therefore the research objective is to better understand why some residents of a municipal ward in Toronto who signed up to have their home assessed for a system decided to purchase, and others decided not to purchase in the short term.

[16] "Net" is used in the sense of a net zero-energy building, as defined by the U.S. National Renewable Energy Laboratory (NREL, 2006: 1).

To achieve this objective, three topics of investigation were identified in respect of differences between knowledgeable adopters vs. knowledgeable non-adopters:

- perceptions of the CSEI
- perceptions of solar energy systems (irrespective of the community initiative)
- household behaviours and characteristics

Recognizing that increased market adoption of solar energy systems is necessary to build a sustainable energy industry in Ontario, this research assesses the motivations and barriers affecting the purchase of solar energy systems identified in the literature and applied to a Toronto-area case study.

In light of the large uptake of solar energy systems that took place through the WISE, a secondary research objective was to determine if distinctive characteristics distinguished WISE participants (both purchasers and non-purchasers) from the larger, mainstream population. Hence, differences were also investigated between characteristics of WISE participants vs. residents of Ward 21 generally.[17]

The investigation of household behaviours and characteristics included an assessment of household electricity performance. This assessment compared the amount of electricity generated by WISE PV adopter households to these same households' consumption levels.

Anticipated benefits of the study

It has been observed that there is no single solution to our society's future energy needs (UCS, 2010). Relying on fossil fuels for more than 80 percent of our energy[18] has destabilized natural carbon cycles, created severe economic risks in regions where demand exceeds domestic supply, and continues to provoke political interference and armed conflict in many regions of the world (IPCC, 2007a; Ballentine and Sherman, 2003). Rather than continuing our heavy dependence on fossil fuels, or even transitioning en masse to another fuel source (e.g. nuclear or one of the renewables), the answer may instead be to diversify our energy supply. As part of

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[17] In an ideal version of this study, with unlimited access to data, all three data types—perceptions, characteristics, and electricity performance—would have been collected from the three respondent groups: WISE purchasers, WISE non-purchasers, residents of Ward 21. Due to difficulties in accessing data, and constraints on the researcher's time and available resources, all three types of data were obtained for some of the groups, but not for others. The reader is referred to appendix A(V) for a table identifying which types of data were collected on which groups.

[18] Homer-Dixon (2009: 66-67) reports that 89 percent of energy used to "heat our homes and to fuel our cars, airplanes, factories, and power stations" is provided by non-renewable fuels--oil, natural gas, coal, and uranium. The IEA reports that nuclear energy comprised 5.9 percent of primary energy sources in 2006. 83 percent therefore is used as a rough figure for the quantity of society's energy needs met by fossil fuels.

a safe and diversified energy system, solar energy technologies can prevent emissions that would otherwise result from combustion of coal and gas, but they may also reduce overall stress on ecosystems when used in combination with other energy technologies.

This research is intended to offer insights that will enable future community-based environmental initiatives to achieve higher levels of participation. To achieve higher participation rates, insights need to be gained into effective social marketing strategies, as well as preferences of both solar energy adopters, and people who seek information but decide not to adopt in the short term.

It is hoped this study will be used to help improve the design and implementation of neighbourhood solar power initiatives by offering recommendations to community organizers, government, and solar vendors (industry). The benefits of this study are therefore expected to include a better understanding of the strengths and weaknesses of CSEIs. This understanding can then be used to improve subsequent initiatives.

Strengths and weaknesses are considered in both qualitative and quantitative terms. Categories for identifying attributes of CSEI and adopters' perceptions of these attributes are drawn from LaBay and Kinnear (1981:2), who identify attribute categories based on earlier literature (Ostlund, 1974; Rogers and Shoemaker, 1971). The attributes most commonly considered include:

1) relative advantage, or the degree to which the innovation is perceived as being superior to the idea or product it replaces;
2) perceived risk, the probability of economic or social loss resulting from innovation;
3) complexity, the extent to which the innovation appears difficult to use and understand;
4) compatibility, the degree to which the innovation is seen as consistent with the innovator's existing values, past experiences, and needs;
5) trialability, the extent to which one can experiment on a limited basis with the innovation; and
6) observability, the degree to which the results of innovating are visible to others.

This research is expected to help both policymakers and members of the general public assess whether the higher price per unit of energy production in residential applications of solar PV relative to other applications and technologies is justified by social and environmental benefits. It is intended to help explain some of the actual and perceived linkages between community-based energy initiatives and certain externalities accounted for in the higher feed-in tariff rate for solar PV under the *Green Energy and Green Economy Act, 2009*.

Chapter 2 will review the general literature related to CSEIs. This literature is used to develop a conceptual framework for adoption of solar energy systems in the CSEI context. This framework encompasses both social and technical aspects of solar energy adoption, and issues of fuel substitution and reductions in electricity demand. Chapter 3 presents the thesis methodology, including an overview of the case study, the West Toronto Initiative for Solar Energy (WISE). Chapter 4 examines the CSEI case study in detail, linking survey findings to the literature on a finding-by-finding basis. In Chapter 5, these findings are 'passed through' an interpretive lens of the conceptual framework developed in Chapter 2, to answer the primary research question, thereby completing an integrated study of adoption behaviour. Before examining the case study in detail, the general literature related to community-based solar energy initiatives will be reviewed.

2 Literature Review

2.1 Introduction

The literature used to guide and inform this thesis was drawn from a broad range of sources. Academic journal articles constitute the largest portion of reviewed literature, with other sources providing additional context. For example, perspectives gained through informal observation[19] and experiential learning have guided the discussion of community, as a real, lived, web of social interactions through which people derive meaning and identity.

This chapter is organized around five general topics, beginning with a discussion of philosophical bases for this research of solar energy adoption in a community context. Community-based social marketing (CBSM) is the second topic reviewed, including five models of attitude-behaviour that inform the design of CBSM campaigns[20]. The review of CBSM-related literature concludes by situating CBSM with respect to other approaches to ecological reform, such as industrial ecology and strong precaution. Thirdly, diffusion of innovations (DoI) theory is reviewed for insight into motivations and barriers to residential solar energy adoption, both generally and in a community context. The review focuses on perceived attributes of solar energy systems (e.g. relative advantage, risk, etc.), as a basis interpreting survey finding on perceived motivations and barriers to solar energy adoption (Chapter 5). Fourthly, a brief review of integrated research is then offered to relate the integrated approach of this research to others in the energy and environment literature. Discussion of relevant Ontario government policy follows (fifth topic). The chapter concludes by drawing ideas from the literature to form a conceptual framework for analysis.

2.2 Philosophical Paradigm

Philosophical categories provided by Flowerdew and Martin (2005) are used to explain the study's paradigmatic basis. Situating this research with respect to philosophical paradigms is regarded as important to establish relevance and validity. Bias due to researcher subjectivity may be reduced to some degree by developing a sense of reflexivity[21], e.g. awareness of the

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[19] The participant observation carried out in this study is similar to that of Whyte (1955), who is reported to have supplemented "extremely informal participant observation with several methods of relatively structured data collection" (Jackson, 1983: 41).

[20] For the purposes of this research, community-based solar energy initiatives (CSEIs) are seen as a particular kind of CBSM, and the case study—the West Toronto Initiative for Solar Energy (WISE)—a notable instance.

[21] described in Steier (1991:2) as "a turning-back of one's experience upon oneself"

researcher's place relative to the research topic. In particular, vested interests might result from a researcher being "embedded" in a narrow subculture, and/or having economic ties with one industry or another.

Flowerdew and Martin provide three pairs of contrasting philosophies: naturalism and anti-naturalism, realism and anti-realism, positivism and postmodernism. They also present three social theories, Marxism, feminism, and humanism, and discuss social structures and human agency. Borrowing from these concepts, a philosophical approach to this research is described, beginning with the observation that when engaged in social science, a researcher is studying a natural system that, were it not for the subjectivity of the researcher, might be described objectively. Ontological reality exists, but we can never know it (von Glasersfeld, 1991 cited in Pelham, 1999). Put another way, a social scientist is like a physicist trying to describe a system in motion without a stationary point of reference. This view of the relationship between a researcher and zer[22] research subject is considered to reside in a postmodern paradigm.

The study assumes that while social systems may be incomprehensibly complex as a whole, they contain smaller, simpler, relationships that can be modeled accurately, given certain conditions.[23] It assumes that these smaller relationships can be identified and manipulated to produce useful and practical results. Hence, the research is congruent with utilitarianism and pragmatism.

The degree to which a social scientist is able to take a naturalist, or objective, view of their research topic, is limited by the degree to which they are a part of the system they are studying (Bhaskar, 1978). There may be a trade-off between the amount of knowledge a researcher has about a social system, and that researcher's ability to look at that system objectively. For example, a researcher might be better able to objectively study members of another social group rather than members of their own group. However, increased knowledge of one's own group may allow a researcher to design more useful research about their own group, subjective though it may be.

[22] gender-neutral pronoun

[23] This stated assumption that it may be possible to model and manipulate social systems despite complexity is meant as a justification for attempting the research (say, as opposed to giving up in the face of apparently overwhelming complexity). This research does not try to isolate a simple problem from a complex context, but rather acknowledges that certain conditions are required for a model of a social system to bear any semblance to reality. The research presented in this thesis may have utility for manipulating like systems; however, complexity might foil such efforts (e.g., due to unknown unknowns).

This research distinguishes between objective and subjective perspectives, most directly, by employing two research methods: an objective measure of electricity performance in kWh, and a survey of homeowners' (subjective) perceptions. It has been argued that the degree to which a given innovation possesses a particular attribute should be measured from the point of view of the potential acceptor or rejector of that innovation (Fliegel and Kivlin 1966 citing Rogers 1961). A solar energy system, for example, may objectively yield certain environmental and technical advantages. However, unless the homeowner can perceive such an advantage, the objective difference alone may have little effect on adoption.

Finally, this research takes a humanist approach in its efforts to effect social change for the benefit of human beings in general, rather than strictly provincial or national (i.e., territorial) interests. Entrikin (1976) describes humanist geography as emphasizing meaning, values, goals and purposes. The present study is considered to take a humanist perspective, given its emphasis on human perceptions and motivations. The research topic, CSEI, is an approach to electricity supply procurement that departs from the existing modernist, mega-industrialist paradigm.

In summary, this research is utilitarian, pragmatist, and humanist. This research is limited in its ability to take an objective view of the topic because the researcher is embedded in a sub-culture of community-based solar energy proponents. However, this embeddedness has allowed the researcher to develop a mastery of the topic--solar energy adoption within CSEIs. This research also recognizes the importance of both subjective and objective factors in solar energy system adoption.

2.3 Community-based Environmental Interventions

2.3.1 Introduction

The literature provides a basis for understanding how models of attitude and behaviour, when applied to addressing real environmental challenges, have led to certain general principles in the design of environmental initiatives (Maibach, 1993; McKenzie-Mohr, 2000; Rolls, 2001; Wilson et al, 2007). Barriers to adoption of solar energy systems at the residential level can be categorized into two groups: technical and non-technical (e.g. social/psychological/regulatory). Certainly there is overlap between the two, and consideration of socio-technical[24] aspects of adoption is critical in assessing any environmental initiative. This section reviews literature relevant to community-based approaches to environmental behaviour change.

[24] Considering interactions between social and technical aspects of energy systems is one type of integration in this study. The integrated nature of this study is further explained in Section 2.8.

2.3.2 Effecting environmental behaviour change with CBSM

This review draws in part from the human geography literature, specifically strategies for effecting behavior change. The most pervasive of these within the literature reviewed is community-based social marketing (CBSM). CBSM draws on research in social psychology that suggests initiatives to promote behavior change are often most effective when they are carried out at the community level and involve direct contact with people (McKenzie-Mohr, 2010). For over 50 years, scholars have repeatedly noted the influence of interpersonal persuasion in behavior change (Valente and Davis, 1999). This interpersonal influence is sometimes aided by mass media and other communication strategies and is sometimes independent of them. Valente and Davis (1999) note that the "power of interpersonal influence had not been systematically incorporated in scientific studies of behavioral promotion and diffusion" (p. 64). CBSM is used to guide intervention programs attempting to apply a structured approach and the insights of social psychology to changing community behaviour in a socially desirable direction (Rolls, 2001).

One of the foundation papers within CBSM literature is *Fostering Sustainable Behaviour Through Community-Based Social Marketing*, by Douglas McKenzie-Mohr. McKenzie-Mohr's work emphasizes applications of CBSM to energy and water efficiency and conservation, promoting products with recycled content, and other interventions in environmental behaviour change. By virtue of CBSM's basis in social psychology and environmental behaviour change, there is a large body of literature that is helpful in understanding how to design and implement an environmental intervention.[25]

The literature presents CBSM as an "umbrella" strategy for understanding the relationship between attitude and behaviour, and how to leverage the former to change the latter. This means that CBSM encompasses the application of psychological knowledge to behaviour change, and so CBSM is as reliable as the psychology that it incorporates. The next section reviews models and theories of human behaviour as a basis for understanding solar energy adoption within CSEIs.

2.3.3 Attitude-Behaviour Models

Hirschman (1980) reports that throughout the 1970s, much of the consumer behaviour literature was dominated by the attitude- and attribute-centered[26] research tradition (e.g., Bettman, 1970; Bruno and Wildt, 1975; Holbrook, 1978). This led to a "vast array of empirical

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[25] Wilson and Dowlatabadi (2007) define an intervention as any regulation, policy, program, measure, activity, or event that aims to influence behavior.
[26] Please see section 2.6.3 for review of literature on innovation and adopter attributes.

findings, models, conjectures and to efforts of middle-range theorization (Hirschman, 1980). Robinson (2007) offers four such models for conceptualizing the relationship between attitude and behaviour: rational-economic, cognitive dissonance, the theory of planned behaviour (TPB), and the norm-activation model. The principal-agent model is included as well as it is relevant to the discussion of implementing renewable energy policy in Ontario. Robinson's paragraph descriptions of each model have been converted to the following table, and an additional column added to relate each model to the present research topic:

Table 1 - Models of human behaviour

Model	Description	Research Implications
Rational-economic	Individuals systematically evaluate alternative choices, such as the purchase a solar energy system vs. electricity from a green retailer (e.g. Bullfrog Power), and then act in accord with their economic self-interest	This model suggests that to influence energy purchase decisions it is only necessary to provide consumers with information on the financial and performance advantages of alternative systems
Cognitive dissonance	Individuals holding two cognitions that are inconsistent with one another will experience the pressure of an aversive motivational state called cognitive dissonance. The individual often seeks to remove this pressure by altering one of the two "dissonant" cognitions (Bem, 1967)	This model suggests that individuals concerned about negative environmental impacts while cognizant of their own contribution to these impacts, may seek to resolve a cognitive dissonance by changing their perceived personal environmental impact
Theory of Planned Behaviour	Intentions to perform behaviors can be predicted from attitudes toward the behavior, subjective norms, and perceived behavioral control (Ajzen, 1991)	This model suggests that through knowledge of an individual's attitudes, it may be possible to classify that individual within one of Rogers' five adopter categories
Norm-activation	Moral norms influence behaviour only when individuals believe that certain actions have consequences for another's well-being (i.e., awareness of consequences) and when individuals accept responsibility for producing those actions, i.e., ascription of responsibility (Joireman et al, 2001)	This model suggests that if an individual is aware of certain consequences of their environmental impacts on the well-being of other people, and if that individual perceives that they have responsibility, and capacity to improve these impacts, they may change their behaviour
Principal-Agent	A "principal" is often obliged to hire an "agent" with specialized skills or knowledge to perform a task. The central concern is how the principal can best motivate the agent to perform as the principal would prefer, taking into account the difficulties in monitoring the agent's activities (Sappington, 1991)	Renewable energy procurement processes are rife with principal-agent relationships. The voting public may be viewed as a principal, hiring government to do its bidding. Government ministries in turn issue directives to regulators, and so on. The P-A model is useful for understanding employment incentives and efficacy of ministerial directives

Source: adapted and expanded from Robinson, 2007

Behavioural energy studies focus on people and their energy-related decisions (Stern 1992; Lutzenhiser 1993 cited in Parker, Rowlands and Scott 2003). These studies can be further divided between energy economics, in which demand is calculated using income and price elasticities, psychological studies that use surveys to collect attitudinal and behavioural data to explain the inadequacies of economic models of behaviour (Parker, Rowlands and Scott 2003). Anthropology and sociology have also contributed to theories about the mechanisms by which attitude and behaviour change occur (Valente and Davis, 1999). Haas and Schipper (1998) expressed amazement at the persistence of economic studies based on income and price elasticities despite the demonstrated importance of technology (Parker, Rowlands and Scott, 2003). Hirschman (1980-1981), Solomon (1983) and others responded to Rogers' critique of conceptual biases in behaviour research by considering social meaning (semiotics) as well as technological attributes. Energy-related decisions are influenced by information, attitudes, social values, capacity and incentives to act, as well as by barriers that prevent or restrict actions to improve energy efficiency (Stern and Aronson 1984; Geller 1992; Stern 1992; Scott, Parker and Rowlands 2001; Brown 2003).

Having explained the philosophical foundations of this research, introduced CBSM and reviewed relevant models of human behaviour, the next section situates CSEIs with respect to other approaches to ecological reform.

2.3.4 CSEI as a form of community-based environmental intervention

In his article, *Towards Participatory Ecological Design of Technological Systems* (2004), Jeff Howard takes a high-level view of approaches to environmental intervention. He situates interventions along a continuum from "technocratic" to "ambivalent" through to "strong democratic" (p.5). Interventions are evaluated according to the degree to which they serve industry or public interests, with CBSM falling in between industrial ecology on the technocratic end of the spectrum and strong precaution on the democratic end. (CBSM is reviewed as an approach to overcoming barriers to ecological reform in Section 2.5.2.)

Figure 1 - Howard's spectrum of approaches to ecological reform

While Howard's continuum is useful for conceptualizing how CBSM relates to other approaches to ecological reform, it creates an artificial separation between the interests of industry, represented by managerial and technical elites, and laypeople, or the general public. Strong precaution is viewed to subvert the basic assumption that social good depends on economic growth, which Howard calls productivism and industrialism; along with two further assumptions, that "central institutions are uniquely capable of guiding this growth (managerialism); and, that science constitutes an objective foundation for both (scientism)" (p. 5). Ignored in Howard's analysis of the conflict between strong precaution and industrialism, are the managerial and technical elites who, being members of the public and sharing concern over protection of public interests, have removed themselves from traditional industrial institutions and are applying their managerial and technical expertise to create new economic opportunities aligned with environmental protection. Further, Howard's analysis overlooks economic growth that is not premised on material resource inputs. Costanza (1997) identifies opportunities for economic growth that monetize ecological services. Even the term "industry", which has become strongly associated with processing of raw materials, should perhaps not be pigeonholed. Certain industries require comparatively little material throughput, (e.g. production of news, entertainment, music, literature, dance, art or other cultural industries) to convert their inputs into a valued good or service.

Many advocates see community energy as a major step towards a more environmentally benign electricity system (Hoffman and High-Pippert, 2005). Paul Fenn (1999), author of the Massachusetts "community choice" legislation, for instance, has suggested that local control is the sole means of making the switch to the clean and reliable forms of energy required to solve the nation's energy dilemma" (quoted in St. Denis and Parker, 2008:2). Community-based energy initiatives might be expected to play a marginal role if promoted exclusively by a small cadre of advocates. Fortunately, the appetite for developing local renewable energy projects can be seen in communities across Ontario (Hamilton, 2010), and even more so abroad.[27]

Agrawal and Gibson (2004) cite research championing the role of community in bringing about decentralization, meaningful participation, cultural autonomy and conservation (Chambers and McBeth, 1992; Chitere, 1994; Etzioni, 1996). Portney and Berry (2007) find that "Americans yearn for more community, for a greater sense of connectedness to those around them" but go on to illustrate ways in which community involvement has declined in the U.S. in recent decades. Despite positive associations with the idea of community, and a desire for more of it,

[27] "Nearly 40 percent of the 22,000 MW of German wind capacity at the end of 2007, or 8,000 MW, is Bürger-owned, while another 10 percent, or 2000 MW, is owned directly by farmers." In contrast, less than 2 percent of the wind generating capacity in the United States is locally owned, and nearly all of that is in one state, Minnesota. (Gipe, 2009:107)

North Americans may lack the practical understanding of how to build community in their own neighbourhoods and cities. How then is this term "community" understood as a term for real, complex forms of social interaction and organization? Within community energy management (CEM) literature, the word "community" is used to delineate the level at which "energy management" occurs, i.e., not at a state, or individual level, but somewhere in between. So, "community" in this sense is an indicator of scale. Offering an alternative perspective, Etzioni (1996) proposes that community can be defined with reasonable precision via two characteristics: (1) A community entails a web of affect-laden relations among a group of individuals, relations that often crisscross and reinforce one another (rather than merely one-on-one relations or chains of individual relations); and, (2) community requires a commitment to a set of shared values, norms, and meanings, and a shared history and identity--in short, a shared culture." Etzioni (1996) continues, "communities are not only aggregates of persons acting as free agents, but also collectives that have identities and purposes of their own and can act as a unit. In effect, these very communities often drive history and set the contexts for individual actions in society" (p. 5). Etzioni's characterization of community as a web of human relations capable of "driving history" seems aptly applicable to forms of social organization currently active in Ontario's renewable energy sector.

There are newer approaches that attempt to improve on CBSM, such as the Precede-Proceed model. Green (1999) lists some of the main principles of Precede-Proceed:

- education is dependent on voluntary participation
- the behaviour-change process must allow personal determination of behavioral practices
- the degree of change in knowledge and health practice is directly related to the degree of active participation
- attention is given to outcomes before inputs. This forces intervention planners to work backwards from desired outcomes to causal inputs

Green (1997:1) describes the Precede-Proceed model as "multidimensional, founded in the social/behavioral sciences, epidemiology, administration and education". Given the plurality of fields in which the Precede-Proceed model was developed, it is applicable in a wide variety of settings, including environmental education (Green, 1997).

CBSM and its derivatives are relatively recent arrivals to the academic discussion of behaviour change.[28] CBSM in particular as a marketing approach builds on older and more established

[28] Several titles were found with the keywords "community-based" and "social marketing" in literature from the 1990s. However, McKenzie-Mohr (1999) contains the oldest title reference to "community-based social marketing" retrievable through Google Scholar.

theories of how and why new behaviours, products and ideas are adopted within the population at large. Central among these is the theory of diffusion of innovations.

2.4 Diffusion of Innovations Theory

Initially developed in the 1940s and 1950s using research in rural sociology, diffusion theory has become a mainstay in the social sciences for explaining how, why, and at what rate innovations are adopted, not only in Western societies, but other cultures as well (Rogers, 1976). Rogers (1983:11) defines an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 11). In the present study, solar energy systems are regarded as the innovation of interest, and CBSM a means by which barriers to adoption are removed, reduced and/or overcome. This section provides an in-depth review of diffusion theory, including temporal development, critiques, and applications to the present study of CSEI.[29]

Four central components of diffusion theory were identified from the literature reviewed.

1. The theoretical existence of five empirically-validated adopter categories based on when, in relation to other market actors, they decide to adopt: innovator (first 2.5% of the population), early adopter (next 13.5%), early majority (next 34%), late majority (next 34%), laggards (last 16%). These are used to categorize any market[30] actor (e.g. individual or firm) that has either already adopted or has the potential to adopt in future.
2. Correlates of adoption: attributes or characteristics of market actors that are correlated with membership in one of the five adopter categories. Attributes such as personality traits, attitudes and behaviours have been used to predict and explain adoption behaviour.
3. Six broad non-mutually exclusive innovation attributes: relative advantage, perceived risk, complexity, compatibility, trialability, and observability. Four additional attributes are less common in the literature: efficiency, communicability, continuity as well as symbolic attributes.
4. A hypothesized stepwise process each adopter passes through:
   Information -> Persuasion -> Decision -> Implementation -> Confirmation

[29] The article *New Product Adoption and Diffusion* (Rogers, 1976) provides a succinct overview of DoI and its applications.
[30] Market is used in the broad sense championed by Bagozzi (1979), Hirschman (1983), and others that expanded the marketing concept "from the realm of economically based exchanges between producers and consumers to resource exchanges between two or more social entities" (Hirschman, 1983: 45).

2.4.1 Developing a conceptual framework using diffusion theory

After reviewing literature in the areas of both innovation attributes and adopter attributes, it was decided to organize the discussion of residential solar energy adoption on the basis of perceived innovation attributes. Two justifications are offered for this format. Firstly, as will be shown, literature seeking to establish correlates of "innovativeness" has produced ambiguous and contradictory findings, indicating that there may be a fundamental ontological error, or at least methodological inconsistencies, in the body of research premised on "innovativeness" as a characteristic of responding units in an adoption cycle. Secondly, since the research topic concerns solar energy adopters' perceptions, this review of diffusion theory places greater emphasis on perceptions of attributes rather than actual attributes (of solar energy systems and of the WISE). Thirdly, since levels of residential solar energy adoption in Ontario at the time of this study situate the market within an "innovator" stage,[31] it was regarded as premature to profile adopters based on theoretical differences between Rogers' five categories. All purchasers in this study are regarded as innovators. Whether non-purchasers are innovators or early adopters is discussed further in Chapter 4.[32] Barriers to majority adoption are discussed in the context of the nine types of innovation attributes identified above.

As most of the reviewed literature concerns product adoption, it was decided that to maintain consistency the present study would treat residential solar energy systems as the innovation and the community initiative as a means of accelerating adoption. However, it should be noted that the initiative itself could be considered a social innovation, defined by Mulgan et al. (2006) as "new ideas that work to meet pressing unmet needs", and compared with other community-based energy projects such as those reported by Jaccard et al. 1997; Murray, 2006; Parker, Rowlands and Scott, 2003; St. Denis and Parker, 2009.

[31] According to diffusion theory, an innovation is typically considered to be at an innovator stage of development until it surpasses 2.5 percent of eligible adopters, at which point it reaches the early adopter market. Assuming that solar energy systems can be installed on 20 percent of the 4,555,025 private households in Ontario (which includes multiunit residential dwellings) the 22,000 applications made to the OPA MicroFIT program would represent 2.4 percent of the market (Ministry of Finance, 2006; Andersen, 2010).

[32] Purchasers certainly belong to the innovator category. It is less clear which adopter category non-purchasers belong to. The non-purchasers possess characteristics of early adopters, early majority, and what Faiers and Neame call the 'pragmatic majority', (which is roughly analogous to the union of Rogers' 'early majority' and 'late majority'). Therefore, since they haven't adopted yet, and seem to possess traits spanning two adopter categories, we cannot conclude that non-purchasers belong to the innovator category.

Before moving on to review the innovation attribute categories identified from the literature, an explanation is offered for emphasizing perceived innovation attributes over actual attributes. Until the late 1960s, most diffusion studies in which attributes of innovations had been considered tended to minimize the subjective element (Fliegel and Kivlin, 1966). Recognizing that perception plays some role in adoption, many diffusion and marketing studies through the intervening decades have sought to understand relationships between actual and perceived attributes, as well as the role of communication in shaping perceptions. Faiers and Neame (2006) argue that understanding consumers' attitudes towards an innovative product provides two key benefits. First, strengths and weaknesses in the innovation attributes can be identified and managed effectively (Hsu et al.,2000). Second, more control can be imposed on the marketing strategy in order that the innovation is made attractive to the most receptive audience (Auty and Elliott, 1998).

The present research assesses both perceived and actual attributes for solar energy systems, by means of 1) a survey of homeowner perceptions, and 2) a quantitative study measuring household energy consumption, and production as well in the case of PV adopter households. The study of homeowner perceptions can be seen as oriented from the perspective of CSEI participants, and is an instrument for gathering subjective information. As such, it is recognized that stated opinions and intentions do not always translate into actual behaviour (Faiers and Neame, 2006). The electricity performance study is an objective assessment of energy performance. Both units of analysis, the community project and solar energy systems, have qualitative and quantitative attributes. However, since the survey instrument provides most of the insights about the attributes identified from the literature, and these insights are subjective, it follows that the literature review will emphasize perceived attributes over actual attributes.

PERCEIVED ATTRIBUTES OF INNOVATIONS

"Rogers (1961) listed five characteristics of innovations: relative advantage, compatibility, complexity, divisibility (trialability), and communicability (observability). Fliegel and Kivlin (1966) expanded this list to include characteristics such as financial cost, social cost, return [on] investment, risk associated with the product, and efficiency of the product in terms of (1) time saving and (2) avoidance of discomfort." (Dickerson and Gentry, 1983: 225), as well as one attribute not present in the other literature reviewed: divisibility for trial. Robertson (1971) and Rogers and Shoemaker (1971) found that the adoption process is positively related to the product's relative advantage, compatibility, divisibility (e.g. for trial), and communicability, and negatively related to its complexity and its cost (Dickerson and Gentry, 1983). These findings were supported by Ostlund (1974) who further reported a negative correlation with perceived risk. Robertson (1971) characterized innovations as "continuous", "dynamically continuous" and "discontinuous", depending on how they affect behaviour. This classification was applied by Moore and Johnson (1998) to describe the diffusion of Internet technologies, and by Egmond, Jonkers and Kok (2005-2006) in studies of energy conservation. In an analysis of attributes of medical innovations Menzel (1960) used the designations, "communicability", "risk", "pervasive in consequences", and "recency of origin". Hirschman (1981) described another dimension along which innovations are generated, symbolic as well as technological. A symbolic innovation is one that communicates a different social meaning than it did previously.

Having introduced the main categories of innovation attributes identified from the diffusion literature,[33] each is now discussed according to a framework based on the following two[34] broad attribute categories: relative advantage and communicability. Relative advantage is considered to depend on nine non-mutually exclusive subcategories. At the end of this chapter, these attributes are organized into an analysis framework for the CSEI case study (p. 66).

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[33] While other innovation attributes were identified, these were found to be the most common in the literature reviewed, with the exception of "efficiency" and "communicability". The rationale for including communicability is offered below in the discussion of this attribute.

[34] While the framework includes twelve subject headings, only ten of them are attributes, i.e., all except "communication" and "networks".

*Note that the attribute "communicability" arguably depends on the three attributes, "trialability", "complexity", and "observability". These attributes might have been treated as subcategories of "communicability" instead of "relative advantage".

RELATIVE ADVANTAGE

Diffusion theory has been used to identify attitudes towards system attributes, and isolate the characteristics that are preventing what some authors have called "a pragmatic 'early majority' from adopting the technology" (Faiers and Neame, 2006: 1797). Using previous adoption behavior to segment respondents into adopter categories: 'early adopters' and 'early majority' adopters, Faiers and Neame found that "although the early majority demonstrate a positive perception of the environmental characteristics of solar power, its financial, economic and aesthetic characteristics are limiting adoption" (p. 1797). Rational-economic model of behaviour may therefore be useful for explaining non-adoption by the majority. LaBay and Kinnear (1981) and Jacobsson and Johnson (2000) reported similar findings. Faiers and Neame observe that if consumers cannot identify the relative advantage of solar power over their current sources of power, which is supplied readily and cheaply through a mains system, it is unlikely that adoption will follow. Based on similar analyses, many studies have concluded that the barriers to the adoption of domestic solar systems lie primarily with the financial aspects of the systems. However, an alternative conclusion is that improving the aesthetics could also increase adoption. Until the mid-1960s, most diffusion studies minimized "the subjective element" (Fliegel and Kivlin, 1966: 239). It is well known that qualitative associations have a major influence on the purchase of consumer goods. Perhaps this fact is often overlooked in the literature due to an implicit assumption that because solar energy systems produce energy, they should be studied in a like manner to other energy technologies (e.g. coal power plants or power systems), rather than as a consumer good, symbolic innovation. This research underscores that residential solar energy systems, namely PV systems, are qualitatively different in some important ways from all forms of energy generation that move, make noise, and depend on the electricity grid. As a source of electricity, they are modular, passive and benign. Entrepreneurs who grasp this subtlety and develop applications of solar energy technology that fully utilize even a few of these qualitative attributes are expected to continue to occupy profitable segments of the market.[35] Faiers and Neame (2006) generally acknowledge this potential, observing that "with product development, the economic, operational and aesthetic aspects could be improved and by utilising sensible marketing strategies that spread awareness of the innovation and improve its observability, the potential for solar power is greatly enhanced". They conclude that in order for widespread adoption to occur, it appears critical that the ''early majority'' have a positive attitude to solar energy systems. This can occur in one of three ways, or via a combination of the three:

(1) changing qualitative attributes of solar energy systems to enhance appeal to majority adopters, e.g. aesthetics

[35] See the case of Carmanah Technologies described by Cohen, 2006.

(2) changing values of majority adopters in the direction of those held by Green Early Adopters (for instance, as appears to have occurred in 2006-2007 with "environment" polling higher than "health care" as the issue of greatest importance to Canadians)

(3) changing the financial proposition of solar energy systems

CSEIs, by vesting local communities with control over procurement of solar energy systems, reorient technological development in a direction congruent with the values of these communities. Hence they offer a mechanism for effecting changes of type one and two. This is further argued in the section "communicability". With respect to the third issue, CSEIs offer their participants discount (~10 percent) over market prices. Also, since government subsidies must be acceptable to the voting public, and CSEIs can help to improve public perception of solar technology's relative advantage, CSEIs can indirectly support financial incentives solar energy systems. If early majority adopters have developed a positive assessment of an innovation's environmental attributes in the absence of adequate subsidy, and then a subsidy is announced, they may decide to adopt. This appears to have been the case with successive rounds of residential solar energy adoption in Ontario:

Table 2 - Successive waves of residential solar energy adoption in Ontario

Wave	Year	Incentives announced
Solar Pioneers	1999	net metering, tax rebate
RISE	2006	RESOP, tax rebate
WISE/Our Power	2007	RESOP, tax rebate
MicroFIT adopters	2009	MicroFIT, tax rebate, capital cost allowance

Sources: personal knowledge; Revenue Canada, 2010

RISK AND UNCERTAINTY

Perceptions of risk among residential solar energy adopters are roughly divisible into two distinct scale categories. The first category has to do with immediate personal risk related to the system's performance, i.e., performance-related risk, financial risk, and social risk. The second category includes risks of non-adoption on a scale sufficiently large to reduce reliance on conventional energy sources, such as enriched uranium and hydrocarbon fuels. These categories of risk will be referred to as "personal" and "societal" based on the scale to which they pertain. They both relate to potential loss.

The first type of identified risk will be assessed on the basis of respondent feedback about their adoption experience. Based on standard product warranties[36] earlier, solar PV equipment is very reliable for the first 20-25 years of operation in the case of panels, 5-10 years for inverters, and 2-5 years for mechanical trackers. At the time of this study, at least one tracker manufacturer/installer was offering a 20-year parts and labour warranty to Ontario customers (personal communication, GSL Group, 2010).

As the warranty information would suggest, there is a large body of literature showing that operation and maintenance costs of PV systems are minimal relative to other generation technologies (Wohlgemuth, 2002). However, system performance is highly dependent on proper system design and siting. Roof penetrations and other changes to a home that result from system installation need not pose a risk to homeowners if the installation is carried out by a professional, certified contractor. The appointment of a bid review committee that includes technical experts is one means by which CSEIs have sought to ensure technical competence. Reliability of solar thermal systems is a much more complex issue, as reliability varies significantly depending on manufacturer, installer, and site conditions. While other studies have used electricity monitoring and social surveys (Keirstead, 2007) to assess household PV system performance, this study appears to be the first (based on literature reviewed) to use both methods with members of the same respondent group.

The category of societal-scale risk can be approached from a number of perspectives: ecological risk, economic risk, political risk, etc. The potential losses in each area range in severity from moderate, (e.g. lower air quality), to extreme, including human loss of life on the scale of tens of millions (IPCC, 2007). Biodiversity loss, sea level rise, increased frequency of droughts and extreme weather events, mass migration, population resettlement, climate change impacts on infrastructure projects e.g. hydropower potential, are some of the most serious risks associated with anthropogenic climate change (IPCC, 2007).

Another societal risk of large-scale non-adoption of solar energy is continuing dependence on nuclear power, which entails both quantifiable and unquantifiable environmental and economic risks. Risk of containment breach or "meltdown" has been estimated using probabilistic risk analyses (PRAs). PRAs attempt to quantify risks from "man-made and natural activities" by estimating frequencies and consequences of various accidents that can occur (Vesely and Rasmuson, 1984).

[36] On the basis of warranties that are currently offered for PV system components, the equipment is highly reliable and requires little maintenance (Enphase, 2010, Kyocera, 2010; Sharp 2010, Schneider Electric, 2009).

Broadening the scope of energy system design to account for complex socio-technical relationships is argued to be necessary to properly compare solar energy technologies to their incumbent competitors, including nuclear reactors[37]. The relative advantage of solar energy technologies relative to nuclear power plants will be examined through the survey in this study.

COST ATTRIBUTES

The costs of adopting a new idea and putting it into operation have frequently been mentioned as obstacles to rapid adoption, usually with at least an implicit "other things being equal" assumption involved in the discussion (Fliegel and Kivlin, 1966). High initial capital cost has often been reported as a barrier to adoption of solar energy systems (Parker, 2008). However, Fliegel and Kivlin offer an interesting exception to this pattern. In a study of Iowa farmers, it was concluded that initial cost involved in adopting an innovation was *not* a deterrent to rapid adoption. “Respondents of the type dealt with here are apparently willing to adopt relatively expensive innovations, probably as part of a general emphasis on expansion of enterprises and the substitution of capital for labour” (p. 242). Hence, among a certain adopter group, in this case farmers, initial cost appears not to be an important barrier. In the present study, attention will be given to different types of cost attributes, e.g. initial capital cost vs. return on investment, and the degree to which these constitute a barrier to solar energy adopters vs. non-adopters.

Fliegel and Kivlin support the hypothesis that some adopter groups are more motivated by a large financial return than a short payback period. “The farm operators studied here are apparently quite willing to make investments and wait for those investments to bear fruit. … The straightforward economic argument, that magnitude of financial reward is an important factor in achieving rapid acceptance of new ideas, receives considerable support from these findings” (p. 244). This points to an interesting possible interaction between the magnitude and rate of return, initial capital cost, and risk, which is discussed below.

Note on the relationship between cost and risk

Potential adopters who are comfortable with debt financing, such as farmers, might be more likely to adopt solar energy under the Feed-in Tariff program than other segments of the population. A similar comfort with large capital expenditures, large mortgages, etc. could help explain why households with higher income levels are typically more likely to adopt a solar energy system than lower-income households (LaBay and Kinnear, 1981; Faiers and Neame, 2006).

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[37] Nuclear technologies considered in this literature review are limited to those currently in commercial operation, namely uranium-based technologies.

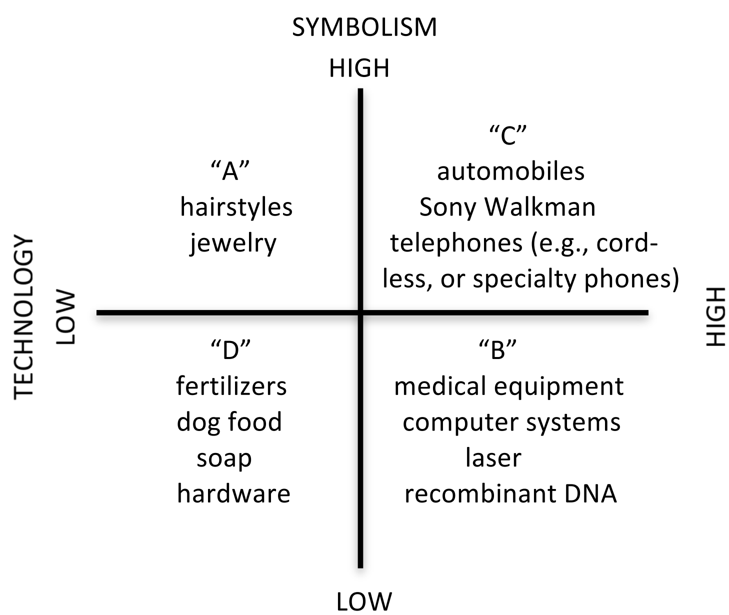
TRIALABILITY

Rogers (1995) defines trialability as the degree to which an innovation may be experimented with on a limited basis. Innovations that can be experienced in a low-commitment, low-risk context, prior to adoption have been theorized to diffuse more rapidly (Dickerson and Gentry, 1983). Fliegel and Kivlin (1966) specify a set of innovation attributes--including one not present in other reviewed literature: divisibility for trial--and explore the extent to which these attributes can be used to explain differences in adoption rate.

Social cost

Consideration was also given to a different type of cost attribute--social cost--or more precisely, a loss of social capital as a result of negative peer assessments of adoption decisions. Considerations of loss in social standing were found in early diffusion literature. Fliegel and Kivlin (1966) decided that the risk of being criticized by friends and neighbors for adopting innovations would not be of major importance. However, their mention of social cost is in the context of Barnett's (1941) finding that "accepters of cultural innovations are…preeminently…the disgruntled, the maladjusted, the frustrated, or the incompetent" (p. 171). Hirschman (1981) developed the idea of social cost in describing a dimension (symbolic or technological) along which innovations are generated. Hirschman coined the concept of a symbolic innovation to delineate innovations of a social/cultural nature from those in the technological realm. Hirschman categorized products along these dimensions, as shown in Figure 2.

Figure 2 - Categorization of Products on the Symbolism/Technology Dimensions



Source: Hirschman, 1981

A symbolic innovation is one that communicates a different social meaning than it did previously. A technological innovation is one which possesses some tangible features never before found in that product class. This definition from Dickerson and Gentry (1983) matter-of-factly positions symbolic innovations alongside technological innovations, with the apparent implication that they are equally worthy of study. Yet, much of the literature on diffusion of innovations, as well as solar energy systems, focuses on technology rather than symbolism. Perhaps the conceptualizing of solar energy systems as a technological innovation has obscured some of their potential for being recognized by researchers, and even by private sector actors, as a symbolic innovation. Marketing solar energy systems on the basis of energy security benefits could represent a symbolic innovation if the technology changed from being one associated mainly with environmental attributes (as documented by Faiers and Neame, 2006) to one of energy independence.

Referring again to Hirschman's two-dimensional categorization, residential solar energy systems belong in the upper right quadrant with other highly technological, highly symbolic innovations. As such, solar energy systems present a challenge to marketers trying to identify would-be adopters in a "consumer" goods market. PV systems present what could be described as a kind of marketing paradox. They share some attributes with established big-ticket consumer goods (e.g. marble counter tops or cars), and some attributes with long-term financial investments . At the same time, they differ in several important ways from any other household purchase. This uniqueness and the related difficulty of marketing a solar energy system in the same way as more established goods or services is motivation for considering the influence of perceived complexity on adoption.

COMPLEXITY

Complexity has been considered as a restrictive factor in adoption, and describes how difficult it is to understand either the innovation, or its principles (Kai-ming Au and Enderwick, 1999; Rogers, 1995 via Faiers and Neame, 2006). Dickerson and Gentry (1983) supported Hirschman (1980) in the finding that the probability that a novel product will be adopted is inversely related to the amount of cognitive effort that must be expended by a consumer to comprehend it as a concept. The perception of complexity as a barrier has been found to be inversely related to education level (LaBay and Kinnear, 1981).

An innovation's complexity should be taken into account in choosing communication modes. For instance, more complex innovations have been found to require periodic follow-up to ensure they are being used correctly (Valente and Davis, 1999). For simpler innovations, a one-time information or training session may be adequate. Addressing complexity as a barrier to adoption was one of the main goals of CSEIs.[38] By connecting innovative potential adopters with each other and with technical and environmental experts, a forum was provided within which the complex nature of solar energy adoption could be addressed. Further discussion of complexity as it relates to communication and Hirschman's concept of "consumer creativity" is offered below in the section on communicability.

EFFICIENCY

Efficiency is not frequently referred to in the diffusion literature. In fact, Fliegel and Kivlin (1966) are the only authors found to mention efficiency, in the context of economic implications of saving time. By comparison, the adoption of a solar energy system does not save time, and in fact may cause some inconvenience.

Efficiency, in the sense of energy conversion, also has some bearing on perception of solar energy technologies vis-à-vis other forms of generation. This issue of perceived efficiency may help explain non-adoption by those who may be waiting for solar panel efficiency to be improved.[39]

COMPATIBILITY

Compatibility has been defined variously within the diffusion literature (Dickerson and Gentry, 1983; Faiers, Neame and Cook, 2007; Fliegel and Kivlin, 1966; LaBay and Kinnear, 2006; Ostlund, 1974). Most definitions relate the concept to similarity and difference between an innovation's perceived attributes and those desired by potential adopters. Studies of

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[38] A disclaimer from a sign-up sheet for the CSEI case study states, "The West Toronto Initiative for Solar Energy (WISE) was formed to encourage the spread of solar energy technology and to *simplify homeowner access to the technology*" (emphasis added).

[39] Solar panels are qualitatively different from any form of energy technology that relies on metered fuel. When the fuel source is free, abundant, and ubiquitous, efficiency is not so great a concern as when fuel is scarce. By way of illustration, consider the history of internal combustion engines (ICEs) and their fuel costs. ICEs are typically 16-20 percent efficient in converting stored chemical energy in hydrocarbon fuel to kinetic energy. In the late 1880s through to the 1960s, when gasoline was relatively cheap to produce in North America, there was little interest in replacing ICEs with a more efficient engine technology. However, with gas prices roughly 2-5 times higher today than they were in the 1950s, and pressing concerns about future price increases as well as declining availability, there is renewed interest in replacing ICEs with electric motors.* In summary, when an energy technology's fuel source is cheap, abundant, and easily accessible, conversion efficiencies in the range of 10-20 percent may not be a major barrier to society-wide diffusion.

* The share of the North American car market occupied by electric and hybrid cars, such as the Nissan Leaf, GM Volt, and Toyota Prius, is expected to double between 2010 and 2013 (Edmonds.com, 2011).

compatibility have also accounted for communication mode (Lee, Lee and Schumann, 2002) and the values, experiences, lifestyle, or culture of potential adopters (Faiers, Neame and Cook, 2007; Rogers, 1995). As the present study is considering adoption within a community setting, the compatibility of the innovation, i.e., a solar energy system, within a community of environmental innovators will be emphasized.

Compatibility tends to be positively associated with the rate of adoption (Rogers, 1995). However, in some cases the perceived compatibility of the new idea with previous experience has led the adopters to utilize an innovation incorrectly (Rogers, 1976). This is unlikely to be a problem in the case of solar PV systems, as the equipment operates autonomously of users' behaviour. Solar thermal systems would be expected to be more subject to this problem, as system performance depends on when draw-off occurs (Knudsen, 2002). A frequently identified source of incompatibility with potential adopters is the appearance of solar energy systems (Faiers and Neame, 2006; Lebay and Kinnear, 1981; Margolis and Zuboy, 2006).

While the present study regards compatibility in a subjective context (i.e., perceptions of potential adopters), there are of course many objective compatibility issues that affect adoption. Solar panels are sometimes incompatible with the physical characteristics of a potential adopter's house (orientation, shading, roof shape and condition, size and location of electrical service) (Adachi, 2009; Sherk and Parker, 2010). There are technical challenges of integrating solar energy technology into existing domestic and district-level energy systems (Adachi, 2009; Sherk and Parker, 2008).[40] There are issues of economic incompatibility as well--availability of skilled labour (Margolis and Zuboy, 2006).

Considerations around efforts to establish correlates of "innovativeness"

A great deal of research has been carried out to develop generalizable findings that build on Rogers' five adopter categories. One effort that has attracted particular attention is to establish correlates of "innovativeness", such as particular attitudes, behaviours, and personality traits (Egmond et al., 2005-2006; Ostlund, 1974, others). These studies are premised on assumptions about market participants and the processes that affect their adoption decisions.

Based on a review of diffusion literature spanning 60 years, a progression can be seen in the way diffusion researchers have conceptualized "innovativeness". In 1976, Rogers reported that about 60 percent of DoI studies defined innovativeness as "the degree to which a responding unit is relatively earlier in adopting an innovation than other units in the system" (p. 298).

[40] While such technical challenges would be similar for most households in Toronto, respondent perceptions of such barriers could vary significantly.

Examining the premises of this definition, it is apparent that "innovativeness" is regarded as a parameter of units in some system (presumably the adoption cycle). This parameter is a process-dependent variable, call it X, that takes on a value x_u relative to the adoption times of other responding units. Rogers' notes that this definition "implies the existence of independent variables, which 'lead to' innovativeness, although it is often unstated or uncertain whether this really means that an independent variable causes 'innovativeness'" (p. 295). This terminology is arguably problematic. The labeling of the independent variable in question as "innovativeness" is regarded as problematic because it imposes specific qualitative assumptions that are not inherent to the variable. Note that the variable in question, X, can be more precisely referred to as "relative time of adoption", and as such, is dependent on factors other than those reasonably associated with the word "innovativeness". For instance, in the present study context, where WISE participants are the responding units, X is dependent on a wide variety of factors that bear little relation to innovation. A participant may have gone on vacation shortly after signing up, and hence missed the opportunity to adopt. Furthermore, X is actually dependent on factors external to the responding unit, which may include sales staff effectiveness or weather conditions during the decision-making process. Hence, it is argued that since the variable in question, "relative time of adoption", is dependent on factors both internal and external to the adopter, it should not be labeled with a descriptor that applies specifically to the responding unit, as is the case with "innovativeness". Doing so may lead to research bias or inconsistent results. In cases where primarily external factors are influencing adoption, a study premised on adopter "innovativeness" may have difficulty identifying correlates of adoption.

Having critiqued this issue of terminology, the present study will refer to the variable X with the descriptive handle "relative time of adoption". As the term "innovativeness" has been frequently used in the diffusion literature, it will be discussed below as a theorized attribute of responding units, which is a common interpretation, rather than in the sense critiqued above. The reader is referred to Midgley and Dowling (1978) for an expanded critique of "innovativeness" on the basis of methodological inconsistencies leading to contradictory results, rather than on strictly logical grounds provided above.

Considerations in applying the concept of "innovativeness" to studies of solar energy adopters

A number of diffusion studies have postulated correlates of "innovativeness", which can be useful for predicting adoption behaviour. Further investigation of the literature however, reveals that some such hypothesized predictors[41] are innovation-specific. Studies have found

[41] Predictors include correlates and determinants.

that adopters are younger than non-adopters of the following innovations: bank cards (Adcock et al. 1977); Mazda cars (Feldman and Armstrong 1975); automatic teller machines (Porter, Swerdlow, and Staples 1979); solar energy systems (LaBay and Kinnear 1981); consumer information services (McEwen 1978); and the internet (Atkin et al. 1998). On the other hand, Rogers and Shoemaker (1971) listed more studies that found older consumers more likely to be adopters than studies with the opposite findings. Gilly and Zeithmal (1985) found that elderly consumers were more likely to adopt electronic funds transfers. Taken together, these findings suggest that age as a determinant of adoption is highly innovation- or group-specific.

At least some of the contradictory findings concerning age as a determinant of adoption can be attributed to the nature of the product; one obvious example would be hearing aids. In the case of residential solar energy systems, an adopter must often be old enough to own a house, but also young enough to outlive the system's payback period--2 to 7 years in the case of SHW systems, and 20 to 25 years in the case of PV (Our Power, 2009; Adachi, 2009). These constraints define a residential solar energy adopter to being roughly middle-aged, and hence offer an example of an adopter attribute (age) being determined by attributes of an innovation (compatibility), rather than by an innate trait (e.g. "visionarity", as proposed by Egmond et al., 2005).

The concept of innovativeness has been shown to have some predictive power for categorizing market participants within Rogers' five adopter categories (Egmond, Jonkers and Kok, 2005-2006; Ostlund, 1976). In exploring the question of whether "consumers assess product attributes in a stepwise process", Faiers, Neame and Cook (2007: 3419) describe characteristics associated with particular adopter categories. "'Innovators' and 'early adopters', who are committed to the concept of the innovation will … put up with inconvenience factors to do with product complexity or lack of performance because they are focused on the long-term benefits the innovation may have." Edmond et al. (2005-2006) supports Wiefels (2002) in a dyadic characterization of "early market" vs. "mainstream" adopters. According to this view, the early market and mainstream actors are assumed to have complementary sets of traits. Egmond et al. (2006) were successful in using Rogers' self-designating method to establish determinants of adoption. Specifically, they were able to identify the early majority actors within the mainstream using a variable called "pragmatism". They report that the early market is characterised by a highly visionary attitude. However, it is extremely important to note, lest too broad a generalization be drawn from these findings, that most of the questions used in Egmond et al.'s studies pertain specifically to energy conservation. Therefore, Egmond et al.'s variables "pragmatism" and "visionarity" must be regarded as innovation-specific. In other words, it would be incorrect to conclude that organizations scoring high levels of innovativeness in Egmond et al.'s study of energy conservation would be similarly innovative with respect to other types of innovations. It could be argued that what Egmond et al. have measured under the heading "innovativeness" could more accurately be described as "compatibility with energy conservation behaviours".

Table 3 - Comparison of the early market and mainstream market[42]

Early market: visionaries	Mainstream: pragmatists
Motivated by future opportunities, challenges	Motivated by current problems
Seek revolutionary advances	Seek evolutionary advances
Contrarian	Conformist
Self-referencing	Reference others perceived as similar
Avoid the herd	Stay with the herd
Risk-taking	Risk-averse
Intuitive	Analytic
Seek what is possible	Pursue what is probable
Long term decision horizon	Short term decision horizon
Will seek best technology	Will seek best solution or vendor

Source: adapted by Egmond, Jonkers and Kok (2006: 3117) from Wieffels (2002)

Ostlund (1974) found that personal characteristic variables had little value for predicting adoption behaviour. Specifically, hypothesized characteristics such as "cosmopolitanism", "interest polymorphism", "privilegedness", "social integration", and "general self-confidence in psychosocial matters" as well as the common demographic variable "education" were included and subsequently removed with no significant effects on prediction of adoption behaviour. Social mobility, general self-confidence in problem-solving, and respondent age were all found to have no significant predictive value. Only venturesomeness, measured using "a single self-perception question", and socioeconomic status bore any relationship (positive) to adoption (p. 27).

Sultan and Winer (1993) are reported to have challenged the profile of adopters as proposed by Rogers (1995), arguing that there is inconsistency in behaviour across products; i.e., an 'innovator' for one product may be a 'laggard' for another (Faiers, Neame and Cook, 2007).

[42] Note that while all purchasers in this study are considered to belong to the 'innovator' category, consideration of early adopter and even early majority characteristics are used to guide the categorization of non-purchasers.

Further to this, Sultan and Winer found that the first buyers of the products are more likely to be people with an involvement or interest in the product (Sultan and Winer cited in Faiers, Neame and Cook, 2007). Sultan and Winer's findings are consistent with those of Ostlund's (1974) that product perceptions predict adoption better than personal variables.

It is apparent that some confusion has existed over the establishment of personality correlates of adoption. Rather than using a conceptual framework of "visionaries" and "pragmatists" with mutually exclusive sets of personality traits as a means of distinguishing adopters from non-adopters, perhaps an alternative framework could seek to establish correlates of adoption based on core values and beliefs. Rogers recognizes values as a factor affecting adoption in his 1995 definition of compatibility: "the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters". To motivate the study of values in the diffusion process, two examples are offered. Consider a Mennonite farmer, who adopts business-related innovations in his farming operation but has not so much as a transistor radio at home for personal entertainment. Indeed, Amish communities have been reported to have the highest per-capita use of solar energy technologies in at least one US state (WIRED, 2007). An individual might be a laggard with respect to a certain class of technologies, because their core values offer little motivation, or are even at odds with the adoption of such innovations. Relating this back to the question of whether "innovativeness" is an innate quality, or innovation-specific, it is proposed that innovativeness has as much to do with personal and group values associated with an innovation as with innate personality traits.

The above argument for distinguishing between adopter values and personality traits has methodological implications. To assess compatibility in situations like that described above, where some respondents possess personality correlates of an innovator, e.g. venturesomeness, risk tolerance, but also hold values that are at odds with the innovation, or vice versa, the survey instrument needs to be sensitive to this distinction. Perhaps one method could be to use a kind of "values filter" to screen potential adopters before categorizing them according to personality correlates. It is suggested that the effectiveness of Egmond et al.'s predictor variables "visionarity" and "pragmatism" was partly due to the specificity of their questions related to one sort of innovation, namely energy conservation (EC). An alternative method of ensuring that values-related perceptions are investigated separately from innovativeness is to pre-select a sample of respondents whose values are relatively in line with the innovation. Once a group of respondents has been identified who hold values that are aligned with "the concept of an innovation"[43], *then* this group can be divided into Rogers' adopter categories. If however this "values filtering" step is ignored, and an attempt is made to classify a random sample of presumed potential adopters, categorization may prove impossible as some individuals who possess Egmond et al.'s "early market" characteristics may also hold values that are at odds with the innovation in question. In the present study, respondents' self-selection as a CSEI participant is taken as an indication that they are more or less aligned with the goals of the CSEI, that is, what Faiers, Neame and Cook (2007: 3419) call "the concept of the innovation".

CONTINUITY

Critique of the categories "continuous" and "discontinuous" as applied in marketing literature

Rogers (1976) proposed that the acceptance of a revolutionary paradigm by scholars in a field, while enabling them to cope with uncertainty and information overload, also imposes a set of conceptual biases that, once begun, is difficult to recognize and overcome. The use of "continuous" and "discontinuous" by Robertson (1967) as a generic descriptive handle for behavior-related innovations is regarded as problematic, due to the specific context, i.e., behaviour research, to which it pertains. By pinning the definition of "discontinuous" and "continuous" to behaviour, a definitional paradox is created at a more general level: a given innovation may be behaviourally continuous by virtue of being technologically discontinuous. It may be for this reason that Moore, Johnson and Kippola (1998: 2) offer a much more general dyadic definition: "When new products build on existing standards, they are termed 'continuous innovations'. When breakthrough products come along which utilize new standards, they are termed 'discontinuous innovations'."

Egmond et al. (2006) acknowledge a behavioural perspective, before defining "continuous" and "discontinuous" in relation to behaviour change. Such a preface is important, as it acknowledges from what perspective the research originates, demonstrating awareness and reminding the reader of its place relative to alternatives. Rogers (1976) reported that encouraging attempts to overcome conceptual biases in diffusion research are provided by network analysis and by the open-systems approach. These are discussed below within the context of "communicability".

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[43] This suggestion conflicts somewhat with Faiers, Neame and Cook's (2007) characterization of innovators and early adopters being "committed to the concept of the innovation" (p.2) while majority adopters and laggards, from their perspective, are not. The concept here, rather, is that within those market participants who are committed to the concept of an innovation, the five adopter categories and personality correlates of adoption can be found (across the spectrum).

It may be that solar energy systems are behaviourally continuous for some (e.g.. those homeowners who have a habit of integrating complex energy management decisions into their daily lives), and behaviourally discontinuous for others (e.g. those homeowners who are relatively unfamiliar with adopting energy technologies and energy-related behaviour change). This potential difference between respondents will be explored in the survey analysis.

COMMUNICABILITY OF THE INNOVATION AND ITS EFFECTS

Communicability is something of an anomaly in the diffusion literature. It is not mentioned in the 4th edition of Rogers cornerstone work, *Diffusion of Innovations*. However, Rogers is reported to have used it synonymously with “observability” in a 1961 paper on characteristics of agricultural innovators (Dickerson and Gentry, 1983). It is used without definition in Menzel’s (1960) study of medical innovations, perhaps not surprisingly, as “communicability” is common in medical parlance in the context of disease transmission.

As the literature was not found to suggest a clear meaning for this attribute, communicability will be defined for the present research context. It is a useful term for describing the diffusion of solar energy systems in a community context. Communicability is the ease by which the concept of an innovation can be communicated by adopters to those who might adopt in future. Since it involves communication, “communicability” it is not an attribute strictly of an object, e.g. a solar energy system, or even of an object and its perceiver.[44] Rather it can be seen as an attribute of a unit of analysis that encompasses four aspects of a diffusion system: the innovation (which may be an object), the adopter(s), those who have yet to adopt, and communication modes. This is analogous to Rogers’ (1983) characterization of elements of a communication process.

The reason for conceptualizing communicability in this way, rather than treating the communication separately from the innovation and potential adopters (in this case, CSEI participants) is that it alters the conventional view of diffusion, treating the diffusion system as more of a whole with interacting components. Including “communicability” in the conceptual framework of this research recognizes the integrated nature of the diffusion process, specifically it may also depend on both rational economic decision-making and on social

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[44] Rogers’ standard six innovation attributes, (relative advantage, perceived risk, complexity, compatibility, trialability, and observability) are all defined in respect to 1) an innovation, and 2) a responding unit who perceives that innovation’s attributes. The role of others who may have already adopted, or have knowledge of the innovation, in communicating the innovation to potential adopters is not involved a priori with the six standard attributes.

(potentially non-rational) factors as well. Adoption is affected by the nature of communication among stakeholders, and how the concept of the innovation (including the issue it is designed to address) is communicated. The benefits of viewing communicability in this way are several fold. This view reflects the structure of CSEIs, which appear to be fairly insular.[45] Secondly, this conceptualization naturally leads to a network of like-innovations and their potential adopters connected via a web of communication modes, while other types of innovations and adopter-units are connected similarly within their own cluster.

A model of diffusion of innovations within communities

Hence, a conceptual model begins to form of communities[46] as clusters of individuals with certain predispositions (e.g. values, attitudes, influences) to certain kinds of innovations, and other communities with other sets of predispositions.

The communicability of an innovation within a community setting is argued to be highly dependent on both the *innovation's attributes* and *characteristics of community members.* Certain attributes pose a greater barrier to some communities than others. Attributes that relate to how difficult an innovation is to use or understand are argued to pose a greater or lesser barrier depending on the cognitive abilities of potential adopters. Fliegel and Kivlin cite research that makes a strong case for the importance of dramatic results, which can be perceived by the casual observer, as a major factor in adoption. "Wow" factor results are precisely what solar energy systems have *not* offered to potential adopters, at least those with reliable grid-access.[47] Faiers and Neame (2006) and LaBay and Kinnear (1981) found that adopters of solar energy systems tend to have a higher education level than the general population. In the present study, the type and level of education of potential solar energy adopters will be investigated as a factor affecting the compatibility of a respondent with residential solar energy systems. Respondent cognitions concerning solar energy systems, and the community initiative, will also be considered as factors in adoption.

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[45] Burt (2000: 349) fig. 2 depicts the structure of communication between "network cliques" connected through "weak ties". In the case of CSEI, external communication is generally limited to the submission of a bid request from within the locus of CSEI organizers to an external industry association, as well as media coverage that may communicate the project to an external audience.

[46] Etzioni's (1996:5) two-part definition of community is provided again for convenience: "A community entails (1) a web of affect-laden relations among a group of individuals, relations that often crisscross and reinforce one another (rather than merely one-on-one relations or chains of individual relations); and, (2) community requires a commitment to a set of shared values, norms, and meanings, and a shared history and identity--in short, a shared culture." Etzioni continues, "communities are not only aggregates of persons acting as free agents, but also collectives that have identities and purposes of their own and can act as a unit".

[47] Dramatic results have been reported in rural electrification projects (Solar Electric Light Fund, 2010).

By linking the three components--the innovation, its adopters, and potential adopters--via communication modes into a single unit of analysis that can be studied for its own properties, a more suitable model for describing diffusion of innovations within communities may be developed. Such a conceptual model is argued to be sufficiently different from other approaches (e.g. those that do not explicitly account for the role of communication in diffusion) as to merit a separate attribute category. Further, because communication is central to CBSM, the concept of communicability is especially apt for the present study.

COMMUNICATION MODES

Communication is "the process by which participants create and share information with one another in order to reach a mutual understanding" (Rogers, 1983: 17). Communication mode[48] is a central consideration in CSEI program design, and this is partly what differentiates it from modernist approaches to marketing, such as those that rely on impersonal mass media and operate within a paradigm that assumes a high degree of homogeneity among market participants.[49] CSEIs necessitate tailoring communication mode to community norms, for instance, by using a newsletter read by most members of a community, or delivering a presentation to members of a local environmental club. Marketing campaigns by outside firms may use persuasion tactics that are not effective in a particular community (Rogers, 1976). The ability of communication style to "make or break" a CSEI program is discussed below in the section on opinion leaders.

Jacobsson and Johnson (2000) acknowledge that the process by which a new technology emerges, is improved, and diffused in society depends on much more than relative prices and entrepreneurial acts by producer firms. The innovation and diffusion process is both an individual and a collective act (Saxenian, 1994 cited in Jacobsson and Johnson, 2000). The determinants of technology choice also "reside in an innovation system which both aids and constrains the individual actors making a choice of technology within it. This 'innovation system' includes a large number of variables (apart from prices)." (Jacobsson and Johnson, 2000:629)

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[48] Communication mode has been defined as "the medium or media of communication used by a group" (Fjermestad, 2004: 240). Examples found in Zack (1993) include face-to-face (FtF), group support system (GSS), telephone, written memo, computer-mediated (CMC). Additional examples include television, radio, community newsletter, national newspaper, and more contemporary forms of CMC: electronic messaging and social networking websites. "Communication mode" is used here synonymously with Rogers' 1983 definition of "communication channel" (p. 17). "Communication mode" has been selected as the preferred term since it is the standard term used in communications literature.

[49] It should be noted that such assumptions are not necessarily unwarranted, depending for instance on the innovation under consideration.

Lee, Lee and Schumann (2002: 2) find that "to date, the bulk of the diffusion studies in the consumer behavior literature have tilted heavily toward either individual predisposition (Hirschman 1980; Midgley and Dowling 1978) or innovation characteristics (Rogers 1995), as precursors of innovation adoption. It is important to note that *communication* is also a critical process factor for the diffusion of innovation (Mahajan, Muller, and Bass 1990)" (emphasis added). Lee, Lee and Schumann (2002: 2) consider the "diffusion of technological innovation as it travels through multiple communication sources employing various communication modes". In their study, "sources" including mass media (i.e., one-way communication from corporations or government to consumers) and word of mouth (i.e., communications with family and friends), are coupled with one or both conversation and/or print modes. Lee, Lee and Schumann (2002) identify a gap in the literature, observing that "previous studies have not differentiated the effects of written and conversational communication", and hence the focus of their study is to investigate "the differential impacts of written and conversational modalities". CBSM similarly recognizes that communication modality, especially "vivid communications", can affect adoption decisions (McKenzie-Mohr, 2000b: 551). The rich forms of communication that occur within local community meetings, such as the use of video followed by group discussion, may have helped established the pre-conditions for adoption.[50]

It can be argued that an innovation is inherently less communicable to the mass market at earlier stages of development, since by virtue of limited adoption, the majority is at least slightly less familiar with an innovation's attributes than later in the diffusion process (i.e., the S curve).[51] This lack of communicability (difficulty of communicating) an early-stage[52] innovation underscores both an advantage of CSEI, in its creation and use of communications channels,[53] as well as a barrier to innovations being communicated via modernist means (i.e., mass media and other impersonal sources).

[50] The researcher attended such meetings, hosted by environmental and civil society groups in ward 21, in 2007 and 2010.

[51] An exception to this issue of an early-stage innovation having low communicability might occur if an innovation's attributes meet precisely an unfilled need in the majority population, specifically a need that members of the majority are already aware of and are seeking an innovation to fill. Informally, the majority could be said to be "ripe" for the innovation.

[52] Note that Rogers defines an innovation relative to adopters, i.e., as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (emphasis added, Rogers, 1983: 11). It follows that even a well-established product, idea, etc. is referred to as an innovation as long as laggards perceive it as such.

Early market adopters are expected to depend more than late-stage adopters on impersonal sources. Few personal sources are available to the earlier adopters, as their relatives, friends, and neighbors are unlikely to have experience with the practice at the time of the innovator's adoption decision (Rogers and Beal, 1958). This lack of access to personal sources is a barrier CSEIs are designed to overcome: CSEIs allow innovators to connect to one another and share information about solar energy technology with each other, and with other potential adopters. Innovators use personal communication channels to form decisions about whether an innovation is worth adopting, or to discuss criteria on which it would be worth adopting (e.g. emissions reduction, contribution to local economic development).[54] Then, later on, innovators become a personal source of information to later adopters. In other words, early market adopters can themselves reduce barriers to adoption for later-stage adopters.

(Rogers, 1976) observed that several early communication scholars came from psychological backgrounds. Hence, it was only natural that their models of communication (and diffusion) largely ignored social-structural variables that affect communication. The overwhelming focus on the individual as the unit of analysis in communication research (while largely ignoring the importance of communication relationships between sources and receivers) is often due to the assumption that the individual, as the unit of response, must consequently be the unit of analysis (Coleman, 1958-59 cited in Rogers, 1976). Rogers (1976) pointed to network analysis as a source of encouraging attempts to overcome the psychological bias in diffusion research. Similarly, it seems likely that social-structural factors have a large influence on the type of communication modes employed in the CSEI case study.

NETWORKS

Given the importance of interpersonal contacts in diffusion, scholars have sometimes relied on formal methods of measuring who talks to whom within a community (Valente and Davis, 1999). Such methods are known as network analysis (Scott 1991; Wasserman and Faust 1994; Rogers and Kincaid 1981). Network analysis is a method of research for identifying the communication structure of a system in which sociometric data about communication flows or patterns are analyzed by using interpersonal relationships as the units of analysis (Rogers and Agarwala-Rogers, 1976). It can be applied to study the effects of social structure on communication behavior. In particular, concepts and terminology found in the network analysis literature, such as social capital, prominence (opinion leadership), structural holes will

[54] Note that while all respondents in this study participated in the same CSEI, they may have perceived the CSEI differently. Differences in perception may help explain their different adoption decisions.

be used to describe various social network-related attributes of CSEIs.[55] Motivation for this review of network analysis concepts comes from Dickerson and Gentry's (1983) discussion of consumer creativity, specifically the problem-solving capacity possessed by consumers to remove barriers to desired products. It is argued that the CSEI case study represents an exceptional example of consumer creativity by virtue of its success in solving problems related to the adoption of solar energy systems.

Social capital

The term social capital has been applied in a variety of settings: as a business competence, a goal for non-profit organizations, a legal category, and "the inevitable subject of university conferences" (Burt, 2000: 346). In building on Coleman's (1990) argument concerning the role of social structure in facilitating action, Putnam (1993: 167) stated: "Social capital here refers to features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated action".

Just as the value of physical capital, e.g. buildings, cars, can vary depending on how physical resources are allocated, so too it is argued, social capital can be augmented via efficient allocation. As an example of the physical case, car sharing allows the car as a physical resource to be more thoroughly utilized, thus increasing its provision of value to members of a social network. Similarly, a district energy[56] system allows a fixed quantity of fuel to provide greater thermal value to users than would be the case if that fuel were allocated to separate HVAC units. The value of social resources such as conversations or shared experiences may also be increased depending on where these resources are allocated. Consider a conversation between two experts. If this conversation occurs in private, the only immediate benefits are those accruing to the participants themselves. However, if such a conversation is accessible to all listeners with an interest in the topic, the same conversation may provide orders of magnitude greater social value. Radio programs and panel discussions are modern instances of this, however the concept itself has broader applications.

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[55] Social learning is another relevant topic that might have been useful to review, had space and time permitted.

[56] District energy systems replace the boilers, furnaces and chillers in individual buildings with a system that distributes heating or cooling through buried pipes, using hot or chilled water, from one or more central heating and cooling plants (CMHC, 2003).

The CMHC (2003) reported that most of the 160 district heating systems in Canada exist on large institutional campuses (e.g., universities and military bases.) Campuses demonstrate the kind of long-term, strategic planning that Sadownik and Jaccard (2001) suggest may be useful to direct urban development towards a more sustainable energy path.

Opinion Leadership

(Rogers, 1971, p. 219) reports that the complicated relationship of leadership and group communication norms has received empirical elucidation by diffusion scholars, resulting in the proposition: "When the system's norms favor change, opinion leaders are more innovative, but when the norms are traditional, opinion leaders are not especially innovative”. Network analysis enables researchers to locate individuals who are more central to a community and thus perhaps more influential. The basic diffusion network model uses these individuals, or opinion leaders, to initiate the diffusion of a new idea or practice. They can function as champions for the new practice and accelerate the diffusion process (Valente 1996; Katz 1957; Katz and Lazarsfeld 1955 cited in Valente and Davis, 1999).

In most organizations and communities, different individuals will be seen as opinion leaders in different domains (Valente and Davis, 1999). However, an opinion leader’s influence on adoption is predicated partly on potential adopters’ assessment of his or her credibility and trustworthiness. Valente and Davis (1999) identify several ways an opinion leader’s influence can be compromised. Self-selected leaders and those from outside the community may be suspected of having agendas different from those of community members, or even agendas harmful to the community. If a leader is unaware of the community’s needs or that the leader may not be sufficiently knowledgeable about the innovation, this can be equally damaging to their influence on adoption. At the same time, an opinion leader does not need to possess expert knowledge. The use of nonprofessional change agents has also been used to aide diffusion in some contexts (Rogers, 1976). Finally, persons not selected by community members may use persuasion tactics that are not effective in that community.

Community members may not always be fully conscious of an opinion leader’s influence on their decision. Psychology literature has documented the ability of unconscious influences to affect behaviour (Jacoby and Kelley, 1987; Jacoby, Woloshyn and Kelley, 1989).

The opportunity or burden of opinion leadership can be shared by a diverse set of individuals within a community. Valente and Davis, (1999: 64) propose that over time the community can formulate itself into a “dynamic learning community that relies on itself and distributed systems of monitoring to continually enhance its performance”.

Structural holes

Burt (2000) reports accumulating empirical evidence that structural holes are a correlate of organizational learning, often discussed in terms of an organization's ability to learn. Cohen and Levinthal (1990: 128) describe an organization's absorptive capacity as follows: "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends." This ability can be studied in terms of industry factors that facilitate absorption (e.g. Cohen & Levinthal, 1990) or external networks that enhance an organization's absorptive capacity (e.g. Cockburn & Henderson, 1998). Burt (2000) commented on an impressive diversity of empirical evidence showing that social capital is more a function of brokerage across structural holes than closure within a network. Rogers (1976) characterized this in his discussion of a network analysis concept called the "strength of weak ties". The proposition summarizing this finding has been paraphrased[57], "An innovation is diffused to a larger number of individuals and traverses a greater social distance when passed through weak ties rather than strong ones" (Rogers, 1976: 299).

> For any given topic, each individual operates in his/her particular communication environment consisting of a number of friends and acquaintances with whom the topic is discussed most frequently. These friends are usually highly homophilous (or similar) … This homophily and close attraction facilitate effective communication, but they act as a barrier preventing new ideas from entering the network. There is thus not much informational strength in the interlocking network; some heterophilous ties into the network are needed to give it more openness. These "weak ties" enable innovations to flow from clique to clique via liaisons and bridges. (Rogers, 1976: 299)

This model of social networks, with clusters of like-individuals, connected via weak heterophilous ties, is an elegant model for describing the social structure of CSEIs.

The three concepts discussed above--social capital, opinion leadership, and structural holes (including absorptive capacity)--inform the discussion of WISE as a case study in what Hirschman (1979) calls "consumer creativity". The reader is directed to Hirschman (1979) for a more detailed discussion of consumer creativity, whose variables include childhood mental stimulation (CMS), formal education (FE), adult occupational stimulation (OS), and urbanization (U). A central area of inquiry arising from Hirschman's concept is that of the sources from which consumers acquire information are applicable to the solution of consumption problems. Attention will be given to some of the above-mentioned variables (e.g. education) among respondents in this study.

OBSERVABILITY

Observability is considered in the sense defined by Rogers (1995): the extent to which the results of innovating are visible to others. Faiers, Neame and Cook (2007) investigated the role

[57] Rogers' (1976: 299) alternative expression of this result is, "The informational strength of dyadic communication relationships is inversely related to the degree of homophily (and the strength of the attraction) between the source and the receiver."

of observability in diffusion by asking potential adopters if they would be less likely to buy a product if they had not seen it in popular use.[58] The observability of a solar energy system could pose a barrier to adoption if the potential adopter has a negative perception of the system's aesthetics. In such a case, an installer might offer to install the system in a less visible location. Conversely, if the system is aesthetically appealing, greater observability could be expected to have a positive influence on adoption.[59] Respondent data in the present study will be analyzed with attention to possible effects of observability on solar energy adoption.

A concluding observation about innovation attributes

The ten[60] attributes identified above overlap in various ways and in some cases are dependent on each other. Relationships between some of the attributes, e.g. cost and risk, complexity and communicability, caused the author difficulty in deciding how to organize the discussion of these attributes. Alternative orderings were considered, however ultimately no grouping of attributes could be found that would preserve the integrity of each discussion topic. Due to this overlap and dependence, discussion of some topics appears under the heading of related topics. For instance, discussion of complexity can be found under the heading "communicability".

2.5 Policy Context

2.5.1 Introduction

Government policy is one means of enabling communities to manage energy resources more effectively. Jacobsson and Johnson (2000) attribute the success of energy system transformations in Denmark, Germany and Sweden to restructurings of their networks and institutions, i.e., structures that both enable and constrain actors in the exercise of their competencies, whether those are industrial trades, research and development, communications, etc. Parker (2007) reviewed the Japanese and Australian experience with

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[58] The interpretation attributed to Faiers, Neame and Cook (2007) is inferred from a true/false statement included in their survey and used to measure the attribute's importance in purchase decisions. "I would be less likely to buy a product if I had not seen it in popular use (observability)" (p. 3419).

[59] Note that while in the present context, "observability" is synonymous with "visibility", this is not the case with all innovations, specifically those that are themselves not visible but whose results are. Hence the reason for defining a new word "observability" rather than "visibility".

[60] relative advantage, perceived risk, complexity, efficiency, compatibility, trialability, observability, communicability, continuity and symbolic attributes.

capital incentives to stimulate the residential market for photovoltaics, demonstrating the ability of a market-sensitive incentive program to stimulate industrial growth, achieve unit cost reductions and shift the market to include a large grid-tied share. Vachon and Menz (2006) found that political interests as measured by pro-environment congressional voting records play a positive role in the adoption of green electricity policy in U.S. states.

Many studies that have identified potential cost-effective investments in energy efficiency in the building, transportation, industrial and electricity sectors, however in many cases, action or implementation strategies have been lacking (Parker, Rowlands and Scott, 2003). Failure to reduce greenhouse gas emissions in the energy sector has been attributed to several causes: the lack of integration in energy policies at local, provincial national and international levels; the lack of inclusion of multiple stakeholders; the lack of integration across different disciplinary perspectives in energy studies; the lack of integration across energy issues such as conservation and fuel substitution; the persistence of inadequate price signals; multiple market failures; conflicting energy and environmental policies; and institutional barriers (Parker, Rowlands and Scott, 2003). These failures suggest a need for increased integration in energy studies and policies.

The period 2006-2010 has seen major advances in Ontario public policy for addressing environment and energy-related challenges. The passing of Ontario's *Green Energy and Green Economy Act* (Bill 150) in 2009, including its advanced feed-in tariff (FIT and MicroFIT) programs, has enabled broader stakeholder participation in renewable energy generation projects.[61] Advanced feed-in tariffs pay higher fees for the electricity generated in recognition of economic (technical), environmental and social benefits, including time-of-use value (production at peak demand times associated with air conditioning loads), distributed benefits (avoiding investment in network capacity to meet peak demand during high temperatures) and the avoided environmental costs associated with poor air quality and greenhouse gas emissions (Parker, 2007). Assessments by Americans for Solar Power (2005), an industry-based group, estimated the value of the ancillary benefits from distributed photovoltaic generation at $US 0.22/kWh (Refocus Weekly, 2005 cited in Parker 2007). Not included in these estimates of technical environmental value of distributed solar energy are the potential *social* benefits associated with community projects. A study by Perez, Zweibel, and Hoff (2011) considering "energy value", "grid value", and "social value" estimated the value of distributed solar PV at between 15 and 40 cents. This same study estimated the combined value to utility ratepayers and taxpayers in Colorado of 26 cents/kWh (vs. a cost of 24 cents/kWh). The present study of

[61] The FIT and MicroFIT programs are successors to an earlier policy measure introduced in March 2006, the renewable energy standard offer program (RESOP). The RESOP offered a fixed rate of 42 cents/kWh to solar PV generators, irrespective of size and application.

solar energy adoption in Ontario builds on the above-mentioned studies by considering *sociotechnical* benefits of lower electricity consumption among PV adopter households.

Recognizing these holistic measures of value, the government of Ontario has created public benefit funds[62] to ease the regulatory approval phases of community-based renewable energy projects (CEPP, 2010).

2.5.2 Technical and regulatory issues

With regard to technical hurdles affecting the adoption of PV in neighbourhoods, much of the dialogue occurring in regulatory circles centers on the challenge of transitioning from a centralized electricity system to a distributed system. Over the past two decades there has been a double-digit growth rate in the market for some renewable energy technologies (Jacobsson and Johnson, 2000; Hoffmann 2006). The consequent alteration in the energy system, has in some jurisdictions been a slow, painful and highly uncertain process (Jacobsson and Johnson, 2000). It has been argued that this process needs to be studied using an innovation system perspective where the focus is on networks, institutions and firms' perceptions, competencies and strategies (ibid).

> "Policy may also be concerned with improving the linkages in the system so that existing knowledge can be widely diffused, opening up for additional experiments by new actors.[63] The degree of connectivity in existing networks influences, of course, the amount of information and knowledge that is diffused in the system. A high connectivity is not, however, automatically created by market forces but is based on the development of trust and a collective identity. Creating bridging institutions and fostering a collective identity is, thus, an important task for policy, as may be the formation of entirely new networks." (Jacobsson and Johnson, 2000: 634)

In the Ontario context, the type of restructuring process described by Jacobsson and Johnson (2000) can be traced back to the dissolution of Ontario Hydro in the late 1990s under Progressive Conservative government of Mike Harris. The passage of the *Energy Competition*

[62] Vachon and Menz (2006) report that PBF are usually created along with electricity market restructuring to provide support to renewable energy development, energy efficiency initiatives, and conservation. These authors report some backlash against PBF in the U.S., where they are "often considered as taxes levied on electricity consumption" (p. 653). One reason for the differences in policy between the European countries and the U.S. is that Americans place stronger trust in the ability of market forces—as opposed to direct regulation—to achieve efficient resource allocation (Vachon and Menz, 2006).

[63] For example, much of the governmental funding has gone into academic research which "has never been put to use by the researchers themselves or transferred to the industry" (Jacobsson and Johnson, 2000: 634).

Act (Bill 35) in October 1998 divided Ontario Hydro into five successor companies: Ontario Power Generation (OPG), the Ontario Hydro Services Company (later renamed Hydro One), the Independent Electricity Market Operator (later renamed the Independent Electricity System Operator), the Electrical Safety Authority, and Ontario Electricity Financial Corporation (Genc and Sen, 2008; Greenberg, 2005). The Ontario Power Authority (OPA) was created in late 2004 to develop an Integrated Power System Plan (Genc and Sen, 2008). Since there is no contract market in Ontario, the OPA is responsible for contracting with market players to ensure capacity targets, technology to be used and conservation targets (Genc and Sen, 2008).

The principal agencies currently managing technical and regulatory issues of Ontario's energy system include the Ontario Power Authority, Ontario Energy Board, Electrical Safety Authority, local distribution companies (e.g. Toronto Hydro), and the Provincial and Federal governments. Regulators are increasingly active within renewable energy industry forums organized by industry associations, such as conferences organized by the Canadian Solar Industry Association and the Ontario Sustainable Energy Association (OSEA). Hence, the aforementioned agencies[64] have an important role as enablers of community-based renewable energy projects.

2.5.3 Distributed renewable energy and Ontario's Integrated Power System Plan

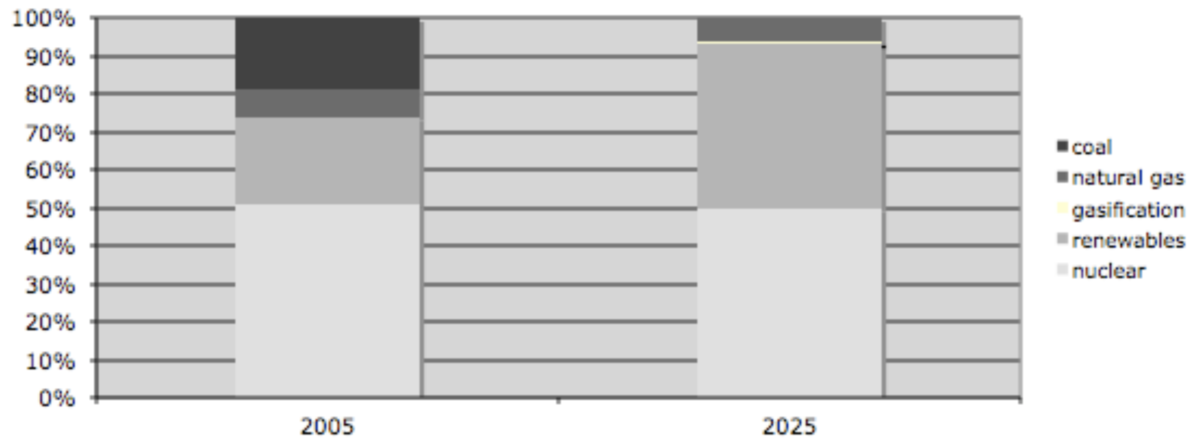
Letters from the Ontario Ministry of Energy and Infrastructure to the Ontario Power Authority (OPA) were reviewed for the purpose of relating CSEIs to government policy in Ontario's electricity sector. In 2005, the Minister of Energy for Ontario, Dwight Duncan, requested a proposal from the OPA for an Integrated Power System Plan (IPSP) - a comprehensive, long-term plan for the Province. In this request, Dwight Duncan notes, "The task you will be embarking on will be of historic importance, and will provide a crucial foundation for the clean, reliable, diverse, and sustainable, electricity supply for the province" (Duncan, 2006:1).

This request also called for recommendations in three areas:

1) conservation targets for 2015, 2020, and 2025.
2) new renewable energy capacity
3) appropriate mix of electricity supply after conservation and renewable sources have been taken into account, and with particular attention to baseload, intermediate, and peak electricity supply

[64] Other agencies include the Independent Electricity System Operator and Ontario Power Generation, however the influence of these agencies on adoption of distributed solar PV is relatively minor.

Figure 3 - The Ontario Power Authority's Electricity Supply Development Plan



Source: OPA, 2008

The Government of Ontario subsequently set a goal to double renewable energy (RE) capacity to 15,700 MW by 2025 from the 2003 base of approximately 7800 MW (MEI, 2009). With almost all of existing RE in Ontario coming from large-scale water power, there is an enormous opportunity for new forms of renewable generation to enter Ontario's electricity supply mix.

A second goal was set to reduce peak demand by 6300 MW through conservation (Duncan, 2006). Distributed solar energy systems procured en masse by electricity end-users may help to foster public knowledge, attitudes, and behaviours that contribute towards addressing these concerns (Hondo and Baba, 2010).

Dwight Duncan's directive to the OPA continued with a request for "nuclear capacity to meet base-load electricity requirements but limit the installed in-service capacity over the life of the plan to 14,000 MW", and additionally, for "coal-fired generation to be replaced by cleaner sources in the earliest practical time frame that ensures adequate generating capacity and electricity system reliability in Ontario" (Duncan, 2006: 2).

Lastly the directive called for the OPA to "strengthen the transmission system to:

i. Enable the achievement of the supply mix goals set out in the directive
ii. Facilitate the development and use of renewable energy resources such as wind power, hydroelectric power, and biomass in parts of the province where the most significant development opportunities exist
iii. Promote system efficiency and congestion reduction and facilitate integration of new supply, all in a manner consistent with the need to cost effectively maintain system reliability.

Notably absent from the directive is specific mention of solar PV as a technology to help meet these supply targets for the province. As a renewable energy resource for which "significant development opportunities exist", roof-top solar has a role to play in achieving the MOE's goals, namely:

- promoting conservation (through energy awareness ripple effects of neighbourhood solar projects)
- improving system efficiency through peak-shaving effects of solar PV
- reducing the need to upgrade the transmission infrastructure by making cities more energy self-sufficient
- cost-effective generation procurement through leveraging personal capital

Recognizing that the IPSP in its original form did not account for the Province's significant renewable energy potential, then Minister of Energy, George Smitherman, issued a follow-up directive to the OPA (Davis, 2008). In it, Minister Smitherman required the OPA to revisit its IPSP to establish new targets in the areas of amount and diversity of RE sources in the supply mix (Smitherman, 2008). This directive was issued after Minister Smitherman visited California, Germany, Spain and Denmark, jurisdictions noted for having progressive renewable energy programs.

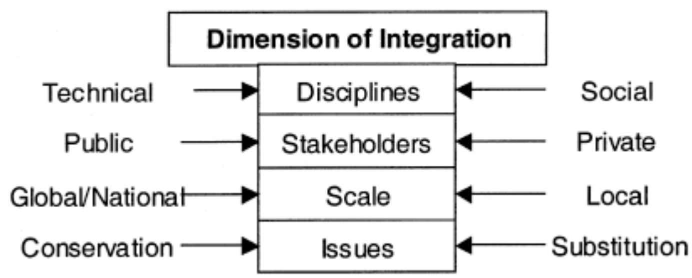
The final goal of the IPSP as outlined by Dwight Duncan in the original 2006 directive to the OPA, was for the plan to comply with Ontario regulation 424/04. Regulation 424/04 requires the OPA to, "consult with consumers, distributors, generators, transmitters and other persons who have an interest in the electricity industry in order to ensure that their priorities and views are considered in the development of the plan" (Electricity Act, 1998: 1). The 2008 follow-up directive from then Minister Smitherman ensured that renewable energy potential was properly reflected in the IPSP. Ensuring that Ontario's electricity system reflects the desires of the people of Ontario with respect to reliability, risk, and sustainability objectives is more than a technical or economic challenge. Policy initiatives such as the *Green Energy and Green Economy Act* are an integral part of meeting this challenge.[65]

[65] A document released in 2010 by the Ministry of Energy and Infrastructure called "Ontario's Long-Term Energy Plan" is regarded as woefully inadequate for fostering sustainability in Ontario's energy systems. It is the researcher's opinion that this document is incompatible with fundamental trends in the global energy sector, as it calls for a combined total of less than 2.5 percent of Ontario's electrical energy to be sourced from wind and solar resources in 2030.

2.6 Conceptual Framework - An 'integrated approach' to research and project design

This section draws ideas from the reviewed literature to construct a conceptual framework for better understanding solar energy adoption in a community context. The term 'integration' has been used to describe methods that integrate across disciplines (engineering/technical and social science/behavioural), scales (global/national and local), stakeholders (diverse interests) and issues (conservation versus substitution) (Parker et al. 2003).

Figure 4 - Four dimensions of integration in energy studies



Source: Parker, Rowlands, and Scott, 2003: 171

Rather than applying a single attitude-behaviour model, e.g. rational economic, to the problem of energy and environmental behaviour change, an integrated study seeks to examine the interactions among technical and social factors, as has been proposed in the case of energy efficiency by Brown et al. (1998) and Shove (1998). 'Integrated approaches' extend established techniques to assess technical potential by incorporating behavioural and social insights (Parker, Rowlands and Scott, 2003). The four dimensions of integration will be considered in the examination of the CSEI case study and will be recognised in the framework for this study. This is discussed further at the end of this section, along with a framework for analysis uniquely tailored to this study of CSEIs.

The integrated approach used by Parker, Rowlands, and Scott (2003) is similar to those found in other integrated resource management (IRM) studies. Thai (1997) integrates scale on regional and provincial levels with environmental considerations (i.e., issue). Doberstein (2008), Geng and Doberstein (2008), and Geng et al. (2009) integrate the dimensions of scale with stakeholders in studying economic development that "can 'leapfrog' past environmental damage that is typically seen as economies industrialise" (Geng and Doberstein, 2008: 231). Geng et al. (2009: 231) uses tools of IRM to achieve "simultaneous positive outcomes for the…economy, society, and the environment".

The present study has reviewed literature on two themes relating to the adoption of solar energy systems within a community context. Firstly, a review of community-based approaches to environmental behaviour change was presented. This was followed by a review of diffusion of innovations theory, which included using network analysis to frame the role of social structure in facilitating adoption. To bring these two themes together in a single framework for analysis, this research builds on the comprehensive framework for integrated research developed by Parker, Rowlands and Scott (2003). The framework was intended to be reviewed and adapted to meet the needs of other national or local energy studies, and hence is regarded as suitable for the present study.

Parker, Rowlands and Scott (2003) profile a community-based initiative called the Residential Energy Efficiency Project (REEP). The REEP is an environmental non-profit organization that has successfully applied CBSM to spur adoption of energy conservation in one Canadian municipality. In this respect, it is similar to the present case study in its use of an integrated approach. The REEP sought to integrate the disciplinary approaches of technical and behavioural studies, "address the scalar problem by linking local and national initiatives, include the diverse needs of stakeholders and recognize the complementary issues of conservation through efficiency and fuel substitution" (ibid). As will be shown, these four objectives are similarly reflected in the outcomes of the present case study, and are recognised in the framework for this study.[66]

To answer the primary research question about why some residents purchase solar energy systems and others do not, this study evaluates a ward-based CBSM campaign designed to address and overcome barriers to residential solar energy adoption. The campaign, called the West Toronto Initiative for Solar Energy (WISE), made use of existing community-based communications channels as well as creating new channels in order to establish a network through which information could be shared and adoption decision acted upon.

This study of WISE participants explores each of the four dimensions of integration at various levels of depth. Of primary interest is the role of social context (community) on the sociotechnical potential to achieve environmental behaviour change. Hence, social and technical disciplines are considered.

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[66] The West Toronto Initiative for Solar Energy (WISE), a CSEI based on the Our Power, model represents a similarly integrated, and innovative, approach to improve energy-related behaviour and decision-making. While the WISE was ostensibly focused on fuel substitution through the installation of solar energy systems to provide hot water and electricity, there may be a secondary benefit of increased energy awareness leading to energy conservation. There is a direct mechanism by which adoption of a solar energy system through the WISE would have influenced household energy decisions: the Federal government requirement that an EcoENERGY™ audit be conducted on the home in order to receive a capital subsidy (EcoENERGY grant) for the purchase of a solar thermal system. It was hypothesized that there might also be measurable reductions in total electricity consumption among households that adopted a solar PV system.

The initial integrative step in energy studies is often to link engineering and economic components (Parker, Rowlands and Scott, 2003).[67] This study instead links the technical and social disciplines to the issues of fuel substitution and household energy demand[68]. The investigation of fuel substitution and household energy demand is operationalized by quantifying electricity generation and consumption of solar PV adopter households.

The stakeholder dimension is integrated in two ways. Firstly, the WISE offers an example of local advocacy groups working with private sector partners to reduce barriers to solar energy adoption. Hence, the interests of both public and private stakeholders are considered. Secondly, while CSEI participants and solar equipment vendors are the most immediate stakeholders, the interests of government and regulatory agencies are also considered. Parker, Rowlands and Scott (2003) examined how community-based implementation can enhance the effectiveness of a national energy-efficiency program (the EnerGuide for Houses [EGH] program, administered by Natural Resources Canada). Similarly, the CSEI case study leveraged the relationships of local community members to create communications channels (forums) through which local residents were able to engage in discussions about the technical, financial, and environmental considerations involved in the adoption of a solar energy system. Hence, the study integrates the dimensions of scale in its evaluation of a local initiative designed to increase uptake of provincial and federal government subsidies, namely the ecoENERGY grants, administered by the Federal Government's ecoACTION program and the Ontario Ministry of Energy, and the Renewable Energy Standard Offer Program (RESOP).

By surveying participants' perceptions of the WISE, as well as of solar energy technology and related policy, insights are gained into four dimensions of integration involved in the adoption of solar energy systems in the context of a CSEI. The attributes of innovations identified from diffusion literature will be used to frame the analysis of respondent perceptions of solar energy systems.

Table 4 presents a framework for analysis that was developed for the present study. The framework consists of the attributes of innovations identified from DoI theory, re-organized and expanded upon to be suitable for analyzing adoption behaviour in the specific context of a CSEI. Communicability, which concerns the ease by which the concept of an innovation can be

[67] Notes that this is not an integration at the level of dimension, but of discipline (i.e., technical and economic).

[68] Note that reductions in household energy demand are achieved either by conservation or improved efficiency. The reader is referred to Sherk and Parker (2010) for a discussion conservation, efficiency and renewable energy, as three distinct aspects of sustainable energy systems.

communicated, depends on communication modes and networks within the community of interest. This attribute been added to account for the important role of communication to diffusion of innovations in a community context.

Table 4 - Perceived innovation attributes adapted for a community context[69]

Relative Advantage

Cost attributes	Efficiency
Risk and uncertainty	Observability / Symbolic attributes[70]
Trialability	Compatibility
Complexity	Continuity

Communicability

Communication modes	Networks

The above framework for analysis is used in Chapter 5 to organize the results from Chapter 4 into integrated conclusions about adoption behaviour in the CSEI case study. This is done by passing each finding[71] through an interpretive lens of the framework in order to relate the findings from this study to the broader literature. Before examining the findings, the study methodology will be described in Chapter 3, including an overview of the case study, the West Toronto Initiative for Solar Energy (WISE).

[69] The attributes listed in this table are drawn from Diffusion of Innovations Theory and re-organized for analysis of CSEI respondent data.

[70] Potential effects of observability and symbolic attributes on adoption behavior are considered together in the analysis. This is because observability—the extent to which the results of innovating are visible to others—and symbolic attributes (such as perceived meaning of the innovation) are considered likely to be strongly interdependent in their effects on adoption behaviour. For example, if a domestic SHW system were perceived as both highly observable and unaesthetic by a potential adopter, this would be a barrier to adoption.

[71] Findings are based on both open-ended and closed-response (importance-scale) questions.

3 Methodology

3.1 Introduction

The methodological foundations of this research are both qualitative and quantitative. Hence, the research employs a mixed methods approach. Mixed methods research is characterized by pluralism or eclecticism, which when applied to the social sciences frequently results in superior research compared to mono-method research (Johnson and Onwuegbuzie, 2004). The methods used to investigate the research question include primarily (1) surveys of self-reported (subjective) attitudes and behaviour, and (2) a study of actual (objective) household electricity performance. Informal participant observation was also carried out within a variety of civil society contexts, mostly in Waterloo Region and the Toronto area. The role of the researcher was usually that of passive observer (e.g. audience member at a public forum), and occasionally of participant or community organizer. These observations were used to inform the analysis of survey data. Additionally, the chair of the WISE steering committee, Earth Day Canada president, Jed Goldberg, was interviewed at the outset of the investigation to gain insight into community-based social marketing (CBSM) of solar energy technology. (A transcript of this interview may be found in Appendix C I.)

A mixed methods approach is regarded as appropriate for the present research topic for several reasons. The phenomena of interest, referred to here as community-based solar energy initiatives (CSEIs), have existed in Canada for little more than a decade,[72] i.e., is relatively new. Readers may be unfamiliar with the qualitative attributes of homeowners who have participated in CSEIs, in particular, homeowners who belong to the "innovator" segment of the solar energy market.

Qualitative methods offer rich insights into a phenomenon that to a new observer may appear mysterious. In 2007, residents of Ward 21 purchased a far higher quantity of solar energy systems relative to other neighbourhoods in Ontario. An investigation of why some residents decided to purchase, and others not to purchase in the short term, necessarily involves qualitative methods such as semi-structured interviews and open-ended survey questions.

As a complement to the surveys of self-reported data, utility account data were collected to assess certain energy-related characteristics of these same homeowners, providing an objective measure of their household's energy performance. This study measured household electricity

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[72] evidenced by the solar pioneers program mentioned by Parker Rowlands and Scott (2003: 179) and by Murray (2006) which occurred in Toronto in 1998-1999.

performance to determine how much electricity was produced by solar PV systems in the case study, and how much electricity was consumed by PV-adopter households.

This mixed methods approach builds directly on Keirstead (2007: 4131) by “[pairing] two types of data: detailed monitoring data (measuring the generation and demand of PV households for at least one year before and after the installation of PV) and social surveys (describing the attitudes and behaviour of the monitored households on a similar time-scale)”. Difficulties in data accessibility led Keirstead to deem this “paired data” approach infeasible. Hence, the willingness of respondents in the present study to participate in university research projects is particularly valuable.

In addition to applying a mixed methods approach, the development of the survey instruments was informed by a participatory research design (PD). The PD movement seeks to actively engage laypeople, i.e., non-techno-elites, in the design of techno-social systems (Howard, 2004). Participatory research methodologies have been characterized as "reflexive, flexible and iterative" (Cornwall and Jewkes, 1995: 1668). Following in this vein, the development of Chapters 2, 3, and 4 were iterative and dependent, rather than linear. (For instance, themes in respondent answers helped suggest topics for review in Chapter 2.) The motivation for including laypeople in the design of energy systems emerges from a broader concern over the expert/lay divide in technological affairs, and conceiving design as a process that “fuses material and social practice” (Howard, 2004:41).

This chapter presents the participatory mixed-methods approach used to gather information about energy-related attributes of CSEI participants. The surveys of self-reported attitudes and behaviours are discussed in Section 3.2, followed by a discussion of methods used in the study of household electricity performance, specifically the collection and analysis of household electricity consumption and photovoltaic (PV) production data.

3.2 Study of WISE Homeowner Characteristics and Perceptions

3.2.1 Introduction

Surveys were used to gain an understanding of the attitudes, opinions, and self-reported behaviour of potential solar energy adopters. Information gathered in this way is used to identify barriers to adoption, and understand the characteristics of purchasers vs. non-purchasers.

The surveys take an exploratory approach to identify motivations and barriers to solar energy adoption among WISE participants. This approach differs from others in the diffusion of innovations literature that use a confirmatory approach to test hypotheses about specific attributes (either of an adopter group or of an innovation). Faiers, Neame and Cook (2007) for instance use a conceptual framework based directly on diffusion theory. Their study has one-to-one correspondence between six theoretical innovation attributes (relative advantage, compatibility, etc.) and six corresponding survey questions. In the present study, an exploratory approach is considered more likely to reveal fresh insights into the adoption considerations of participants within the particular social context of a community-based solar energy initiative. Respondent answers were categorized based on patterns in their answers initially, and then these "data-derived" categories were compared to those in the literature. In other words, the data were used to suggest categories before considering those categories identified by the theory of diffusion of innovations. This approach is in line with Michealsen's (2007) comparison of exploratory (inductive) approaches vs. confirmatory (deductive) approaches to research (Appendix C II).

Who was studied?

The respondents in this study are homeowners who signed up to have their home's solar resource assessed as part of a ward-based CSEI in Toronto, Ontario.
This initiative was called the West Toronto Initiative for Solar Energy (WISE).

> "The West Toronto Initiative for Solar Energy (WISE) is a community-led renewable energy project to organize the bulk purchase of Solar Photovoltaic (PV) and Solar Hot Water (SHW) systems by residents of West Toronto. … The project demystifies solar technology, simplifies product research and the purchase decision, creating the opportunity for participants to decrease their personal environmental footprint while contributing to reducing greenhouse gas emissions in Toronto. … The numbers were impressive. WISE 2007 had 160 requests for home site evaluations." (Our Power, 2008)

All of the respondents in this study are drawn from those 160 sign-ups mentioned above, and nearly all of them are residents of Ward 21, St. Paul's. The ward is located in downtown West Toronto. According to the City of Toronto Ward Profiles, the ward holds a higher proportion of university-educated residents than the Toronto average. English is the first language of 80 percent of the population, relative to 64 percent for Toronto. The ward has a higher proportion of residents of Jewish origin than all other Toronto wards but one, (the neighbouring Ward 16). In terms of population and family demographics, Ward 21 is similar to the Toronto average.

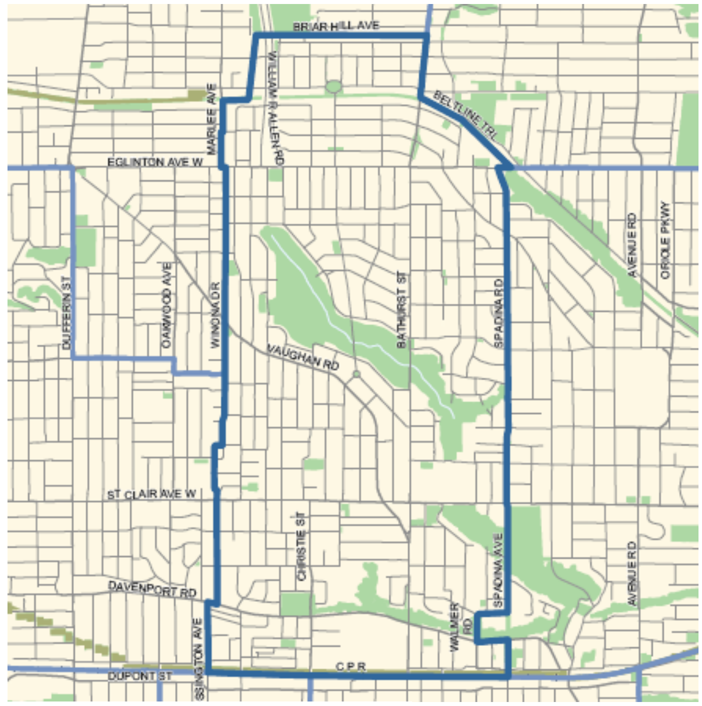

Figure 5 - Ward 21

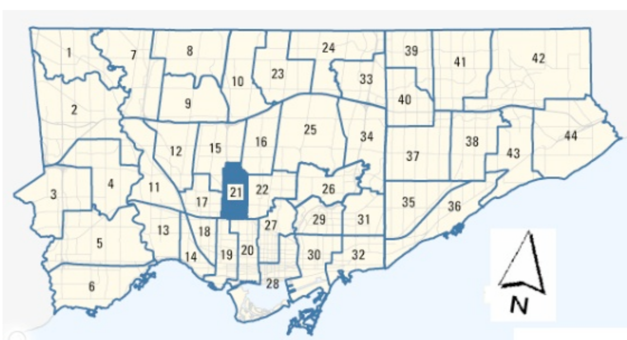

Figure 6 - Wards of Toronto

The ward's most distinctive quality, in respect of the present research topic, is perhaps its high levels of civic involvement. The WISE is just one of many community-based environmental projects initiated by residents. These initiatives, which include environmental culture festivals, community shared agriculture networks, and perhaps most impressively, the cooperative purchase of a former streetcar railyard and conversion into a community centre, artists' residence, equipped with geothermal heating and cooling, and hosting a range of community events, from gala dinners to a weekly local farmers market.

Recruitment process

Survey respondents were recruited as follows. The WISE organizers possessed a list of people who had filled out a form requesting to have their home's solar resource assessed. Most of these people were residents of Ward 21, and had filled out the form during a community information meeting about solar energy systems. Some others on the list had found out about the program through word-of-mouth or through another source[73]. After ARISE Technologies Corp. was selected by the WISE organizers as the 'preferred PV systems vendor'[74], WISE sent this list of people who had signed up for a solar assessment to ARISE. For privacy reasons, WISE never provided this original list of all WISE sign-ups to the researcher. Rather, the researcher provided recruitment scripts to ARISE and WISE, who then emailed these to people on the list on behalf of the researcher. PV purchasers were emailed by ARISE salesperson, Jerry Austin. SHW purchasers and non-purchasers were emailed by WISE organizer, Ken Traynor. 119 people responded to these initial recruitment emails. Contact information for these 119 people were then sent by ARISE and WISE to the researcher. The researcher then sent a second recruitment email, including instructions on how to participate in the survey, directly to these 119 people. Forty-six surveys were completed. Materials required for the study included a recruitment email, a cover letter and the survey itself. (Samples of recruitment materials may be found in Appendix A I.)

"WISE participants" denotes the respondents (mostly from Ward 21) who completed a survey. There were three surveys conducted, one of PV purchasers, a second of SHW purchasers, and a third of non-purchasers.[75] One of these respondents had purchased both types of systems, and hence completed two surveys. This respondent's answers were removed from the survey of SHW purchasers and only the responses to the pv purchaser survey were analysed because this was the more expensive investment decision. No separate analysis was done of respondents who had purchased both types of solar energy system.

[73] A full list of sources through which respondents heard about the WISE is provided in section 4.3.

[74] One vendor was selected for each type of system, PV and SHW respectively. Being the 'preferred vendor' meant being invited by WISE to perform solar resource assessments and sales visits for residents on the WISE list.

[75] A challenge has been to relate these groups to the categories in the diffusion literature, namely "innovator", "early adopter", "early majority", etc. It is expected that based on attitudinal and behavioural characteristics (e.g., expressed risk aversion, information-seeking, etc.) the respondent groups in this study will be able to be compared to categories in the diffusion literature. Another challenge has been defining the "innovation" of interest, i.e., is it precisely "a residential solar energy system", or something more holistic, such as "a solar energy system, lower-than-average electricity consumption, and an environmental ethic".

Table 5 - Study and sample populations of the surveys

	Completed a survey (therefore, a respondent or participant)	Did not complete a survey (therefore, not a respondent or participant)	Total
Purchased both PV and SHW	1	7	8
Purchased PV only	14	2	16
Purchased SHW only	13	5	18
Did not purchase anything	16 + 1 who received PV purchaser survey	60	77
TOTAL	45	74	119

The WISE participants consist of:

15 PV purchasers: respondents who purchased a PV system[76]
(response rate: 15 of 24, or 63 percent)
13 SHW purchasers: respondents who purchased only a domestic solar hot water system
(response rate: 13 of 18, or 72 percent)
17 non-purchasers: respondents who signed up to have their home's solar resource assessed but had not purchased as of December 31 2007
(response rate: 17 of 77, or 22 percent)

Why conduct a study of WISE participants?

WISE participants were selected because of 1) their high rate of solar energy adoption relative to other geographic communities in southern Ontario,[77] 2) their apparent enthusiasm for overcoming barriers, including a signed commitment by PV system purchasers to participate in research, and 3) pre-existing relationships of the researcher with stakeholders connected to the WISE.

[76] The PV purchaser cohort includes the one respondent who completed both the PV and SHW surveys
[77] This is based on the calculation (section 1.2) of the minimum percentage that WISE represents of all PV systems sold in Ontario in the spring and summer of 2007. The calculation shows that a geographic community with less than 0.37 percent of Ontario's population adopting at least 13 percent of all PV systems sold in Ontario during that period. Clearly the proportion of homes in this neighbourhood that purchased a solar energy system is far in excess of proportions in most other Ontario neighbourhoods.

3.2.2 Survey Development

The survey was developed with input from attendees at the Ontario Sustainable Energy Association (OSEA) Community Solar Roundtable on October 24, 2007, including directors of the Toronto Renewable Energy Cooperative (TREC), Toronto Atmospheric Fund (TAF), and the WISE. Representatives of ARISE Technologies Corp, and faculty members at the University of Waterloo with experience in residential solar applications were also consulted. An interview was conducted with Jed Goldberg, President of Earth Day Canada and founder of the WISE, to further inform the survey questions and the general research topic. Informal observation was carried out within a number of community-based environmental interventions within the Greater Toronto Area and Waterloo Region.[78] These observations helped inform the analysis of primary data by providing context for respondent answers, and suggesting possible reasons for opinions and reported behaviours. Preliminary data were collected through a review of secondary materials and discussions with the parties mentioned above. A survey formerly used in a study of the Residential Energy Efficiency Project (REEP)[79] was used as a template for the survey of PV purchasers. (Subsequent versions of the survey, for SHW purchasers and non-purchasers, were based on the PV purchaser survey.)

Instructions for survey design were taken from *Methods in Human Geography* by Martin and Flowerdew (2005). Specifically, attention was given to the wording and design of questions - avoiding double-barreled questions, making questions relevant to the research hypotheses, avoiding leading questions, and ensuring the questions are geared at the right level of respondent understanding.

A draft of the survey was presented to University of Waterloo students and faculty during an energy research group meeting to solicit feedback on the questions. This draft was also sent to interested parties at TAF, TREC, and WISE several weeks after the above-mentioned roundtable meeting. Input from these stakeholders was then used to improve questions and remove unnecessary questions. A full list of survey questions, organized by respondent group (Table 5), can be found in Appendix A III: WISE Surveys. The survey questions were reviewed and approved by the Office of Research Ethics before invitations were sent to the first group (PV purchasers) of potential respondents. Recruitment materials can be found in Appendix A I.

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[78] CREW's Solar Initiative for Distributed Energy (SIDE), the Toronto Solar Neighbourhoods Initiative (TSNI), BikaPOLOoza! 2010, various events organized by The Bicycle Forest.

[79] The REEP initiative was similar in several respects to the WISE, as described earlier in Section 2.6.

Three surveys were administered, one to each respondent group. The surveys were composed of 25 questions (29 for SHW purchasers and non-purchasers) designed to explore:

(1) the strengths and weaknesses of the WISE
(2) motivations and barriers to participation
(3) demographic and behavioural characteristics of respondents

It is expected that information collected on these topics will be useful to answer the primary research question: "Why do some residents who express interest in having their house assessed for a solar energy system decide to purchase, and others decide not to purchase in the short-term?"

3.2.3 Survey Implementation

Efforts were made to minimize non-response. Since this study is sponsored in part by industry, it was important to avoid perceptions on the part of respondents that the survey was merely "market research" and therefore less valuable than a purely academic study. This was primarily addressed through the university ethics review process. The Office of Research Ethics required that participant contact information be obtained through proper channels. Permissions to use customer contact information was obtained from each customer by either the company sponsor or WISE organizers, and passed onto the research team for follow up. This led to informed consent. The non-response issue was also addressed in the wording of the survey and supporting documents, such as the information letter. An attempt was made to give the survey an educational component so that respondents experience a direct benefit from doing the survey.

After the initial invitations were emailed, two follow-up attempts were made: a phone call to each non-respondent, and second follow-up email to those who responded favourably to the phone call, but had still not completed the survey after several weeks. No additional follow-up was done for fear of arousing negative responses from participants, i.e., in order to avoid the perception of being "pestered". Ultimately, 46 surveys were returned, for a response rate of about 29 percent from the 160 who had initially signed up to have their home's solar resource assessed, and 39 percent of the 119 who responded to recruitment emails sent by ARISE and WISE.

The survey was administered to each respondent in one of two ways: 1) a face-to-face visit, during which the researcher led the respondent through the survey while recording their answers on a laptop computer, or 2) with the respondent completing the survey by themselves online. Respondents consisted of 15 homeowners who had purchased PV systems from the WISE's preferred PV vendor[80], ARISE Technologies Corp.,14 homeowners who had purchased a solar hot water system from the WISE's preferred SHW vendor, Globe Solar Energy Inc., and 17 Toronto homeowners who had not proceeded to purchase as of December 31 2007. Each respondent had agreed to participate in the study after receiving an email from ARISE or WISE explaining the purpose of the research. Respondents were given the option to complete the survey either in-person, or online. Based on their preference, seven PV purchasers were surveyed in-person. The remainder, including eight additional PV purchasers, 14 SHW purchasers, and 17 non-purchasers, completed the survey online.

The surveys conducted in-person were useful to determine whether respondents interpreted the questions as intended, to clarify wording of the questions when necessary, and to identify possible topics of interest that had not been included in the survey's initial draft. Follow-up questions were asked of some respondents in order to clarify their response and gain deeper understanding of the ability of community solar energy initiatives (CSEI) to overcome barriers to roof-top solar installations in Toronto. The face-to-face meetings also provided an opportunity to observe respondent reactions to questions, such as emotive and non-verbal cues. These cues provided richer insight into the affective nature of purchasers' decisions than could be gained from an online or telephone survey.

Respondents were compensated by entering them in a draw for one of three $50 gift certificates to a local restaurant. Respondents to the survey of PV purchasers were also emailed a copy of a final stakeholder report. All respondents will be sent a download link for this thesis if it receives committee approval.

Responses to closed form survey questions were exported from the survey software into Microsoft Excel for analysis. Open text responses were exported to a .txt file and then into Microsoft Word for coding.[81] Open text responses were analyzed for recurrent themes. Then the frequencies of these themes were assessed and condensed into the tables. These tables are the basis for the results and discussion offered in Chapter 4.

Question designs used in the surveys

Both open-ended and closed-response questions were used to measure respondents' perception and characteristics. Content analysis was used to organize and condense responses

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[80] Please see footnote 75 for a description of the term 'preferred vendor'.

[81] The development of categories and heuristics used to operationalise the 'codes' are described in chapter 4.

to the open-ended questions into tables (see Appendix A III). The closed-response questions used importance-scale ratings. These ratings were aggregated by means of a novel equation similar to equations used in probability theory to define expectation or probability density (see Chapter 4, questions A6, A8, and B2). Ordinal level data was represented as averages although this may not be correct and the reader is asked to look at differences with caution. While not meeting the fundamental assumption of ratio data, the ordinal data enables comparison.

Iterative analysis of self-reported survey data

The survey analysis was carried out in an iterative fashion. A small literature review was conducted for a pilot version of the study. CBSM was identified during this pilot phase as an area of academic research and project design that was relevant to the WISE case study. The researcher's supervisor provided a copy of a prior survey instrument, which had been used in a study of the Residential Energy Efficiency Project (REEP). This was used as a template and adapted to the present study of the WISE. The REEP survey was modified by the researcher, and ultimately included 26 questions in the case of PV purchasers, (29 in the case of SHW and non-purchasers). Most of the open-ended questions used very broad wording, asking for instance about "motivations for participating in the WISE", or "disadvantages of PV systems" generally. The use of broad questions was intended to allow respondents the freedom to identify perceived motivations and barriers to adoption of solar energy through the CSEI case study that might not have previously been examined in the literature.[82] The textual data was examined for patterns, topics and themes using content analysis tables (further explained in Appendix A III). Once patterns had been identified, the researcher returned to the literature to look for studies and theories that might be useful to help explain these patterns. This second literature review was intended partly to allow the primary data to be made relevant to the academic literature. This was important to ensure that the research would make a contribution, reinforcing findings in the literature as well as providing genuinely new insights. Diffusion theory's innovation attributes were identified as providing a suitable framework for analysis, with some adaptation to reflect the particular nature of solar energy adoption in a community context. After the framework was developed, the primary data were then re-analyzed in order to apply the DoI framework to explain adoption behaviour.

[82] It should be noted that this open-ended approach differs from other studies in the DoI literature, such as Faiers, Neame, and Cook (2007) who used a questionnaire based directly on six standard innovation attributes.

3.3 Study of Household Electricity Performance

The investigation of household behaviours and characteristics included an assessment of household electricity performance. This assessment compared the amount of electricity generated by some of the WISE PV-adopter households to these same households' consumption levels. This comparison provided an objective measure of net[83] electricity performance for eight households who purchased a PV system through the WISE.

3.3.1 Implementation of household electricity performance study

In October 2008, an email was sent to Jim MacDougall, Manager of Distributed Generation at the OPA to request disclosure of utility account information for RESOP participants. Mr. MacDougall referred the researcher to 'Exhibit B' of the RESOP rules. (Exhibit B of the Standard Offer Program rules is a letter for authorizing a Local Distribution Company to release information relating to the RESOP applicant and a Load Customer to the OPA.) Exhibit B was emailed to the researcher by Manyu Liang, a co-op student working at the OPA under the supervision of Mr. MacDougall. Exhibit B was modified for submission to Toronto Hydro to authorize the release of PV purchaser household electricity production and consumption data. The researcher then emailed Joyce McLean, Director of Strategic Issues at Toronto Hydro, to ask whom the appropriate contact person at Toronto Hydro might be. Ms. McLean referred the researcher to Gordon Baird, Supervisor of Customer Management Services at Toronto Hydro. The modified version of Exhibit B, which will be hereafter referred to as "the consent form", was emailed to Mr. Baird for him to review. A number of clarifications were sought between the researcher and Mr. Baird, and the consent form was revised accordingly. (The final version of the consent form administered to PV purchasers can be found in Appendix B II.)

In the fall of 2009, contact information for 31 PV system owners was provided from WISE organizer, Ken Traynor, on the researcher's request.[84] Survey invitations were emailed to 31 PV purchasers in October. (Please see Appendix B I for recruitment materials used in the study of household electricity performance.) Efforts were made to minimize non-response: one follow-up phone call and one email were sent to each non-respondent. Ten PV purchasers responded affirmatively. Consent forms were emailed to these 10 respondents. Eight households were

[83] "Net" is used in the sense of a net zero-energy building (ZEB), as defined by U.S. National Renewable Energy Laboratory (NREL, 2006: 1).

[84] This number is larger than the 24 PV purchasers in the survey sample frame because more Ward 21 residents had purchased a PV system by the time the quantitative study was carried out (Fall 2009).

ultimately included in the study.[85] Six of these eight respondents were found to be present in the sample of 15 PV purchasers previously surveyed. Two could not be confirmed present in the survey sample (due to anonymity).[86]

No remuneration was offered to participants in this study. (The purchase contracts signed by PV purchasers included a clause to participate in university research.)

Consent forms adapted from the Ontario Power Authority's "Exhibit B" were administered via email to the 10 WISE PV system owners who responded to the recruitment letter. Eight forms were returned. These were then submitted to Gord Baird, a manager of customer relations at Toronto Hydro, who authorized a member of his staff, Deepika Samadder, to send the researcher household electricity consumption data. PV system production data were obtained from a Toronto Hydro billing specialist, Joanne Gavros, in a similar manner. Electricity consumption and PV production data were obtained from eight households that purchased PV systems through the WISE was conducted in Spring 2010.

Table 6 - Study and sample populations of the electricity performance study

	Returned consent form (therefore, a respondent or participant)	Did not return consent form (therefore, not a respondent or participant)	Total
WISE PV purchaser households	8	23	31

Electricity consumption among WISE households was recorded independently of PV electricity production. The PV systems were not net-metered, but rather connected to the grid through an independent "grid-selling" meter. Therefore, the term "household consumption" in this study represents total household consumption, and is independent of the amount of electricity produced by the PV system.

Data were drawn from utility account records. Consumption data (kWh) for each of the surveyed households cover the period from January 2005 through December 2009. Production data (kWh) for each PV system covers the period from March 2008 through December 2009. Households are assigned an anonymous identifier, a digit between 1 and 8, to protect account

[85] One respondent declined to complete the consent form, on grounds that its requests were "too broad". A second respondent didn't return the consent form despite a follow-up email, a phone call reminder, and an in-person reminder.

[86] This is because one of the PV purchaser surveys was returned anonymously and the survey sample was larger than the electricity performance study sample. Hence, the one survey that was returned anonymously could have belonged to either of the two respondents present in the electricity performance study, or neither of them.

holders' privacy.[87]

There were outliers in the consumption data for Household 2 in Feb-March 2005 and April-May 2005. The recorded values were 2417.6 kWh and 46.7 kWh respectively. A likely explanation for the huge consumption recorded one period and small amount the next is a misreading of the meter.[88] To correct this, 1000 kWh was subtracted from March 2005 and added to May 2005. Values of 1417.6 kWh and 1046.7 kWh were substituted for March and May respectively. The July value for Household 7 consumption was missing. An estimate of this value was substituted, using an average of adjacent values (one period before and after).

The Toronto Hydro data were provided in bi-monthly intervals. Heating degree days (HDD) and cooling degree days (CDD) were used to temperature-adjust the annual consumption data. See Appendix B III for a description of methods used for the weather normalisation.

Analysis of consumption and production data was completed in April 2010 for the eight households. Regression analysis was done using time as an explanatory variable and bi-monthly temperature-adjusted household electricity consumption as the response (dependent) variable. Data were plotted and visually inspected for similarities and differences. Explanatory variables considered in the analysis were (1) time, (2) HDD, and (3) CDD.

3.3.2 Limitations of the study of household electricity performance

It was acknowledged above that systematic error due to non-response limits the extent to which results of this study can be generalized. Further consideration was given to a possible 'Hawthorne effect'[89] contributing to lower-than-average consumption among PV purchaser. Such an effect is regarded as unlikely, as the purchasers were not made aware of the measurement study (at least by the researcher) until three months before the end of the period over which their data were collected. Electricity data was not sought from the WISE non-purchasers. This was due to time and resource constraints on the part of the researcher, and of

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[87] 10 identifiers were used rather than eight since it was the researcher's hope that the respondents would submit their consent forms before analysis had been finished, and could be included in the study. This however was not the case.

[88] By way of justifying the transfer of 1000 kWh from the period February-March to the period April-May, the following explanation is offered. A sudden drop is observed in the February-March period, and a roughly equal rise in the following 2-month period. This was suggestive to the researcher and his supervisor of measurement error, rather than a representation of actual consumption over those periods.

[89] The central idea of the Hawthorne Effect is that behavior during the course of an experiment can be altered by a subject's awareness of participating in the experiment (Jones, 1992).

staff at the local utility company. The researcher also anticipated difficulties accessing data from the non-purchaser cohort.

3.4 Overall Research Design Limitations

3.4.1 Representativeness and Intended Audience

Sampling biases due to non-response mean that any definite conclusions from this research apply only to respondents. However, despite the lack of statistical representativeness, it is expected that the case study will be useful to a wider audience for its insight into one particularly successful CSEI. The applicability of findings to other populations is expected to depend on the extent to which that population shares the characteristics of respondents in this study.

One potential limitation to consider before generalizing the findings in this study to other regions in Ontario is that Ward 21 is considered to be a progressive ward in the city of Toronto with respect to environmental awareness, as well as community and civic involvement.

In generalizing the findings to WISE participants as a whole, it should be noted that there was a 56 percent[90] response rate among purchasers and only 22 percent[91] response rate among non-purchasers, based on the sample frame of 119. The resulting number of respondents in each group is small in size (15 PV purchasers, 13 SHW purchasers, and 17 non-purchasers respectively) so the findings presented here must be treated with caution. They represent the opinions expressed by respondents and are in general agreement with the broader literature on early adopters.

3.4.2 Considerations in studying the diffusion process by means of a survey methodology

Rogers (1976) cautions about the use of survey methods for studying diffusion. Since diffusion is a process, studying it by means of what he characterizes as a "snapshot" methodology can pose certain problems. This Rogers calls the "change over time" issue and concerns respondents' abilities to look back and mentally reconstruct past history (p. 295). Specifically,

[90] 15 PV purchaser respondents from a study population of 24, and 13 SHW purchase respondents from a study population of 26.
[91] 17 non-purchaser respondents of 77 potential non-purchaser respondents.

Rogers identifies three factors that can affect respondents' recall accuracy: (1) the innovations' salience to the respondents; (2) the length of time over which recall is requested; and (3) individual differences in education, mental ability at the time of the survey, etc. In response to Rogers' caution, it is acknowledged that this research might better have used a more process-oriented methodology. A narrative analysis of media articles could have been used to reconstruct the history of CSEIs in Toronto, going back to the Solar Pioneers program of the late-1990s (Greenpeace, 2007; Parker, Rowlands, and Scott, 2003). However, recall error is not expected to affect the validity of this study, because respondents are asked mainly about current perceptions rather than past experiences. Also, a certain degree of continuity in process evaluation can be obtained by means of a literature review that includes studies of the same phenomenon by other researchers. Murray (2006) and Adachi (2009) are two prior studies that investigated solar energy adoption among homeowners who signed up for solar resource site assessment with one of the Our Power CSEIs.

Alternative sources of data can also be used to provide validity checks on recall data over time (Rogers, 1976). In addition to purchasers and non-purchasers, one organizer was also interviewed, and there were periodic communications with a number of industry representatives with knowledge of the process. This communication took place informally at industry conferences, and consisted of asking questions such as, "how many PV systems have been connected?", "have any issues arisen with the [solar energy] systems installed through the WISE?", etc. Answers to these questions were used to triangulate[92] on survey content. For instance, information from vendor staff about metering delays was used to corroborate respondent complaints about delays in grid connection.

3.4.3 Acknowledgement of common biases in diffusion research

Brief responses are offered to two other biases found in diffusion research: (1) inherent pro-change bias, which assumes that the innovations studied are "good" and should be adopted by everyone, and (2) assumed causality (Rogers, 1995: 100).

Pro-innovation bias

It is proposed that given the seriousness of climate change, there is a need for significant change to modern energy systems. While solar energy systems are considered part of the solution to mitigating climate change, one caveat is offered: "innovation" per se may in some cases be less important than looking back to pre-industrial periods for models of urban form

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[92] The reader is referred to Appendix A(IV) for a more detailed description of how triangulation was used in this study.

and social organization that are not premised on cheap, abundant hydrocarbon fuels. Similar lessons might be found by studying cultural and behavioural norms in non-industrialized societies, for instance those where dance and music are more common than energy-intensive recreations.

Causality

Rogers (1995) reports that pro-innovation bias and overwhelming reliance on correlational analysis of survey data has led in the past to avoiding or ignoring the issue of causality. It is acknowledged as a limitation of the present study (specifically the quantitative survey) that findings will be limited to the correlation of electricity consumption with time and purchase of a PV system through the WISE. Future research could explore correlations with solar energy adoption more generally, or go further to test causality between variables such as solar energy adoption and energy conservation.

Table 7 describes the general purposes and research methods used in social science research. The table is used to situate this thesis with respect to the broader literature, and in particular other studies of diffusion of innovations. Stage 2, *variable identification,* indicates the research focus of the open-ended survey questions (light grey shading). Stage 3, *determination of relationships among variables*, (grey shading) indicates the focus for the importance-scale questions, as well as the investigation of household electricity performance. The dark grey shading indicates steps for future research.

Table 7 - A classification of stages in social science research

Research Stages	Research Purpose	Research Method
1. Problem delineation	To define what we are looking for, and the extent to which it is a social problem	Qualitative analysis, such as case studies, observation, unstructured interviews, and literature review
2. Variable identification	To identify variables which might be linked to the problem, and to describe possible interconnections between these variables	Exploratory case studies, and other qualitative methods that are low on structure
3. Determination of relationships among the variables	To determine the clusters of relevant variables required for prediction, and to analyze their patterns of relationships	Cross-sectional, correlational analysis of quantitative survey data
4. Establishment of causality among the variables	To determine which factors are critical in promoting or inhibiting the problem	Longitudinal studies, and small-scale experiments with (1) over-time data, (2) in which at least one variable changes prior to the others, so as to determine time order
5. Manipulation of causal variables for policy-formation purposes	To determine the correspondence between a theoretical problem solution and the manipulable factors	Field experiments
6. Evaluation of alternative policies/programs	To assess the expected, as well as the unanticipated consequences of various programs/policies before and after they are applied on a large scale, and to determine the effectiveness of such programs in overall problem solution	Controlled field comparisons, such as the interrupted time-series field experiment

Source: Rogers, 1976: 296

Integration of open-ended and closed-response questions

Chapter 4 presents the study's empirical findings according to content area. This sequence is explained more fully in the introduction to Chapter 4. Connections are made in Chapter 4 between the literature and the empirical data on a topic-by-topic basis, rather than in an integrated way.[93] The framework for analysis from Chapter 2 is used in Chapter 5 to organize the topic-based results reported in Chapter 4 into integrated conclusions about adoption behaviour in the CSEI case study. This is done by passing each finding through an interpretive lens of the framework for analysis developed in Chapter 2. Findings are based on both open-ended and closed-response (importance-scale) questions.

[93] Integrated in the sense of bringing together the material from chapters 2 and 4--social and technical disciplines integrated with issues of fuel substitution and energy conservation--to answer the primary research question about adoption behaviour.

4 Results and Discussion

4.1 Introduction

Findings are presented from three surveys of homeowners who participated in a community-based solar energy initiative in a municipal ward of Toronto, the West Toronto Initiative for Solar Energy (WISE). Three cohorts were surveyed: non-purchasers, solar photovoltaic (PV) system purchasers, and solar hot water (SHW) system purchasers. All surveys contained three sections (1) an evaluation of the community initiative, (2) motivations and barriers to participation, and (3) household characteristics (demographics). Household electricity data were also collected. These measured data provide a level of objective verification of self-reported energy behaviours among the 15 WISE PV purchasers.

The discussion under each heading is based on either a content analysis table compiled from responses to open-ended questions, or a summary table of responses to closed questions. These tables are in Appendix A III.[94] Should the reader wish to refer to one of the tables, each content area[95] is labeled with the corresponding survey question identifier (e.g. Question A1).

To aid reader interpretation, and to more clearly answer the primary research question[96], the survey findings presented in this chapter have been re-organized around three topics: 1) household characteristics, 2) respondent perceptions of the community solar energy initiative (CSEI), and 3) perceived motivations and barriers for the purchase of a solar energy system.

Unless otherwise stated, the number of respondents to each question is 17 for non-purchasers, 15 for PV purchasers, 13 for SHW purchasers, and 47,085 for Ward 21. In the discussion of each content area, non-purchaser responses are discussed first, followed by a comparison of non-purchaser responses to those of purchasers (PV and SHW). In some cases, all three respondent groups are discussed separately before cross-comparisons are made; in other cases, the discussion of purchaser responses has been condensed into the cross-comparison. Rather than presenting the results of all cross-comparisons, only those comparisons that are useful to the research purposes (as introduced in Section 1.4) have been included.

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[94] Except in cases where the table conveys the data more concisely than the text.

[95] A content area here is defined as portions of text that address a specific topic in a survey. This definition is adapted from Graneheim and Lundman (2004:106-107) to suit the present study context; an example is provided in Appendix A III. Each survey question was designed to investigate one content area.

[96] i.e., why some residents who signed up with the WISE decided to purchase in 2007 and others did not.

4.2 Characteristics of WISE Households

4.2.1 Demographics

Demographic characteristics for Ward 21 have been used to profile the neighbourhood as a whole.[97] The population of Ward 21 can be thought to be roughly analogous to the majority market, while non-purchasers are analogous either to "innovators" or possibly "early-adopters"[98], and purchasers to "innovators". By comparing the household characteristics of each group, insight is gained into their similarities and differences, which in turn can help explain adoption behaviour.

Age distribution of survey respondents
Question C1, closed, n = 46 (15 PV purchasers, 13 SHW purchasers, 17 non-purchasers)

The weighted averages in Table 8 suggest that WISE participants tended to belong to the "baby boom" demographic.[99] SHW purchasers were on average older than PV purchasers and non-purchasers, however the differences are not large: five and three years, respectively.

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[97] While this was not an experimental study, the segregation of WISE PV purchasers from WISE non-purchasers from Ward 21 as a whole constitutes an effort to compare selected variables of the population based on likelihood to adopt.
[98] All WISE participants (both purchasers and non-purchasers) make up less than 2.5% of the Ward population, and would therefore be considered according to DoI theory to belong to the innovator adoption category. However, the views expressed by non-purchasers correspond more closely to those attributed by Faiers and Neame (2006) and LaBay and Kinnear (1981) to members of the early majority.
[99] The Baby Boom began in 1946, peaked in 1957 and ended sometime between 1964 and 1972. (Mankiw and Weil, 1989; Bouvier and DeVita, 1991)

Table 8 - Age distribution of survey respondents

Decade	Proportion of PV purchaser responses	Proportion of SHW purchaser responses	Proportion of Non-purchaser responses	Ward 21 Profile*
<1940	0.00	0.08	0.00	0.15
40s	0.19	0.15	0.35	0.11
50s	0.50	0.54	0.35	0.15
60s	0.19	0.23	0.18	0.16
70s	0.06	0.00	0.12	0.17
80s	0.06	0.00	0.00	0.12
≥1990	0.00	0.00	0.00	0.14
Total	1.00	1.00	1.00	1.00
Weighted Average[100]	1958	1953	1956	1965

***** Age demographic categories differ by two years from WISE survey categories.[101]

Size and age distribution of households

Question C2, closed, n = 32 (15 PV purchasers, 17 non-purchasers)

Non-purchaser vs. PV purchaser households

More than half of non-purchaser households comprise middle-aged couples with children under 30, which is similar to the result for PV purchasers. The age distribution in non-purchaser and PV purchaser households is similar, with about half of the households consisting of middle-aged couples with children under 30.[102] This lack of difference is consistent with LaBay and Kinnear's (1981) finding that attitudinal characteristics are a better indicator of likelihood to adopt than demographics.

Non-purchasers vs. PV purchasers vs. Ward 21

Figures 7 and 8 show that WISE households are much more likely than Ward 21 households to have two to four cohabitants.

[100] Weighted average = ∑(decade mid-point)*(percent frequency)

[101] These categories are: 1931 and earlier, 1932-1941, 1942-1951, 1952-1961, 1962-1971, 1972-1981, 1982-1991, 1991 and later. The reason for these seemingly unusual decadal ranges is that the City of Toronto categories are based on age ranges of 5 years, and were collected in 2006, while the researcher's categories are based on decade of birth.

[102] n= 10, 59%[102] of non-purchasers, n = 8, 44% of PV purchasers.

Figure 7 - PV purchaser and non-purchasers households by size

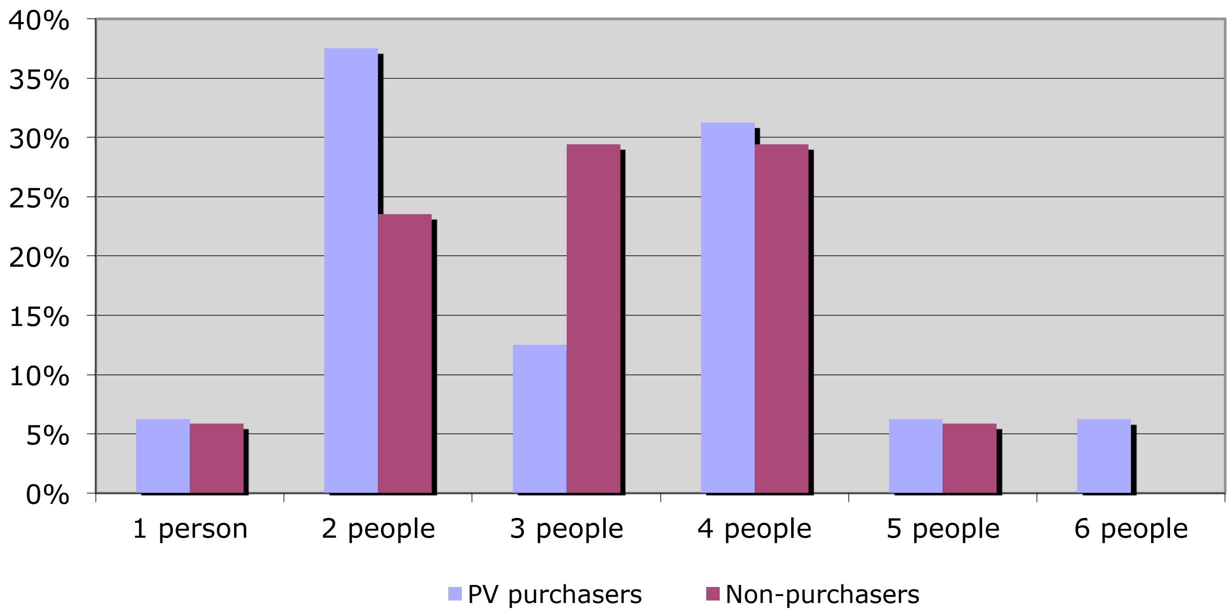
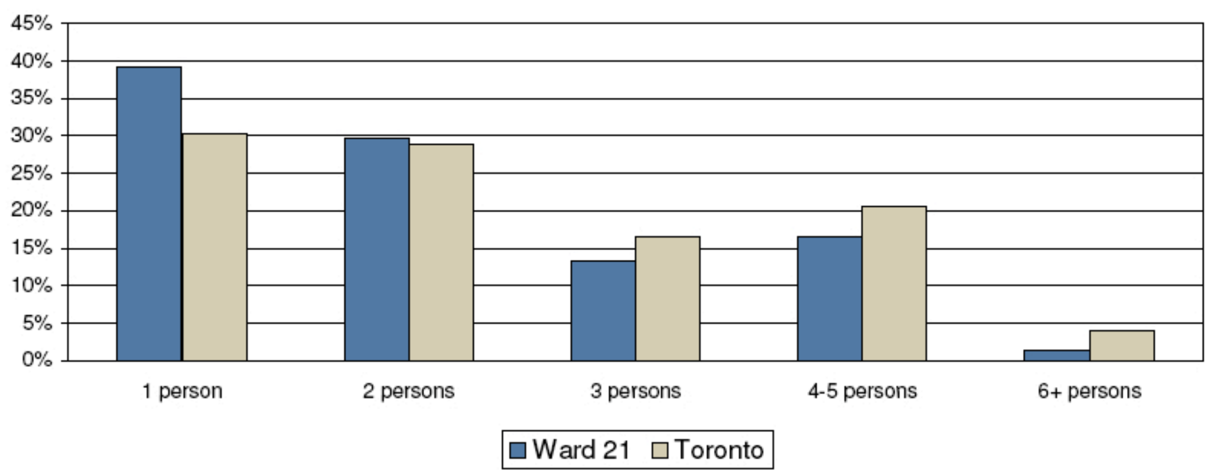


Figure 8 - Private households by size - 2006



Source: City of Toronto, 2006

Respondents were pre-selected as homeowners with an interest in solar energy. Recognizing that purchasers needed to own their own home while also being young enough to outlive a 15-20 year payback period, one would expect to find a much higher percentage of middle-aged couples with children relative to the general population.

How often respondents discuss energy issues with family, friends, and trades people
Question C3, closed, n = 32 (15 PV purchasers, 17 non-purchasers)
Note to reader: a table with the full results for this question is in Appendix A III

Non-purchasers vs. PV purchasers
Non-purchasers talk nearly as often about energy issues with their family as do purchasers. However, PV purchasers talk about energy much more often with friends than do non-purchasers. Taken together, these results may indicate that non-purchasers regard energy as more of a household expense than a topic of social/cultural interest.[103] This pattern supports anecdotal evidence that homeowners talk to their spouses and children about energy use as it relates to the household budget, e.g. turning off lights and taking shorter showers to avoid "wasting electricity/energy", but that they don't talk as often about broader energy issues in social/cultural contexts, i.e., with friends and neighbours. This finding suggests a metric by which a "culture of conservation" could be measured. Presumably a "culture of conservation" would be one in which energy is a topic for social conversation beyond immediate household finances. Therefore, the extent to which respondents talk to friends about energy issues could be used as a measure of the degree to which they belong to such a culture. Socialization characteristics identified by Granzin and Olsen (1991) and Shrum (1995: 80) led Rowlands, Scott and Parker (2003) to examine a number of hypotheses that related socialization characteristics to environmental attitudes. A brief proposal for future research into a culture of conservation is offered in Section 5.4.

Highest level of education attained by someone in household
Question C4, closed, n = 46 (17 non-purchasers, 15 PV purchasers)

Non-purchasers vs. PV purchasers
Non-purchasers and PV purchasers exhibit different patterns with respect to education type. The two groups are similar in that all respondents have achieved at least a Bachelor's degree.[104] However, non-purchasers are nearly three times more likely than purchasers to hold a professional degree. Conversely, purchasers are 70% more likely to hold a graduate degree. In other words, PV purchasers were found to be more highly educated outside of the professions.[105]

[103] An alternate interpretation is that non-purchasers talk less often to their neighbours than PV purchasers do.
[104] There is 23.5% (non-statistical) uncertainty in this statement, and all other statements in the discussion of question C4. This is because it is possible that all respondents who chose not to answer do not have a Bachelor's degree.
[105] 50% of purchasers hold graduate degrees vs. 30% of non-purchasers.

Non-purchasers vs. PV purchasers vs. Ward 21

WISE participants are more educated than Ward 21 residents as a whole. The percentage of non-purchasers holding professional degrees stands out next to the Ward 21 profile. It is possible that some participants interpreted "professional degree" too broadly, for instance including the professional trades or technical certificates. If the non-purchasers claiming to have a professional degree do indeed belong to the professions[106], this suggests an approach to marketing to WISE non-purchasers by tailoring marketing efforts to values, norms and networks of professionals (see Section 5.3.1 "Communicability"). Finally, Ward 21 on the whole is more educated than other Toronto wards.[107]

Table 9 - Highest level of education attained by someone in household

	Graduate Degree (Masters, Ph.D.)	Professional Degree (MD, LL.D., etc.)	University (Bachelor) Degree	Some university or lower	Choose not to answer	Total
PV purchasers	50.0%	12.5%	37.5%	0%	NA[108]	100%
Non-purchasers	29.4%	47.1%	0%	0%	23.5%	100%
Ward 21[109]	13.3%	6.6%*	24.3%	55.8%	NA	100%

Approximate annual income (pre-taxes) of household

Question C5, closed**,** n = 41 (13 non-purchasers, 15 PV purchasers, 13 SHW purchasers)

Income categories:

___ under $40,000 ___ $80,000 to $119,999 ___ $160,000 to $199,999

___ $40,000 to $79,999 ___ $120,000 to $159,999 ___ greater than $200,000

Non-purchasers

Almost half (46.5%) of non-purchasers report household incomes between $80,000 and

[106] Sum of "Degree in medicine, dentistry, veterinary medicine" and "University certificate above bachelor level"

[107] 86% of Ward 21 residents have a certificate, diploma, or degree vs. 79.6% of Toronto residents (City of Toronto, 2009).

[108] Note on possible source of error: the lack of a "Choose not to answer" option in the survey delivered to purchasers makes the comparison of the two groups' answers less reliable.

[109] Data drawn from the City of Toronto, Ward Profiles, 2006.

$200,000. The weighted average[110] of non-purchaser responses is ~$134,000. When considered together with a later finding (Section 4.4.1, question B2) that "payback" is almost as important as "initial cost", this result provides a clearer picture of non-purchasers as a fiscally prudent, wealthy sub-segment of the "practical majority".

Non-purchasers vs. PV purchasers

More than half (56.3%) of the PV purchasers had incomes in the upper middle-class range.[111] Figure 9 shows that PV purchaser responses were bimodal, with a large peak (46%) in the $80,000-$120,000 income bracket and in the high-income bracket. Non-purchasing household incomes were distributed much more uniformly across each income bracket above $40,000.

Here, as in question C4[112], the small sample size of purchaser respondents along with their peculiar distribution relative to the neighbourhood as a whole, suggests that respondents may belong to a sub-community[113] within Ward 21.

Non-purchasers vs. PV purchasers vs. SHW purchasers vs. Ward 21

The demographic data available for Ward 21 was collected for very different data ranges.[114] The Ward 21 upper income category is >$100,000, while the WISE survey uses an upper category of >$200,000. It is nevertheless clear that the distributions of both purchasers and non-purchasers are centered much higher than the distribution of the ward overall. The weighted average incomes are $125,060 for PV purchasers, $133,927 for non-purchasers, $124,031 for SHW purchasers, and $58,780 for Ward 21.[115] Based on the respondent sample, it appears that non-purchasers are the highest-income cohort, followed by PV-purchasers and SHW purchasers (whose mean incomes are similar). All three WISE cohorts report higher household incomes than the Ward 21 average. However, due to non-response, no definite conclusions can be drawn concerning mean income of the WISE cohorts. It is interesting to note that the only household to report an income below $40,000 is a PV purchaser household.

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[110] Category midpoints were used to calculate average income for each respondent group.

[111] $80,000-$119,999

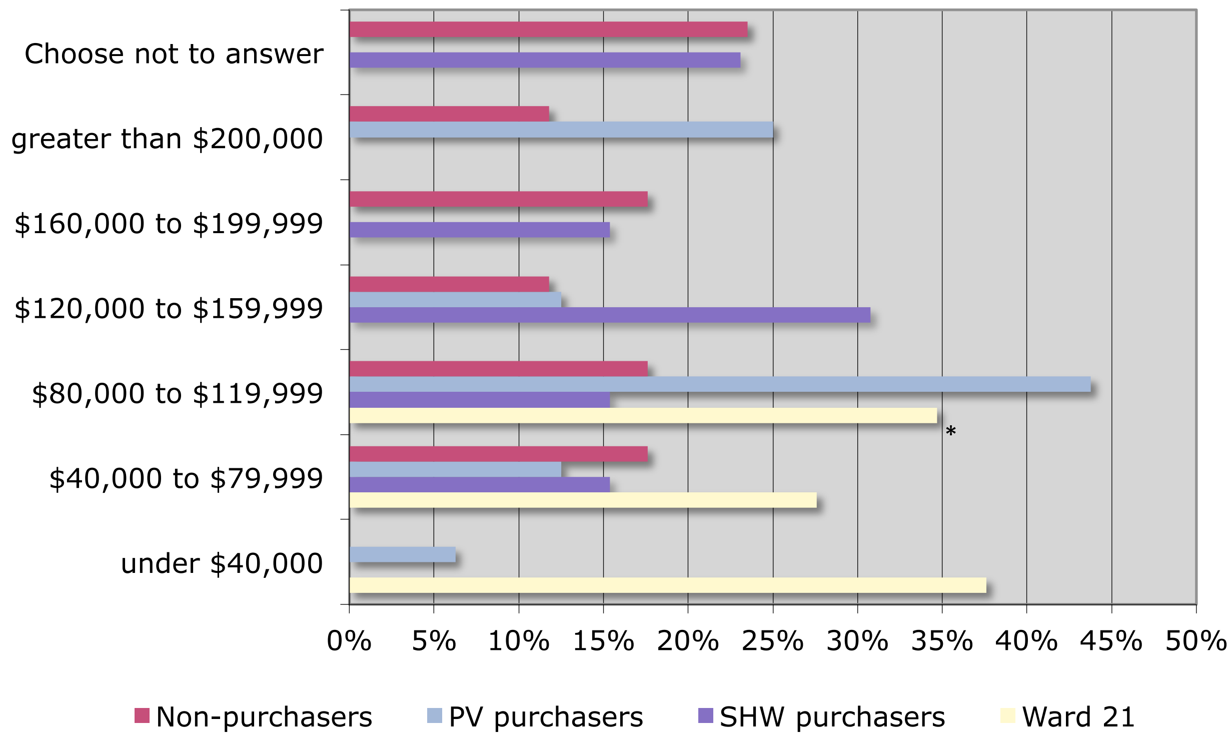
[112] E.g., medical or law professionals

[113] A condensed version of Etzioni's (1996: 5) definition of community is provided for convenience and clarity: affect-laden, criss-crossed relationships between people with shared values.

[114] The income brackets reported in the City of Toronto Ward Profiles do not distinguish above $100,000. All households with incomes above 100,000 are reported in an "$100,000 and over" category. Since the same resolution of income data above $100,000 as was gathered for WISE participants was not available for Ward 21 households, the plot places all households with incomes of $80,000 and above in the $80,000-$119,999 category.

[115] weighted average = ∑(income bracket mean)*(percent frequency)

Figure 9 - Household income



*includes all Ward 21 households with incomes above $80,000 (explanation in footnote 124)

Uncertainty from non-response to questions about income and education

Given that almost half the respondents are highly educated professionals, some portion of those who chose not to answer may belong in the "greater than $200,000" household income bracket. For example, the purchasers' household income distribution has a large spike (26%) above $200,000, and both groups are highly educated compared to the general population. An alternative interpretation is that the same respondents who chose not to answer C4 about education, also chose not to answer this question about income. Since income and education level are highly correlated (Florida, 2009), those who chose not to report their education and income levels would have skewed the answer distribution for both questions in the same direction.

Number of years respondent has lived in current home

Question C6, closed, n = 32 (17 non-purchasers, 15 PV purchasers)

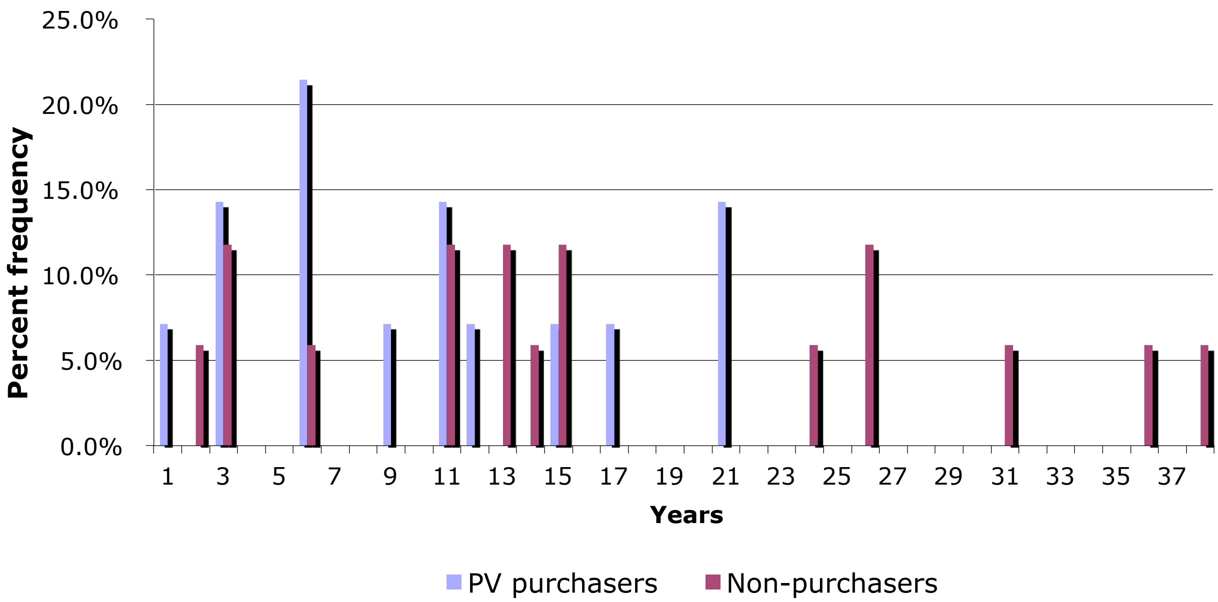
Non-purchasers vs. PV purchasers

Overall, non-purchasers have lived in Ward 21 for longer than purchasers have. Table 10 shows that the minimum and all four quartiles (including the mean) are larger for non-purchasers than for PV purchasers. The length of time a respondent has lived in their home appears to be a factor in their adoption decision, i.e., those who have lived in their home for more than 25 years did not purchase (Figure 10).

Table 10 - Years respondent has lived in current home

Years in Home Quartiles		
	PV purchasers	Non-purchasers
Minimum	0	1
First quartile	5	10
Mean	11	16
Third quartile	17	25
Maximum	22	37

Figure 10 - Distribution of respondents according to number of years in current home



Number of years respondent has lived in a West Toronto neighbourhood
Question C7, closed, n = 32 (17 non-purchasers, 15 PV purchasers)

Non-purchasers vs. PV purchasers

Non-purchasers have lived in the neighbourhood for slightly longer than purchasers. Table 11 shows that the minimum and all four quartiles (including the mean) are larger for non-purchasers than for PV purchasers. The differences between the groups are negligible. However, the fact that three-quarters of both groups have lived in the neighbourhood for at least ten years shows that WISE participants are not new to the ward, and presumably feel strongly connected, or "rooted" in their neighbourhood.

Table 11 - Years respondents have lived in a West Toronto neighbourhood

Years in Neighbourhood Quartiles		
	PV purchasers n = 15	Non-purchasers n = 17
Minimum	0	2
First quartile	10	14
Mean	20	25
Third quartile	25	35
Maximum	50	45

Number of years respondent expects to live in current home
Question C8, closed, n = 32 (17 non-purchasers, 15 PV purchasers)

Non-purchasers vs. PV purchasers

Non-purchasers report somewhat shorter expectations about how long they will live in their home (Table 12). It is important to note that 75% of non-purchasers plan to move within 20 years. This means they would expect to move before their SOC contract expired. However, less than half of purchasers expected to move within 20 years. This difference is consistent with findings in Section 4.4 (question B2) that non-purchasers place a higher importance than PV purchasers on "planning to move" and "not being able to recoup resale value" (1.18 vs. 0.76 out of 4).

Table 12 - Years respondents expect to live in current home

Years to be in Home Quartiles		
	PV purchasers n = 15	Non-purchasers n = 17
Min	5	5
Q1	13	8
Mean	23	17
Q2	30	20
Max	50	50

Type of car owned and membership in car sharing organization
Question C9, mix of open and closed, n = 32 (15 PV purchasers)

PV purchasers were asked what type of car they own and whether they belong to a car sharing organization. Interestingly, one-quarter of PV purchasers own hybrid vehicles. One said they belonged to a car-sharing group.[116]

[116] Unfortunately, the questions about car type and carshare membership were accidentally omitted from the surveys of SHW purchasers and non-purchasers.

Respondent awareness of green energy retailer (Bullfrog Power)
Question C9a, closed, n = 32 (17 non-purchasers, 13 SHW purchasers)

The vast majority (88%) of non-purchasers have heard of Bullfrog Power. The responses of SHW purchasers were similar (85% YES). PV purchasers did not receive the question.[117]

Table 13 - Respondent awareness of green energy retailer (Bullfrog Power)

	Number of non-purchasers	Percentage
Yes	15	88%
No	2	12%

Respondent adoption of green energy retailer (Bullfrog Power)
Question C9b, closed, n = 30 (17 non-purchasers, 13 SHW purchasers)

The vast majority of non-purchasers do not subscribe to Bullfrog Power. The responses of SHW purchasers were similar (15% YES). PV purchasers did not receive the question.

Table 14 - Number of respondents subscribed to green electricity retailer

	Number of non-purchasers	Percentage
Yes	2	12%
No	15	88%

It is interesting that the answers to the above two questions are inverses of each other. 88% have heard of Bullfrog, but only 12% are subscribers. This, along with their participation in WISE, suggests that non-purchasers are aware of renewable energy options, but may not fully understand or appreciate the benefits and/or are typical of the "practical" majority, who require some financial benefit in order to adopt.[118] In other words, Bullfrog has made these homeowners aware that their company exists, but has not persuaded them to subscribe. Similarly, the WISE organizers have made these homeowners aware of their program, but have not persuaded them to adopt. This agrees with Rogers' theoretical stages of adoption (1) awareness (2) persuasion (3) adoption (4) implementation (5) confirmation.

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[117] This is because the survey of PV purchasers was administered before the survey of non-purchasers, and before the researcher had thought to include this question.
[118] Faiers and Neame (2006: 1805) state, "the 'chasm' [between 'early adopters' and the 'practical majority'], previously considered by Moore (1999) to exist primarily in the hi-tech sector, is also applicable to other technologies and innovations. The barriers to the adoption of domestic solar systems lie primarily with the financial aspects of the systems."

4.2.2 Household Electricity Performance

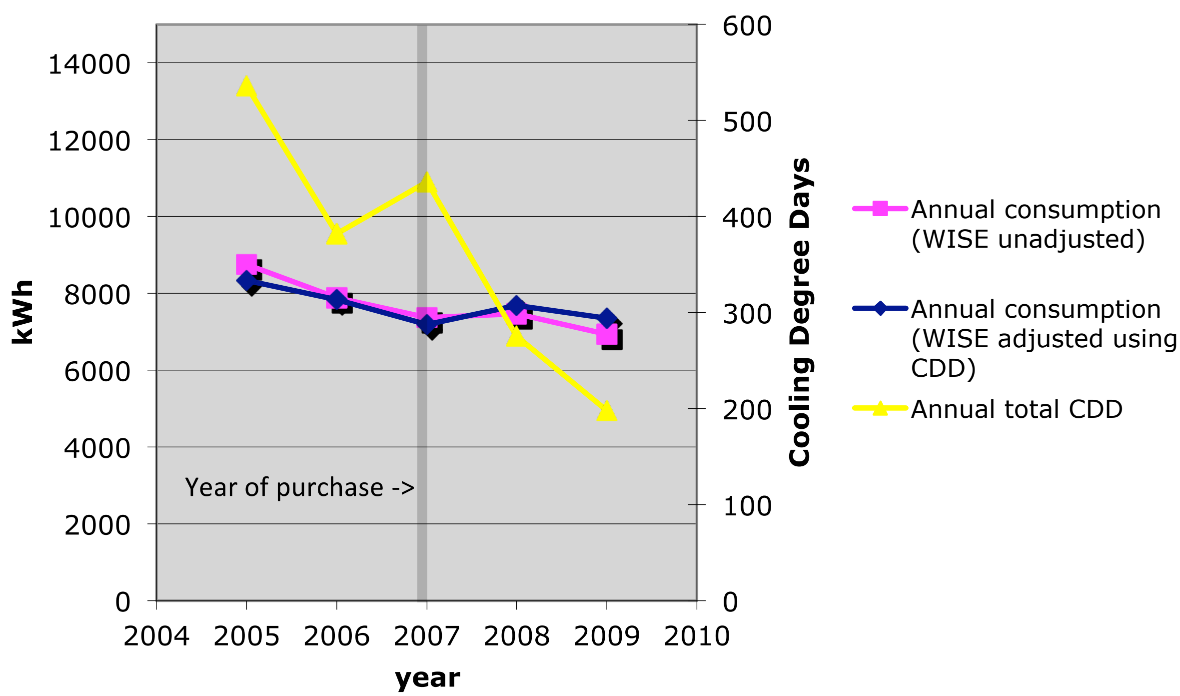
Introduction

This section presents findings based on electrical utility account data from eight WISE PV-adopting households in Ward 21.[119] The consumption from each household is compared to the production of electricity from the solar PV system installed on its roof.

Results and Discussion

The consumption data were plotted with trend lines that compared average annual changes in residential consumption for each of the eight homes with PV installations. Heating degree days (HDD) and cooling degree-days (CDD) are a proxy for the amount of electricity used by homes to maintain "a comfortable temperature of approximately 18°C" (Environment Canada, 2009). While annual HDD readings were fairly stable over the five-year study period, CDD varied from year to year with a gradual decline from 500 to 200 degree days. It was important therefore to account for CDD as it was strongly correlated with consumption data.[120] A decrease was found among the eight WISE PV-adopting households over the five-year period spanning January 2005 to December 2009 (Figure 11).

Figure 11 - Temperature-adjusted electricity consumption



[119] At least six of these eight belong to the cohort of PV purchasers who participated in the self-reported surveys.

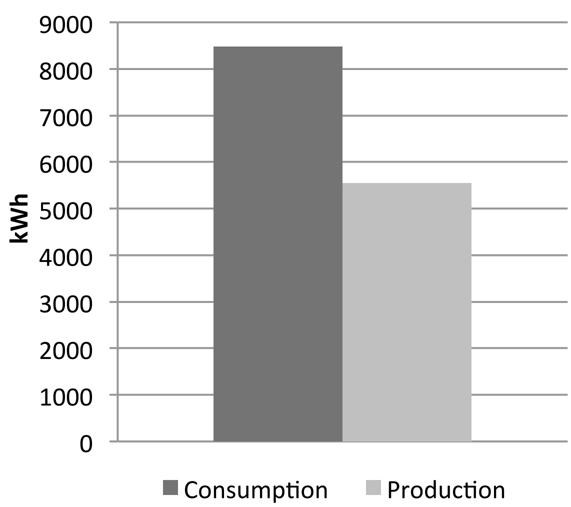
[120] r^2 = 0.946 for CDD and -0.184 for HDD

The observed decrease in electricity consumption may be indicative of a gradual process of education and action taking place within the households around energy issues. Electricity price trends in Ontario over the 5-year study period may have also affected electricity consumption behaviours in these eight WISE households.

The eight PV systems produced 37 percent as much electricity as the homes consumed in the period after the PV systems were installed (March 2008-Dec. 2009).

Figure 12 shows electricity production and consumption for the PV system belonging to respondent 1,[121] which has been labeled "Household 1". This household was one of half in the sample that demonstrated the significant combined effect of solar PV with reduced household electricity consumption at reducing a home's electricity footprint.[122] Household 1 produced two-thirds (66 percent) as much electricity as it consumed over the period of measurement. The nameplate capacity of the PV system belonging to respondent 1 is 2.55 kW, and the system produced 1103 kWh/kW in 2009 (the only complete year for which data were available). Household 1 exhibited the highest ratio of PV production to household consumption of all homes in the sample. The lowest ratio came from a home that produced 18 percent as much electricity as it consumed, and approximately 880 kWh/kW.[123] The mean, as noted above, was 37 percent.[124]

Figure 12 - Electricity Consumption and Production for Household 1, March 2008 - December 2009



Consumption was found to vary widely between homes, with a maximum of 17,786 kWh and a minimum of 7672 kWh, over the 22-month study period. PV production levels were somewhat less varied, ranging from 2956 kWh to 5549 kWh. Hence, differences in consumption explain

---

[121] This household was selected partly because it is one of only two households for which the nameplate capacities provided by Toronto Hydro could be verified (by inspection using Google Maps). During the course of the research, it was discovered that some of the nameplate capacities provided by Toronto Hydro were inaccurate (i.e., matched the actual installed PV system capacities).

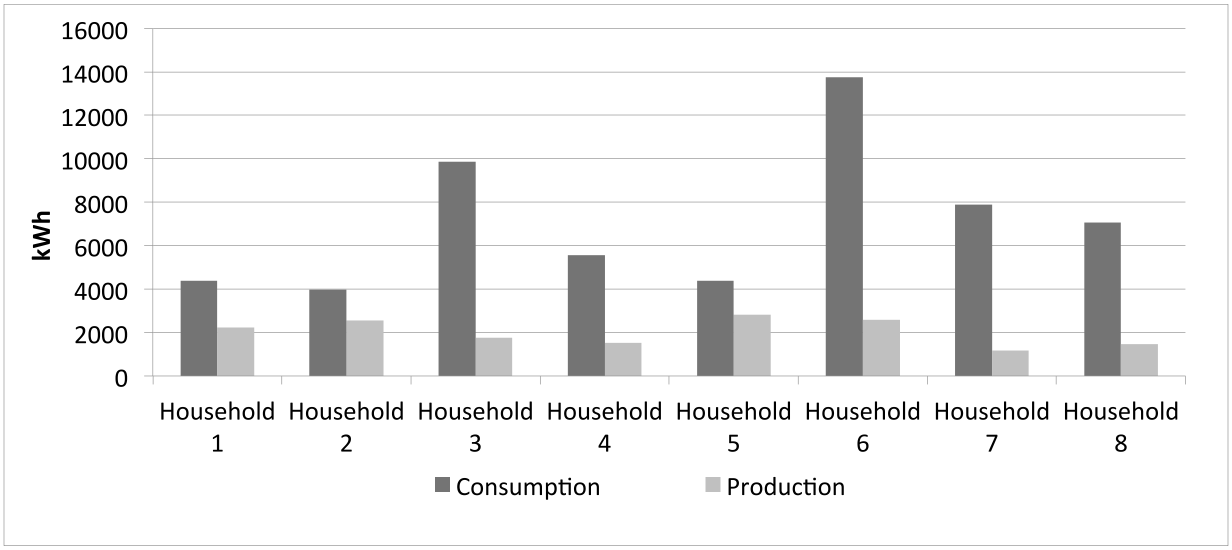
[122] Three of the eight homes produced more than half as much electricity as they consumed. One produced more than one-third, and four produced less than one-quarter.

[123] The approximate value is due to uncertainty around the name plate capacity for this home.

[124] Production per unit of capacity (kWh/kW) could not be calculated due to the above-mentioned issue with verifying PV system nameplate capacities.

most of the variation in how close a home in this sample is to achieving net-zero[125] electricity performance. Figure 13 compares consumption and production levels for the year 2009. 2009 was the only full year for which complete sets of both consumption and production data were obtained for the eight households.

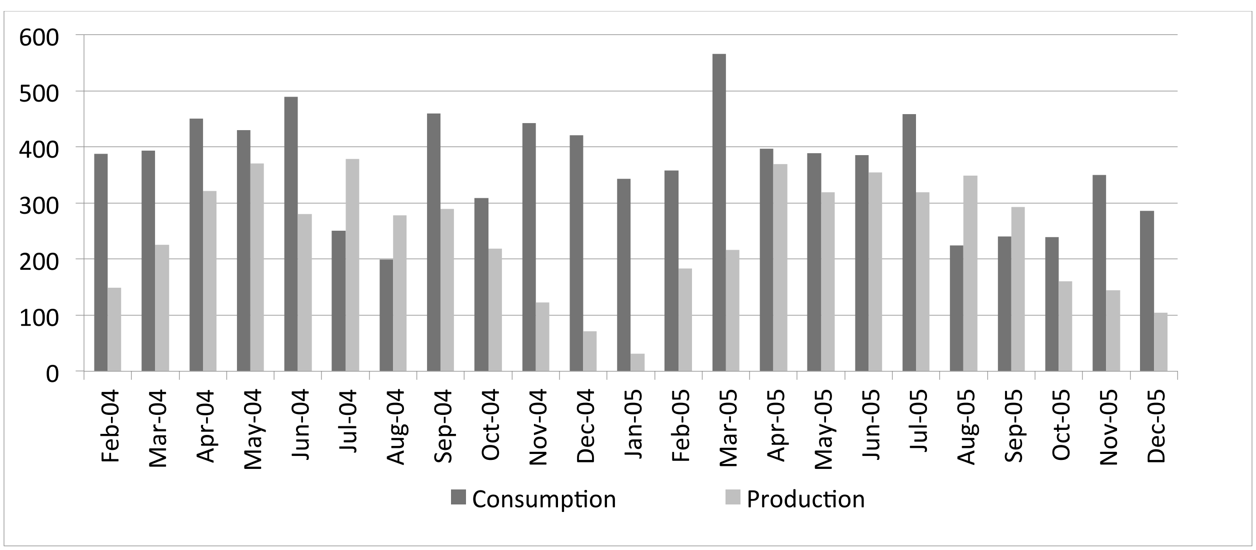
Figure 13 - 2009 Consumption and Production for Eight WISE Homes



Description of figure: Variation in consumption rather than production explains most of the differences in how close each home is to achieving net-zero electricity performance.

Figure 14 shows that for Household 1, PV production more or less matched household consumption from May to October 2009. Households 2 and 5 showed similar results.

Figure 14 - Monthly Electricity Consumption and Production for Household 1



[125] consumption matches production

4.3 Respondent Perceptions of the CSEI

How respondents heard about the West Toronto Initiative for Solar Energy (WISE)
Question A1, open, n = 44 (17 non-purchasers, 13 PV purchasers, 13 SHW purchasers)

Non-purchasers vs. purchasers (PV and SHW)
Half of the purchasers heard about the WISE mostly through Toronto City Councillor Joe Mihevc's e-newsletter (13 of 26 respondents). Community organizers also cited councillor Mihevc's email list as an important publicity tool for the WISE (J. Goldberg, personal communication, July 22, 2007). One-quarter of all respondents[126] mentioned a community meeting hosted by Joe Mihevc at which Jed Goldberg, WISE founder and president of Earth Day Canada spoke. The involvement of local leaders was important for diffusing awareness of the CSEI to potential adopters. Based on the profile of WISE PV adopters presented in Section 4.2, this communication channel may have been especially effective since it reaches locally- and politically-engaged members of the community who have taken the action of signing up for their councillor's regular email. Councillor Mihevc appears to possess a high degree of opinion leadership as defined by Robertson and Myers (1969).

The finding that WISE participants heard about the initiative through three different local news sources—their city councillor's e-newsletter, a neighbourhood association e-newsletter, and a local environmental community group (Green Neighbours 21) e-newsletter—is remarkable.

A smaller proportion of non-purchasers heard about the WISE through Joe Mihevc's e-newsletter (24% vs. 62% for PV purchasers and 38% for SHW purchasers). One-quarter of non-purchasers cited an impersonal source (media or flyer), while none of the purchasers cited the media as their source of information about the project. This suggests an official, yet intra-community, communications channel may be more effective for building trust about the project than the media.[127]

[126] 23 percent of purchasers and 24 percent of non-purchasers.
[127] If purchasers were predominantly those who heard about the WISE through official, intra-community channels, while more non-purchasers heard about it through an impersonal source (media or flyer), then this difference in communication mode may help explain adoption decisions.

Table 35 - How respondents heard about the WISE

Purchaser Response	Percent Frequency	Non-purchaser Response	Percent Frequency
Joe Mihevc e-newsletter	62% 8 PV 38% 5 SHW	Joe Mihevc e-newsletter (12%) Councillor e-newsletter (12%)	24%
Community meeting organized by Joe Mihevc and at which Jed Goldberg spoke	23% 3 PV 23% 3 SHW	Community meeting (organized by Joe Mihevc and at which Jed Goldberg spoke	24%
Neighbour	15% 2 PV 15% 2 SHW	Neighbour(s)	18%*
Media	0%	Media	18%
Mailbox flyer	15% 2 PV 0% 0 SHW	Mailbox flier	6%
Neighbourhood association newsletter	0% 0 PV 8% 1 SHW	Neighbourhood email group	6%
Through Green Neighbours 21	15% 2 PV 0% 0 SHW	Green Neighbours 21 e-newsletter	6%
Through a friend	15% 2 PV 0% 0 SHW	Resident in the area	6%
Through the RISE	8% 1 PV 0% 0 SHW	Relative who attended public meeting	6%
Through son who lived in the neighbourhood	0% 0 PV 15% 2 SHW		
"I was in at ground floor before the initiative had a name."	0% 0 PV 7% 1 SHW		
TOTAL	153%** PV 107%*** SHW	TOTAL	114%*

*At least one of these was a neighbour of Jed Goldberg
**Some respondents gave multiple answers.
***Among SHW purchasers, only one respondent gave more than one answer.

Purchasers tended to use Joe Mihevc's name when referring to his e-newsletter while non-purchasers used more impersonal terms, "local/city councillor". [128] Purchasers use the names of people and organizations involved, e.g. "Joe Mihevc"[129] and "Green Neighbours 21" rather than "city councillor" and "environmental group" more often than non-purchasers. Considering this together with the finding that a higher proportion of non-purchasers heard about the program through the media (i.e., an impersonal source), this may suggest a greater social distance between the WISE organizers and non-purchasers vs. purchasers. The importance of aligning an intervention's goals with institutional norms in which it is being implemented is well documented in the literature (Drumwright, 1996; Handelman and Arnold, 1999; Jacobssen and Bergek, 2004; Jacobssen and Lauber, 2006; Jacobssen and Johnson, 2007).

Appeal of the WISE

Question A3, open, n = 41 (15 non-purchasers, 13 PV purchasers, 13 SHW purchasers)
Note to reader: a content analysis table for this question may be found in Appendix A III

Non-purchasers vs. PV purchasers and SHW purchasers

"Community", "good source of information", and "group discount" were the three most appealing aspects of WISE to non-purchasers. Other advantages are evident. Two responses using the words "seem", "assuming" and "appears" suggest that non-purchasers had less trust in WISE's recommendation than did purchasers.

The three appealing aspects of the WISE most frequently mentioned by purchasers were 1) "organizational capacity to reduce complexity and risk", 2) "community focus", and 3) "power of bulk purchase", which involved increasing the quantity of systems being installed, obtaining a discount, and assuring quality. Access to vendor-neutral research by trusted community members was also important. Note that environmental considerations such as air quality and climate change are not among the identified appeals of the WISE. This suggests purchasers distinguish between the environmental benefits specific to solar energy systems, and those aspects of the community initiative that are not inherently related to solar energy.

'Ripple effect'

Awareness has often been acknowledged as a precursor to behaviour change. Diffusion theory postulates that, in some cases, adoption follows a stepwise process: awareness -> attitude formation -> behavioral response (Faiers and Neame, 2006; LaBay and Kinear, 1981). A number

[128] More than twice as many purchasers' responses included Joe Mihevc's name in their mention of his e-newsletter than did non-purchasers (7/15 or 47% of purchasers' responses vs. 3/17 or 18% of non-purchasers' responses).

[129] Purchasers' statements of "through Joe Mihevc" may refer to Councillor Mihevc's newsletter, or personal contact. This is not always clear from respondents' wording.

of comments by purchasers support findings in the literature about the effectiveness of CBSM to increase energy and/or environmental awareness (such as those reported by McKenzie-Mohr (2000), Marcell, Agyeman and Rappaport (2004), and Buck (2009)). One WISE PV purchaser stated that her neighbour, after driving past her panels day after day in his SUV, decided to downsize to a smaller vehicle. She said he was proud about his decision. Ripple effects described by respondents such as neighbours signing up for the project, or downsizing to a smaller vehicle, demonstrate that rooftop solar energy applications can both create awareness and lead to environmental behaviour change, such as energy conservation. High profile, highly visible projects spur public discussion that may increase environmental awareness and lead to behaviour change.

Enabling capacity

Respondent 12 wrote, "There's satisfaction that we can get organized and do something ourselves when the various levels of government have largely abandoned any leadership role in this area." This is a typical sentiment[130] in that the project was empowering, enabling individual and community-level environmental action. However it is also atypical[131] in that it discounts the RESOP as a sign of leadership by government. Nearly all purchasers[132] in this study expressed a high degree of trust in WISE's competency and neutrality (i.e., ability to identify and recommend the best supplier.)

One SHW purchaser (resp. 23) characterized the project as, "ingenuity of neighbours getting together to pool resources & find creative solutions…positivity: activist aspect without being against anything or anyone". This comment sums up the win-win benefits of the WISE quite well: more business for solar enterprises, easier availability & affordability for homeowners. This same respondent continues, "[WISE] introduces solar energy directly & indirectly to huge numbers of people who otherwise wouldn't have the opportunity, interest or occasion (through community events, newsletters, etc. as well as seeing the panels on homes in their neighbourhoods)". Another respondent observed, "The volunteers did all the legwork for me - researching technology options and companies, selecting the companies. Negotiated a bulk price. Community meetings for information. Follow-up support has been great when I've had questions about a company". This sentiment was supported by a third respondent, "expert advice do the haggling work with the city make the whole thing easy!"

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[130] WISE's organizational capacity is the most frequently mentioned appealing aspect for PV and SHW purchasers (Appendix A III, question A3).

[131] Payback improvements resulting from the RESOP was rated as an important motivation by both PV purchasers and non-purchasers.

[132] 10 of 15 PV purchasers and 12 of 13 SHW purchasers

Neighbourhood identity

Improved morale among residents and feelings of neighbourhood identity were also mentioned: “Participating in the WISE initiative made me feel good about my neighbourhood. … It adds to my sense of commitment to and investment in the neighbourhood” (resp. 15). One respondent emphasized the appeal of diversified energy supply: “I believe the way out of the oil crisis is a diversity of supply, and I feel that solar matches that belief. If I lived in the country I might buy geothermal or wind, but as a city dweller, it's PV” (resp. 5).

Perceived disadvantages of the WISE

Question A5, open, n = 41 (14 non-purchasers, 15 PV purchasers, 12 SHW purchasers)

Non-purchasers provided a wide variety of responses about the disadvantages of the WISE, making it difficult to categorize/summarize their responses. The most common single response was that there were no disadvantages to the WISE program (Table 16). This suggests that future efforts might best be focused on non-program-related barriers, such as costs and permitting.

Table 16 - Disadvantages of the WISE according to non-purchasers

n = 14	**Response Frequency**
None	5

Table is condensed; full table in Appendix A III

The most common disadvantage of the WISE identified by PV purchasers was the wait time for connection. Customers who were aware that the project was a relatively new sort of endeavor tended to be more accepting of the connection delay (4 of 15 respondents). Others reported feeling that they had been misinformed (5 respondents), or even taken advantage of (1 respondent). The second most frequent customer concern was inadequate communication. This included communication between SWH and PV vendors, as well as vendors’ communication with customers (particularly regarding updates on the status of the connection process). Customers were also confused about knowing where to direct questions.

Table 17 - Disadvantages of the WISE according to PV purchasers

n = 15	**Response frequency**
Wait time for connection/metering delays	7
Communication PV vendor and SWH vendor Vendor and WISE Vendor and participants (purchaser) Vendor internal (installers/logistics/management) Vendor and utility	6
Initial capital / up-front cost / price **Long payback**	5
Lack of maintenance contract/training manual for SWH **Innaccurate estimates of connection timelines** **Customers confused about "who's who", vendor/organizer** **Responsibilities unclear**	3
"One-size-fits-all" lack of customization, especially battery back-up **SWH requires a maintenance contract** **"Fly-by" assessment not sufficient, site surveyor needs to see the roof** **Confusion about tax implication**	2

Table is condensed; full table in Appendix A III

The most common response is that there were no disadvantages (Table 18). Three respondents indicated that communication could have been better, for instance between the two preferred vendors (PV and SHW) in deciding how to allocate roof space to their respective technologies. Four respondents mentioned difficulties obtaining building permits.

Table 18 - Disadvantages of the WISE according to SHW purchasers

n = 12	**Response Frequency**
None	5
Communication issues	3 (5)*
Inadequately resourced	2
Difficulty obtaining permits	3 (4)
Inadequate for dealing with City bureaucracy	

Table is condensed; full table in Appendix A III

*Bracketed numbers are the sum of the adjacent content area and related content areas (listed immediately below). For example, the "communication issues" listed by respondents were related to a perception that the WISE was inadequately resourced.

Non-purchasers vs. purchasers (PV and SHW)

With the exception of communication issues, both non-purchasers and purchasers identified very few disadvantages of the WISE. Non-purchasers identified a wider variety of non-program related barriers.

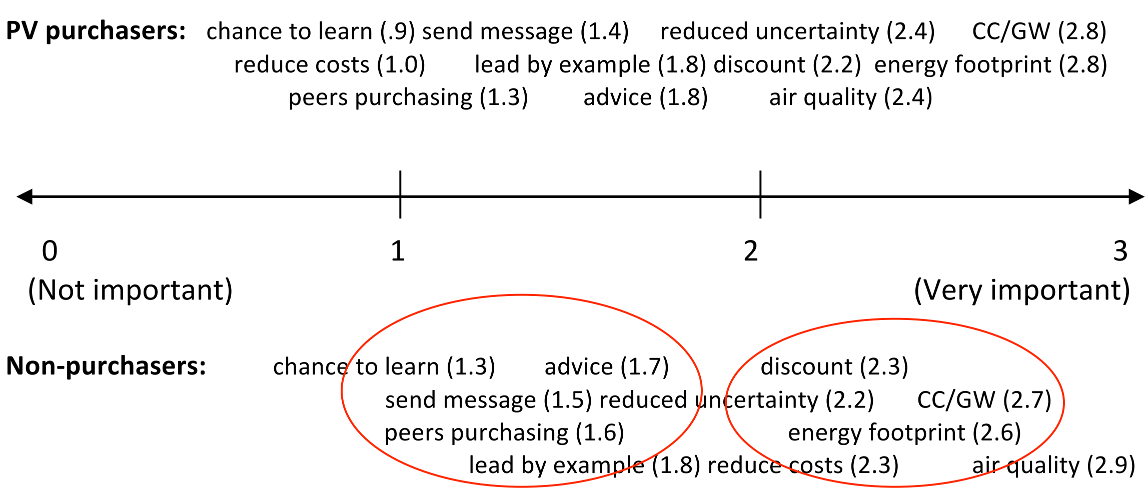
Importance of (motivating) factors in PV purchase decision as part of the WISE

Question A6, closed, n = 46 (17 non-purchasers, 15 PV purchasers, 13 SHW purchasers)

Responses on a linear scale[133]

Question A6 was used to quantify[134] the importance of certain key motivating factors in respondents' decision whether or not to purchase a PV system as part of the WISE. Figure 15 shows these considerations plotted on a linear scale. This representation of the participants' responses shows a hierarchy of relative importance for each group, and that the hierarchy is different for each group. The PV purchaser responses cover a more complete spectrum of importance, while non-purchaser responses cluster around two levels. This may be evidence of greater nuance in the cognitions of purchasers relative to non-purchasers concerning adoption of a PV system through the WISE.

Figure 15 - Importance of Considerations Affecting Purchase Decisions



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133 A conventional summary table can be found in Appendix A(III). The linear scale plot is presented here, as it offers a more concise representation of aggregated importance scores.

134 The following formula was used to aggregate 16 importance-scale responses to a single number measuring importance on a scale of 0 to 3: importance of factor = $\sum xf(x) = \sum weight(proportion)$, e.g., importance of air quality to PV purchasers = $\sum xf(x) = 0(.06) + 0(.06) + 1(0) + 2(.19) + 3(.69) = 2.44$. The two zeros in the first two terms of the formula represent importance weightings for the factors, "did not consider" and "not important", respectively.

PV purchasers rated climate change as the most important factor in their decision to purchase, while non-purchasers rated air quality highest. This difference suggests PV purchasers are most concerned about global issues, while non-purchasers are more motivated by local environmental concerns. This finding is further supported by findings from B3, concerning closure of coal-fired power plants. Analysis of SHW purchaser responses (not represented[135]) produced a similar ordering to that of PV purchasers, with two notable differences: 1) "reduced uncertainty" and "energy footprint" switch places in the ordering, so that "reduced uncertainty" is of second-most importance, while "energy footprint" is fourth, 2) there is no clustering, rather importance of SHW purchaser considerations decrease incrementally from 2.8 to 1.1. The finding that SHW purchasers placed a very high value[136] on "reduced uncertainty" is interesting in light of the more complex mechanical nature of DSHW systems relative to PV systems. Noting also that SHW purchasers frequently mention "complexity", "permitting", the benefits of the bulk purchase (e.g. to "make it easy", save "a lot of work", and provide a "great product and service")[137], it appears that the WISE's offer of reduced uncertainty was of particular value to SHW purchasers due to the complexity of adopting a DSHW system.

Purchasers rated "climate change" and "footprint" higher than the non-purchasers rated any consideration, except air quality. However "climate change" and "footprint" were the ONLY consideration purchasers rated higher than did non-purchasers.

Non-purchasers rated importance of "group discount" higher than did purchasers. (This is consistent with findings in Section 4.4 (question B2) that non-purchasers place a higher importance on cost as a barrier/hurdle relative to purchasers.) Non-purchasers also rated "reduce or eliminate net electricity financial costs" more than twice as important as purchasers did.

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[135] SHW purchaser responses to question A6 were essentially identical to those of PV purchasers, and so it was decided the minimal amount of additional information their answers would provide was not worth the "cluttering" (i.e., adding complexity) to the table. Please see Appendix A III for the corresponding ranking of SHW considerations.

[136] SHW purchasers rated "reduced uncertainty" of second-most importance, 2.8 out of 3. The consideration of greatest importance, "reduce net energy consumption" scored only 0.1 point higher, at 2.9.

[137] Please see SHW purchaser responses to question B1 and A7.

Personal motivations for interest in the WISE

Question B1, open, n = 44 (16 non-purchasers, 15 PV purchasers, 13 SHW purchasers)[138]

Answers to the question about "motivations for interest in the WISE" differ somewhat from those concerning the WISE's "appealing features" (question A3). Question B1 tended to be interpreted as pertaining to personal motivations, while the question in Section A to the WISE as a collective effort. The fifteen PV purchasers articulated their motivations in vivid detail, and these responses are presented verbatim in Appendix A III. Tables 19 through 21 present condensed versions of their responses, with motivations summarized by content area.

Non-purchasers vs. purchasers (PV and SHW)

The five motivations mentioned most frequently by non-purchasers reflect findings in the broader environmental behaviour change literature, of the early market as active information seekers (Lee, Lee and Schumann, 2002), and seeking a sense of belonging to a broader group, i.e., identity formation (Jacobsson and Johnson, 2000). Only two respondents mentioned saving money as a motivation. This agrees with findings by Faiers, Neame and Cook (2007: 3419) that innovators are more likely to put up with poor financial performance because they are committed to the concept of an innovation. Based on their answers to this question, non-purchasers appear to belong to the early market (i.e., innovator, early adopter, or early majority adopter groups).

More than one-third (38 percent) of SHW purchasers indicated a predisposition to adopt sustainable energy innovations. Comments such as "We were…believer[s], WISE made it easy", support findings from Chapter 2 that innovators tend to be aligned with the concept of an innovation (Faiers, Neame and Cook, 2007). The WISE was an enabler for homeowners who are already committed to the concept of solar technology as a sustainable source of energy. The other motivations reflect earlier comments about advantages of the WISE: protecting the environment, saving money, promoting a sustainable energy economy, and building community.

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[138] This question can be seen as an open-ended version of question A6, which asked respondent to rate the importance of factors in their purchase decision as part of the WISE. It is interesting to note that while the same types of motivations appear in both the open-ended and closed questions, the way these are expressed in the open-ended version (i.e., in the respondents' own words) produces somewhat different results in the final analysis. For instance, the most common motivation listed by PV purchasers in their answers to the open-ended question was "to set an example". However, in the closed-answer version, "lead by example" was rated sixth overall, and of mid-level importance. This raises some interesting methodological questions. With respect to validity, the researcher wishes to point out that the five factors that were rated more important in the closed-answer version, were those about which the respondents are "setting an example". So, the responses are consistent, despite a difference in emphasis.

Table 19 - Motivations for participating in the WISE according to non-purchasers

Motivation n = 16	**Response frequency**
Help/Facilitation/Information	5
To be more environmentally friendly	3 (5)[139]
Climate change/global warming	2
Sending a political or social message	4
To be part of a great initiative	2
Save money	2

Table is condensed; full table in Appendix A III

Table 20 - Motivations for participating in the WISE according to PV purchasers

Motivation n = 15	**Response frequency**
To set an example for children	3 (4)
To lead by example by managing resources better	1
To be part of the solution	3
To respond to global environmental challenges	2

Table is condensed; full table in Appendix A III

Table 21 - Motivations for participating in the WISE according to SHW purchasers

Motivation n = 13 SHW	**Response frequency**
Existing interest in sustainable energy (predisposition)	5
Environment and economy	3
Reduce carbon footprint	2
Collective action for transitioning to renewable/sustainable energy	2 (3)
Support for seniors	1

Table is condensed; full table in Appendix A III

[139] The bracketed numbers in content analysis tables indicate the total number of responses if all related categories are grouped together. These related categories appear in the row(s) below the bracketed number. For example, referring to question B1 above, "to be more environmentally friendly" appeared in respondent answers three times. Related responses about "climate change" or "global warming" appear in the cell immediately below, and when grouped with the first category increase the frequency of that response to five.

Situations where the WISE did not properly or completely respond to participant needs
Question A7a, open, n = 28 (14 non-purchasers, 13 SHW purchasers)
Note to reader: a content analysis table for this question may be found in Appendix A III

Non-purchasers vs. SHW purchasers
Non-purchasers' complaints around poor customer service suggest that the factors "satisfaction with site assessment" and "promptness of follow-up" may have differed between these two groups. WISE participants who received better customer service (e.g. prompt follow-up, satisfactory site assessment) may have been more likely to purchase than those who experienced customer service issues.

Would respondents have seriously considered installing a solar system (within the next 5 years) without help from the WISE?
Question A9a, closed, n = 46 (17 non-purchasers, 15 PV purchasers, 13 SHW purchasers)

N**on-purchasers**
Almost half of non-purchasers say they would have seriously considered purchasing solar thermal without the help of WISE. This suggests that the role of WISE in convincing non-purchasers to seriously consider purchasing was less important for thermal systems than for PV. This makes sense considering that thermal systems had a better payback and lower initial cost at the time of the survey. Since the high initial cost and poor payback are greater barriers for non-purchasers than purchasers, it follows that thermal would need less support from WISE to be seriously considered by potential adopters.

The most common non-purchaser[140] answer was "Yes", suggesting that at least 30 to 50 percent of non-purchasers would have seriously considered purchasing in the next five years without the help of the WISE. This result supports Adachi's (2009: 128) finding that the role of CSEIs as a "catalyst for the purchase of solar PV systems" by "the earliest of adopters … whereas the reduction of monetary and institutional barriers may be more effective in garnering the participation of later adopters".

Non-purchasers vs. purchasers (PV and SHW)
When considering a PV system, non-purchasers' answers distributed approximately equally, one-third in each category. This is a significant difference from PV purchasers, who had a Yes/No/Not Sure split of 25/50/25. A higher proportion of PV purchasers would not have considered installing solar PV without help from the WISE. In other words, the WISE was more of an enabler to PV purchasers than non-purchasers. The same is true of SHW purchasers, half

[140] tied for most popular, in the case of PV

of whom would not have considered purchasing without the help of WISE.

When considering a solar thermal system, PV purchasers exhibited about a 20:55:25 split vs. 50:30:20 for non-purchasers. Given that 55% of purchasers answered "No" compared with only 30% of non-purchasers; this indicates that WISE was more important to purchasers than non-purchasers in facilitating the adoption process.

Other comments about CSEIs in Ontario

n = 27 (10 non-purchasers, 6 PV purchasers, 11 SHW purchasers)

The discussion below is based on responses to a "catch-all" question at the end of Section A of the survey.

Non-purchasers vs. purchasers

Purchaser responses were overwhelmingly positive, along the lines of "great", "good idea", and "we need more". Some purchasers suggested expanding the program to include larger rooftop applications, and directly pressuring government to remove barriers. Non-purchasers are less clear than purchasers in their understanding of which vendor is selling what technology. Comments are similar to those that appear in earlier questions, having to do with aesthetics and finances. One non-purchaser wants to use solar for space heating. Another non-purchaser suggests "improving" the initiative by allowing customization or product differentiation to allow participants to choose a system appropriate to their situation. The sentiment of community solar being the "way of the future in Ontario" is repeated.

One respondent's statement that the WISE was "well motivated" but "probably needed more than volunteers doing the work" could be interpreted as a suggestion to hire professionals for some portion of the program (e.g. coordinator, vendor selection).

4.4 Respondent Perceptions of Solar Energy Systems

4.4.1 Importance of factors motivating purchase

Discussion of factors motivating the purchase of a solar energy system[141]

Question B3, closed, n = 46 (17 non-purchasers, 15 PV purchasers, 13 SHW purchasers)

Non-purchasers vs. purchasers

The differences in highest priorities support the earlier finding (question A6) that non-purchasers place more relative importance on the local environment vs. global warming/climate change than do purchasers. Considering non-purchasers' stated concern about air quality (A6), it may be concluded that non-purchasers were more strongly motivated by the desire to improve air quality than to address climate change/global warming. Here, purchasers again indicate that their primary motivation is "negative impact of carbon emissions", while non-purchasers rate this consideration fourth, after (1) "help close coal plants", (2) "reduce net energy consumption (footprint)", (3) "reduce need for more power plants".

Footprint and carbon emissions were tied as the most important motivations to PV purchasers. Interpreted in light of WISE participants' known familiarity with environmental issues, this suggests that purchasers had internalized the concepts of "greenhouse effect" and "footprint".

As in Section 4.3, PV purchasers are more motivated than non-purchasers by the reliability of the system to produce electricity. This suggests that purchasers are more concerned with the system's "primary effects" (i.e., greenhouse gas reduction), while non-purchasers are more concerned with secondary effects, i.e., reducing coal dependence, financial aspects. That non-purchasers place greater importance on reduced transmission line dependence lends some additional support to this finding.[142] Note that "reliability" and "reducing transmission corridors" switch positions in the ordering of PV purchaser responses vs. those of non-purchasers (see arrows in Table 22).

[141] This discussion is based on a summary table in Appendix A III. A linear scale plot is presented and discussed below, as it provides additional insight by emphasizing different relationships in aggregated importance scores.

[142] The corresponding importance scores are 3.71 vs. 2.63. The content analysis table for question B3 can be found in Appendix A III.

Table 22 - Factors motivating the purchase of a solar energy system

Motivation (PV Purchasers)	Importance (0-4)	Motivation (Non-purchasers)	Importance (0-4)
1) concern about negative impact of carbon emissions	3.69	1) to help Ontario close its coal-fired power plants sooner.	3.47
2) reduce our home's net energy consumption (footprint)	3.69	2) reduce our home's net energy consumption (footprint)	3.41
3) reduce the need to build more power plants in Ontario	3.06	3) reduce the need to build more power plants in Ontario	3.41
4) to help Ontario close its coal-fired power plants sooner.	2.94	4) concern about negative impact of carbon emissions	3.35
5) reliability of PV technology	2.88	5) reducing need for transmission corridors (high voltage power lines)	2.71
6) access to sufficient information to make an informed decision	2.63	6) payback improvements coming from the Standard Offer Program	2.65
7) payback improvements coming from the Standard Offer Program	2.44	7) access to sufficient information to make an informed decision	2.53
8) reducing need for transmission corridors (high voltage power lines)	1.63	8) reliability of PV technology	2.06

Discussion of relative importance on a linear scale

When the motivations are plotted on a linear scale, it is immediately apparent that non-purchasers do not appreciate the reliability of PV as strongly as PV purchasers. PV purchasers rated "reliability" almost one point higher on the importance scale than did non-purchasers.[143] Just as "climate change/global warming" and "carbon footprint" were the two most important considerations for PV purchasers (question A6), reducing carbon emissions and footprint are the main motivators for PV purchasers. Non-purchasers are also highly motivated by these considerations, but equally by a desire to help close the coal plants, and presumably reduce air pollution since air quality placed first among considerations for non-purchasers (A6).

Non-purchasers rated "reduced transmission corridors" as a more important motivation than PV purchasers did. This is in line with non-purchasers' high rating of the need to close coal power plants, and be less grid dependent (four counts, open question A2).

"Payback improvements resulting from the SOP" was an important motivation for both groups.

SHW purchasers were asked a similar question about motivations for purchase. Five motivations scored an aggregate rating of three or higher: "reduce carbon emissions" (3.90), "reduce the need for more power plants" (3.80), "reduce footprint" (3.78), and "help close coal plants" (3.33), "access to information (3.11).

Purchasers were found to be more confident[144] in the reliability of solar energy systems. Non-purchasers ranked "reliability of PV technology" last, which suggests they have not been educated or persuaded about the low maintenance and high reliability of PV.

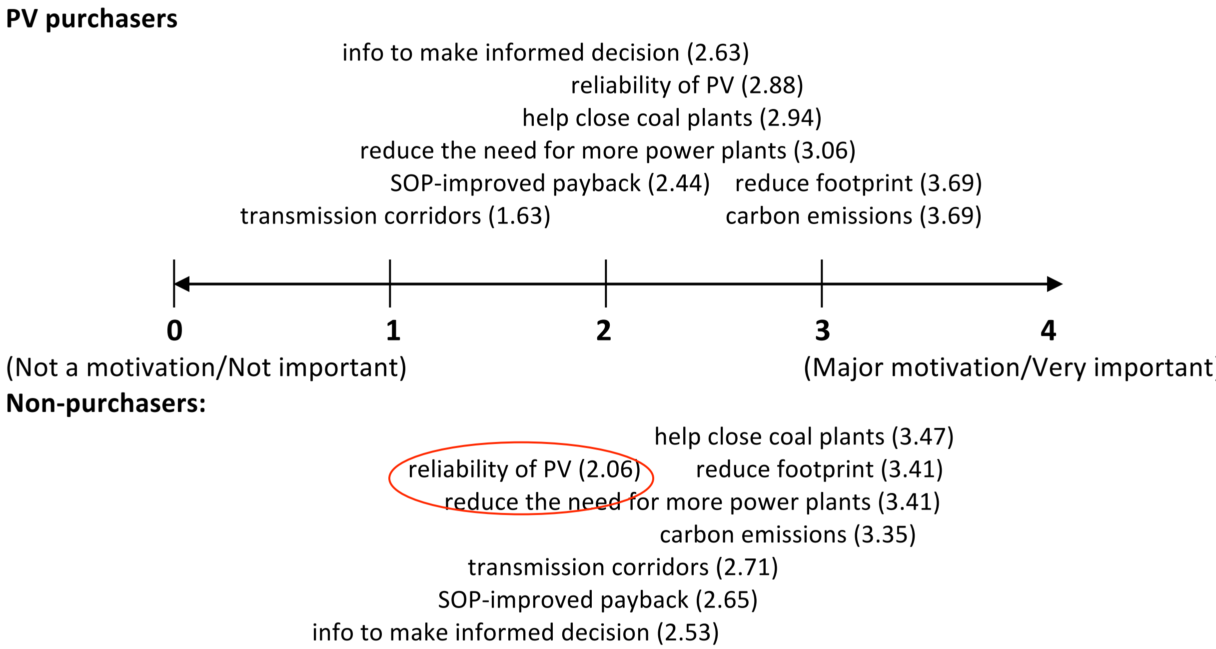
SHW purchasers lie in between PV purchasers and non-purchasers with respect to the appeal of financial vs. environmental considerations. While non-purchasers most frequently mention financial aspects of solar thermal systems, and PV purchasers most frequently mention environmental benefits, SHW purchasers gave equal mention to both environmental and

[143] It is interesting to note that answers to open-ended answers did not mention two of the eight "motivations" ("SOP" and "reliability"). Also not mentioned is the need to reduce "transmission corridors/high voltage powerlines", although the related item, "reduce grid-dependence" is identified. The closed form of this question can be leading in that it is possible that respondents had not considered one or more of the motivations listed. After reading the question, they may have rated it based on general importance rather than the degree it had initially motivated their desire to install a solar energy system. Alternatively, having rated the motivations listed, they may have not felt strongly enough to add comments about all of them in the open question. Overall, survey design can influence results and the greatest attention should be paid to the motivations with the highest ratings.

[144] Their higher rating of reliability as a motivation to purchase is taken as evidence of confidence.

financial considerations.

Figure 16 - Motivations for Purchase of Solar Energy System[145]



Perceived advantages of solar panels

Questions A2a and A2b, open, n = 46 (17 non-purchasers, 12 SHW purchasers)

The surveys of non-purchasers and SHW purchasers included two additional questions (Appendix A II), one asking respondents to list "the three most appealing features of solar electric panels" and a similar question about solar hot water.

Non-purchaser vs. SHW purchaser perceptions of advantages of solar panels

When asked to list the most appealing features of solar panels, SHW purchasers tended to mention causal relationships--"reduce emissions", fuel switching[146], "environmental impact", "demonstrate support for alternative energy", "reduce bill", "set an example" (n = 10). Responses from non-purchasers varied widely and were sometimes incorrect or out of step with the project's goals, e.g. solar technology reducing dependence on hydro dams. Further,

145 In the case of non-purchasers the question concerned "desire to purchase" rather than actual purchase.

146 Respondents did not use the term "fuel switching", but mentioned equivalent concepts, e.g., "minimize use of fossil fuels/nuclear", "diminishes my reliance on environmentally damaging fuel sources", "using less water, dam potential", etc. For a complete list, please see the content tables for question A2a and A2b in Appendix A III.

non-purchasers' use of abstractions such as "saving the environment" or "good for environment" (n = 6) suggests a shallower understanding of environmental issues. To form a concept requires that an individual learn or identify, the critical (defining) attributes of examples of that concept and also identify the interrelationships among those attributes (Hirschman, 1980). Differences between purchasers' and non-purchasers' conceptualizations of solar energy vis-à-vis environmental issues are discussed in Chapter 5. (The reader is referred to Appendix A IV for a table listing importance ratings of all motivating factors for all WISE respondent groups.)

Table 23 - Perceived advantages of solar electric panels

Appeal to non-purchasers[147] n = 17	**Response frequency**	**Appeal to SHW purchasers**[148] n = 12	**Response frequency**
Positive environmental	6 (23)*	**Positive environmental**	2 (16)*
Carbon footprint, global warming	5	**Alternative source of energy**	3
Abstract appeal of renewable/sustainable energy	5	**Environmental leadership**	3
Reduce pollution	2	**Sustainable energy source**	2
Reduce environmental impact	1	**Clean**	2
Financial	8 (12)**	**Reduce emissions**	2
Autonomy	2	**Fuel switching**	2
Reducing consumption from conventional energy sources	2	**Save the planet**	1
Progressive	2	**Financial**	4
Good aesthetics	2	**Electricity system improvement**	
		Energy self-sufficiency	2
		Low maintenance	2 (3)
		Durable	1

Table is condensed; full table in Appendix A III
* if all answers with environmental connotation are included
** if all answers with financial connotation are included

[147] This question was included in the 2008 surveys of SHW purchasers and non-purchasers. However, it was not included in the first survey, of PV purchasers. Please see question B1 for responses related to PV purchasers' motivations to adopt a PV system through the WISE.

[148] This question was included in the 2008 surveys of SHW purchasers and non-purchasers. However, it was not included in the first survey, of PV purchasers. Please see question B1 for responses related to PV purchasers' motivations to adopt a PV system through the WISE.

Table 24 - Perceived advantages of solar thermal systems

Appeal to non-purchasers n = 17	**Response frequency**	**Appeal to SHW purchasers** n = 12	**Response frequency**
Lower costs/save money	7	**Positive financial**	9 (10)**
Positive environmental	6	**Availability of rebates**	1
Renewable/sustainable energy	4	**Positive environmental**	8 (12)*
Carbon footprint/greenhouse gas/global warming	4	**Fuel switching**	2
Pollution	3	**Free/easily-accessible fuel**	2
Fuel switching	2	**Very little maintenance**	3
Not as costly as PV	2	**Self-sufficiency**	2
Not sure	2	**Not as costly as PV**	2
		Hot water	2

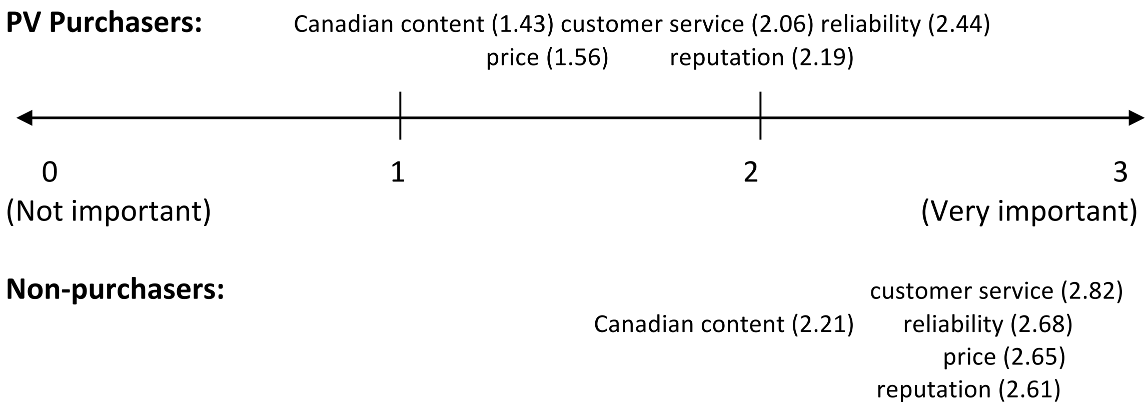
Table is condensed; full table in Appendix A III
* if all answers with environmental connotation are included
** if all answers with financial connotation are included

Importance of factors in choosing a PV system vendor (presented on a linear scale)
Question A8, closed, n = 46 (17 non-purchasers, 15 PV purchasers, 13 SHW purchasers)

As in the analysis of question A6, a conventional summary table can be found in Appendix A III. This table indicates the importance[149] of certain key factors in respondents' choice of PV vendor.[150] Figure 17 shows these same considerations plotted on a linear scale. Analysis of the SHW purchaser responses (not represented)[151] revealed that price, reliability, reputation, and customer service were of equal importance (2.54 out of 3). Canadian content was more than one full point lower, at 1.47[152].

[149] The following formula was used to aggregate 16 importance-scale responses to a single number measuring importance on a scale of 0 to 3: importance of factor = ∑xf(x) = ∑weight(proportion), e.g., importance of air quality to PV purchasers = ∑x*p(x) = 0(.06) + 0(.06) + 1(0) + 2(.19) + 3(.69) = 2.38, where x denotes the level of importance, and p() is the (step-wise) probability density function for the distribution of respondent answers concerning a particular factor. For example, p(not important) = .06 is the proportion of respondents who indicated that "air quality" was not important.
[150] Note that this question is somewhat hypothetical, even for PV purchasers, since the WISE organizers had already selected ARISE Technologies as the CSEI's 'preferred vendor'.
[151] It is the researcher's opinion that complicating the plot by adding SHW purchaser responses would add little value to the analysis. A table of SHW purchaser responses may be found in Appendix A III.
[152] an average of 1.31 and 1.62 for "designed in Canada" and "made in Canada"

Figure 17 - Importance of Considerations Affecting Choice of Vendor



For PV purchasers, the ability of the company's system to produce electricity was most important, whereas for non-purchasers, customer service was most important. This suggests a "suboptimal hierarchy" of values for achieving the project's aim, i.e., the non-purchasers may not have been fully "on-board" with the WISE's core mission to work collaboratively to streamline the process of getting solar on rooftops to produce "clean", emissions-free, energy. Instead, non-purchasers placed high importance on "customer service". So if a participant places a higher value on customer service, this suggests a greater disconnect between their motivations and those of the program.[153] The reader is referred to Section 5.2.2 for elaboration of this point.

Note that non-purchasers rated ALL factors affecting their purchase of PV more important than PV purchasers did. This supports the findings of LaBay and Kinnear (1981: 275) that innovators and early adopters tend to place less importance than non-adopters on complexity, financial risk, social risk, observability, and trialability. LaBay and Kinnear (1981:275) note however that the trends in their study are not strong.

Price was rated of secondary importance by non-purchasers, after customer service. In contrast, price was rated only fourth out of six factors of importance to PV purchasers.

Reputation of the company was rated at about the same absolute level by both groups (2.61 by non-purchasers vs. 2.19 by purchasers.) Relative to other considerations, reputation was the second most important consideration to purchasers, but fourth for non-purchasers (after customer service, price and reliability of electricity).

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[153] Though WISE was intended to facilitate the process of purchasing solar energy systems, its core motivations and primary appeal to residents was environmental. Put another way, WISE sought to create an opportunity for individuals to take morally responsible action to address climate change.

“Customer service” was of primary importance to non-purchasers and “reputation of the company” was fourth, while purchasers rated “reputation” more important than “customer service”. This suggests that purchasers were more willing to make their purchase decision based on the company’s reputation, while non-purchasers wanted to have the quality of customer service verified. Relating this to Rogers’ innovation attribute category “risk”, purchasers and non-purchasers appear to differ in the extent to which they trust a company’s reputation (or at least the WISE organizers’ assessment thereof) vs. preferring to verify the quality of a company’s customer service for themselves.

Both respondent groups rated “designed in Canada” and “made in Canada” with the same level of importance, and rated these two considerations of least importance. In the context of the Ontario’s efforts to create 50,000 “green” jobs through the *Green Energy and Green Economy Act* (Toronto Star, 2008), it is interesting that respondents rated Canadian content of least importance in their purchase decision. Only two non-purchasers mentioned stimulating a domestic industry in their open-ended responses to the survey (question A10). However, it should be noted that, despite being less important relative to other closed-answer options, Canadian content was, on average, rated “somewhat important” by PV purchasers and “important” by non-purchasers.

Interestingly, customer service is rated slightly higher importance than price, even though in questions A4 and B2, price is the number one disadvantage or barrier. Though participants may not perceive customer service to be as great a barrier as cost, a positive/persuasive/confidence-instilling front line contact is often necessary for adoption. The site assessment and initial sales visit plays an important role because they influence a participant’s feelings about the program and the quality of service.

Feedback to SHW vendor to improve overall products and services[154]

Question A10, open, n = 26 (11 non-purchasers, 7 PV purchasers, 3 SHW purchasers)

Note to reader: a content analysis table for this question may be found in Appendix A III

Non-purchasers vs. purchasers

Half of the non-purchasers (n = 8) didn’t accept or understand some important aspect of the program, whether this meant wanting a custom system, concern about panel efficiency, lack of

[154] All non-purchasers were administered this question, irrespective of whether or not they had received a sales visit from an ARISE representative. This was because the survey researcher was not able to distinguish between non-purchasers who received a visit and those who had not. The non-purchasers who had not received a sales visit tended to note that the question was premised on incorrect information.

trust in the program, etc. Non-purchaser priorities do not align as closely as purchasers' do with the goals the WISE (as defined in Section 1.3).

Two SHW purchasers also suggested that training or a maintenance manual for the SHW system would have been helpful.

Feedback to PV vendor to improve overall products and services
Question A11, open-ended, n = 16 non-purchasers

Non-purchasers recommend that ARISE simplify their sales information and focus on a few compelling messages, expressed clearly in a brochure. They point out that many homes have available solar resource, but not enough money to purchase (or invest in) a system. Hence, there is a perception that solar energy systems are only accessible to the rich; the service and product is good, but price is prohibitive. This agrees with findings in the literature that initial capital cost has frequently been reported as a barrier to adoption of solar energy systems (Parker, 2007)

Non-purchasers also encourage continued investment in R&D. Comments by one non-purchaser indicated ze was unclear about which company was providing which technology.

4.4.2 Importance of barriers/hurdles to purchase of a solar PV system

Question B2 was used to quantify[155] the importance of certain key obstacles in respondents' decision whether or not to purchase a PV system as part of the WISE. The following discussion is based on Table 25. Figure 18 shows an alternate representation of these obstacles plotted on a linear scale. The alternative representation of the data reveals insights that may not be immediately apparent from reading Table 25.

[155] The following formula was used to aggregate 16 importance-scale responses to a single number measuring importance on a scale of 0 to 4: importance of factor = $\sum xf(x) = \sum weight(percentage)$, e.g., importance of initial capital cost = $\sum xf(x) = 0(.06) + 1(0.6) + 2(.12) + 3(.23) + 4(.53) = 3.12$

Importance of obstacles[156] to purchase of solar PV system

Question B2, closed, n = 46 (17 non-purchasers, 15 PV purchasers, 13 SHW purchasers)

Non-purchasers vs. purchasers

Non-purchasers rated barriers higher in general than did PV purchasers. This is consistent with their respective adoption decisions. This also agrees with the finding by LaBay and Kinnear (1981) that non-adopters generally rate each factor to be of greater importance than adopters.

Remarkably, purchasers rated "plan to move in the next few years and are not sure we will recoup the cost in resale value" as the second most important hurdle. This reflects the high rate of turnover seen in many residential areas.

PV purchasers rated "payback" of similar importance to other barriers of lesser importance. Arranging financing, and removing technical and information-related barriers, was enough to allow innovators to adopt a PV system. However, the non-purchasers and SHW purchasers placed a high value on payback, which WISE was unable to address.

Faiers and Neame (2006: 1799) found that adopters were more tolerant of poor financial and aesthetic attributes than were non-adopters; "'Innovators' and 'early adopters', who are committed to the concept of innovation, will put up with inconvenience factors to do with product complexity or lack of performance because they are focused on the long-term benefits the innovation may have."

The mid-level importance of "SOP is an inappropriate form of subsidy" suggests that the Ontario's Feed-in Tariff (FIT) program will be insufficient to convince some non-purchasers to adopt. Additional education about the reasons for a buy-back incentive (as opposed to grants or rebates), such as ensuring long-term energy stability of supply may be necessary. In light of non-purchaser answers to the open-ended questions, it may be necessary to "repackage" the FIT in the form of a power purchase agreement to overcome the initial cost barrier among others.

Non-purchasers exhibit "fuzzy thinking" by rating "unconvinced PV would result in significant energy generation" high, but "unconvinced PV can result in significant environmental benefits (emissions reduction)" low. This suggests a disconnect in their reasoning, which is not present among purchasers who rated both factors as low.

[156] hurdles for PV purchasers, barriers for SHW purchasers and non-purchasers

Table 25 - Importance of obstacles to purchase of a solar PV system

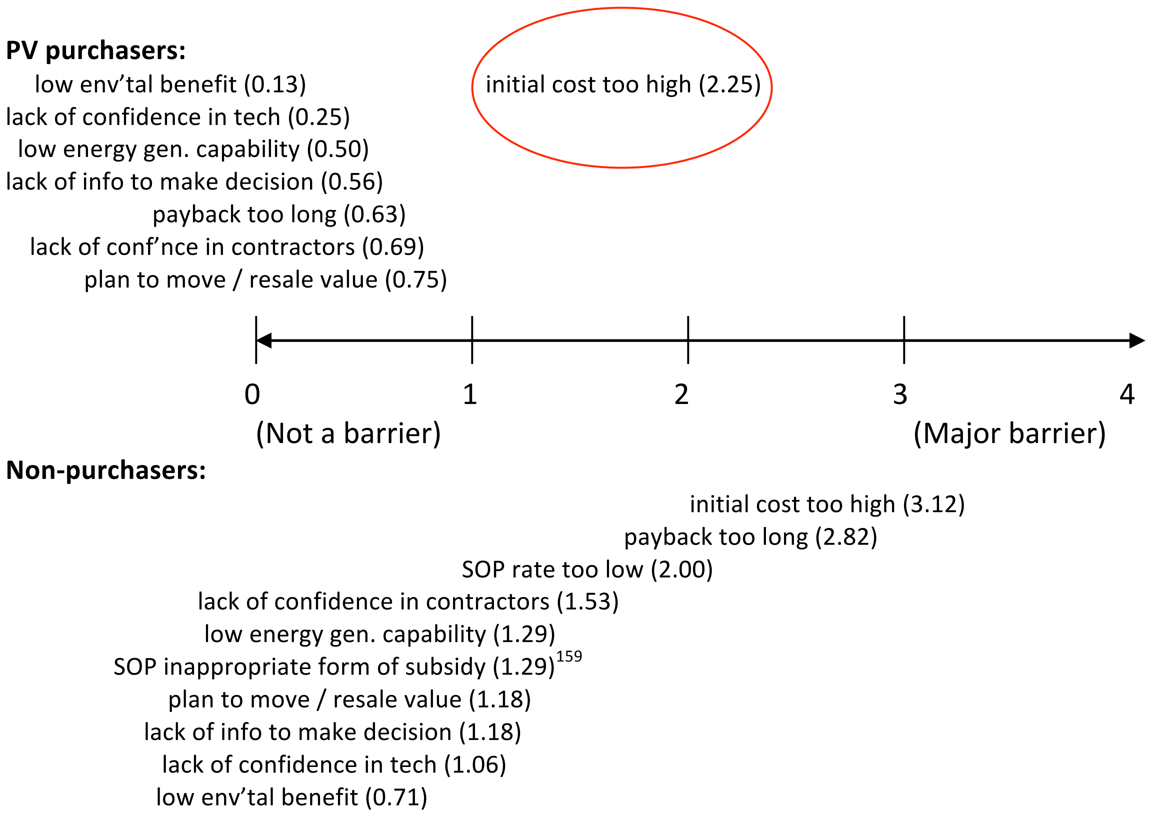
Hurdle (PV purchasers)	Scale 0-4	Barrier (non-purchasers)	Scale 0-4
1) cost of system was too high	2.25	1) cost of system was too high	3.12
2) plan to move in the next few years and are not sure we will recoup the cost in resale value	0.75	2) financial payback too long	2.82
3) lack of confidence in the contractors	0.69	3) the Standard Offer Program rate of 42 cents/kWh too low*	2.00
4) financial payback was too long	0.63	4) unconvinced PV would result in significant energy generation	1.29
5) lack of sufficient information to make an informed decision	0.56	5) the Standard Offer Program is an inappropriate form of subsidy*	1.29
6) unconvinced PV would result in significant energy generation	0.50	6) plan to move in the next few years and are not sure we will recoup the cost in resale value	1.18
7) lack of confidence in PV technology	0.25	7) lack of sufficient information to make an informed decision	1.18
8) unconvinced PV can result in significant environmental benefits (emissions reduction)	0.13	8) lack of confidence in PV technology	1.06
		9) unconvinced PV can result in significant environmental benefits (emissions reduction)	0.71
		10) lack of confidence in the contractors	0.53

Discussion of responses on a linear scale

Initial cost was a far more important hurdle than payback period for PV purchasers. Among SHW purchasers (not represented[157]), initial cost and payback period were found to be of almost equal importance (3.75 and 3.73 respectively). SHW purchasers also perceived the SOP to be too low, and somewhat of an inappropriate form of subsidy,[158] more so than PV purchasers but not quite as much as non-purchasers.

Among SHW purchasers, a perception of "low energy generation" was tied for the position of fourth-most important barrier to PV adoption.

Figure 18 - Barriers to the Purchase of Solar PV Systems



[157] SHW purchaser responses were not included in Figure 18 in order to avoid cluttering the figure and impeding the reader's ability to interpret the figure. SHW responses are very similar to those of PV purchasers. So, it was decided only to include PV purchaser responses. The reader is referred to Appendix A III for a comparable figure representing SHW purchaser responses.

[158] For SHW purchasers, the barriers "SOP rate too low" and "SOP inappropriate form of subsidy" were both found to have an importance rating of 2.00.

[159] Note that this barrier was not included in the list for PV purchasers. Unfortunately, while this question about the SOP was included in the surveys of non-purchasers and SHW purchasers, it was added only after the first survey of PV purchasers had already been administered.

Disadvantages of solar panels

The surveys of non-purchasers and SHW purchasers included two additional questions (Appendix A II), one asking respondents to list three disadvantages of solar electric panels, and a similar question about solar hot water.

Disadvantages of solar electric panels
Question A4a and A4b, open, n = 26 (17 non-purchasers, 9 SHW purchasers)

Non-purchasers and SHW purchasers
"High cost" shows up as a much greater disadvantage than "payback" in this open-ended question. This is an important distinction as it indicates that initial capital cost may be a larger barrier than poor payback for the non-purchasers. In the closed version of this question (B3), payback was found to be "important" while "initial cost" is again "very important". The difference in importance between the two factors in the closed version is much less pronounced. One possible explanation is that for 5 of the 12 responses to the open-ended question, respondents may be using "cost" in a broader sense than just "initial cost".[160]

One non-purchaser mentions Ontario Hydro, indicating they are less aware of the current structure of Ontario's electricity system.

[160] The present study distinguishes two types of financial cost, initial capital cost and payback period. Fliegel and Kivlin (1966) distinguished between three types of financial cost: initial capital, payback period, and magnitude of "payoff" (i.e., financial return). Their findings suggest that initial capital cost is much less a barrier to certain communities (e.g., Iowa farmers) than it was found to be in the present study of Toronto homeowners. Future research could distinguish between these three types of cost, and the degree to which they present a barrier to different communities.

Table 26 - Disadvantage of solar electric panels

n = 17 non-purchasers + 9 SHW purchasers[161]	**Response Frequency**
Initial capital cost*	**19 (24)**
Technology still improving **Inadequate solar resource**	**5**
Complicated arrangement with electrical utility company	**4 (6)**
The permitting requirements of the City	**2**
Return on investment*	**3 (5)**
Rate of return	**2**
High cost to connect to local utility. **Roofing complications** **Aesthetics**	**3**
Not well supported by current government policies **Unable to realize premium with resale value** **Efficiencies**	**2**

Table is condensed; full table in Appendix A III

*Synonyms for "initial capital cost" were mentioned 19 times, by 13 respondents, whereas synonyms for "payback" or "return on investment" were mentioned five times by five respondents.

Disadvantages of solar thermal panels

Question A4b, open, n = 30 (17 non-purchasers, 13 SHW purchasers)

Non-purchasers vs. SHW purchasers

Many of the same design concerns mentioned by non-purchasers are present in SHW purchaser responses. Three SHW purchasers indicated they were unaware of design flaws in the WISE-recommended systems. However, four SHW purchasers knew about the external, electrically heated pipes, and for whatever reason--trust in WISE, tolerance of risk, etc.—proceeded to purchase.

Many of the disadvantages listed pertain to the particular systems procured through the WISE. It would seem that the WISE selection committee did not do an adequate job of assessing the

[161] These two cohorts are considered together since they are both non-purchasers with respect to solar PV.

technical characteristics of the SHW systems before recommending them to participants.[162]

Table 27 - Disadvantage according to non-purchasers

n = 17 non-purchasers	**Response Frequency**
Aesthetics **Cumbersome** (limitations on placement, possible stress on roof, concerns associated with extra tank)	**6**
Initial cost **Creates problem/additional cost for roof maintenance**	**3**

Table is condensed; full table in Appendix A III

4.5 Respondent Perceptions of the RESOP

How respondents first learned about the Renewable Energy Standard Offer Program (RESOP)
Question B4, open, n = 29 (12 SHW purchasers, 17 non-purchasers)

Note to reader: a content analysis table for this question may be found in Appendix A III

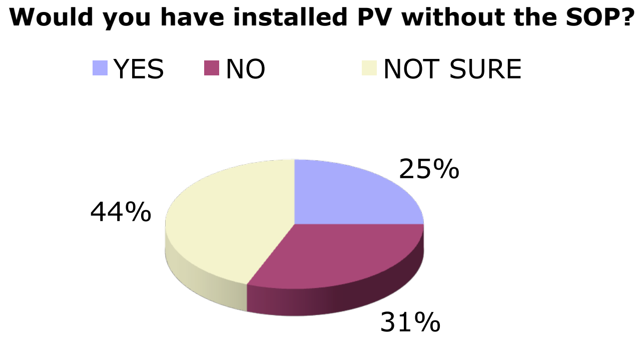
The WISE community meetings were effective at creating awareness of the RESOP. WISE communications (including meetings) were a very important channel by which respondents heard about the RESOP (18 of 29 respondents). Only four respondents listed "media" as a channel by which they heard of the RESOP. This suggests that the media was much less effective at creating awareness of the RESOP among this group of respondents.

Proportion of PV purchasers who would have installed PV without the RESOP
Question B5a, closed, n = 15 PV purchasers

Almost one-third of purchasers would not have installed PV without the Standard Offer incentive. Only one-quarter would have installed PV, and more than half of these would have purchased a smaller system.

[162] The WISE Selection Committee was a subset of initially six, and ultimately four, residents of ward 21 who had been part of the WISE Steering Committee, comprised of about 20 local residents. The role of the Selection Committee was to prepare and review tender documents.

Figure 19 - Importance of the Standard Offer Program for PV purchasers

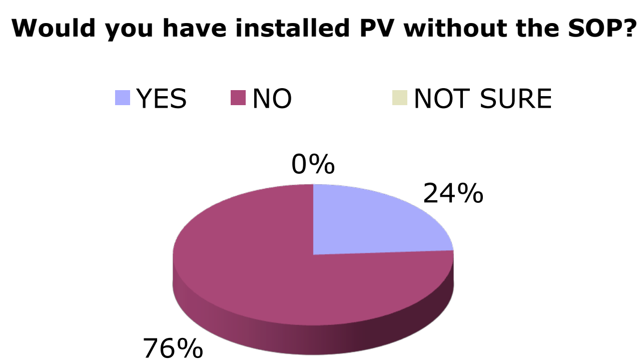


Purchasers described the SOP as a "catalyst", helpful in "overcoming the procrastination factor", or having "sealed the deal".

Proportion of respondents who would have seriously considered purchasing solar panels in the next five years if the RESOP were unavailable
Question B5b, closed, n = 17 non-purchasers

Three-quarters of the non-purchaser respondents stated that they would not seriously consider purchasing solar panels in five years without the RESOP. This implies that the RESOP was important to stimulate their interest in considering the purchase of a system. Non-purchasers rated the SOP 2.65 out of 4 as a motivation for their desire to purchase. In summary, the SOP can be seen as a necessary, but insufficient incentive. It was not high enough to motivate non-purchasers to purchase. This agrees with the finding of the PV purchaser survey that the RESOP was a "catalyst" in purchasers' decision to adopt. It is interesting to note the definiteness in non-purchasers' answers to this question, with 0% of responses falling in the "not sure" category.

Figure 20 - Importance of the Standard Offer Program for non-purchasers



5 Conclusions and Recommendations

5.1 Summary

This research set out to better understand why some residents who signed up for a solar site assessment as part of a community-based initiative decided to purchase, and others decided not to purchase in the short-term. Characteristics and perceptions of potential solar energy adopters were investigated in a downtown Toronto neighbourhood. Based on the results of this study, the main differences between purchasers and non-purchasers affecting adoption behaviour pertain to two themes:

- compatibility of the innovation with the characteristics of potential adopters and their households
- the CSEI as an means of enabling residents to overcome barriers to adoption

Differences were found in respect of these two themes between the three respondent groups, PV purchasers, SHW purchasers, and non-purchasers. These differences offer insight into the adoption behaviours of each group, and in particular, those of purchasers (PV and SHW) vs. non-purchasers.

Chapter 2 developed a conceptual framework for adoption of solar energy systems in the context of a CSEI. This conceptual framework is based on models of human behaviour that inform the design of CBSM, and diffusion of innovations theory. The study took an integrated approach by considering both social and technical aspects of solar energy adoption, with the issues of fuel substitution and reductions in household electricity demand. This conceptual framework applied to the above-mentioned aspects and issues provides a basis for analyzing survey results to better understand adoption behaviour.

Chapter 4 presented findings according to content area. The literature was linked to the primary data in Chapter 4 on a 'finding-by-finding' basis. In this chapter, the findings from both open-ended and importance-scale questions are integrated into conclusions concerning adoption behaviour, using the method described in Chapter 3 (p. 72). Table 28 summarizes the findings from Chapter 4, organized by perceived innovation attribute. Attributes in the table are a subset of those included in the framework for analysis from Chapter 2 (p. 55). Attributes that were found to be useful for explaining adoption behaviour in the WISE case study are included in the table. The attributes omitted from the table[163] are those for which no conclusive evidence was found in Chapter 4.

[163] trialability, efficiency, continuity

These themes are represented in Table 28. Note that the category with the largest number of attributes is "compatibility". The second theme concerning the WISE as an enabler spans several attributes categories, and includes attributes such as "long payback", "confidence in the WISE", "the WISE's organizational capacity to reduce complexity in the adoption process". The importance of compatibility and differences in perception of WISE as an enabler is fully explained in the conclusions that follow.

Table 28 - Reasons for adoption behaviour

Relative Advantage

- Purchasers were extremely positive about the WISE, evidenced by their enthusiastic descriptions of its benefits. While also positive, non-purchasers were less enthusiastic.

Financial cost

- Non-purchasers and SHW purchasers rated "long payback" a much greater barrier than did PV purchasers. Beyond offering a bulk purchase discount, WISE could do little to improve payback.

Risk and uncertainty

- Purchasers had more confidence than non-purchasers in the reliability of PV.
- Non-purchasers attached greater importance to all barriers than did PV purchasers.
- Non-purchasers had less confidence in the WISE's ability to overcome barriers.

Complexity

- Purchasers perceived greater value than non-purchasers in the WISE's organizational capacity to reduce complexity in the adoption process.
- Non-purchasers expressed a greater desire for simple, clear messaging.

Observability / Symbolic attributes

- PV purchasers were more motivated than non-purchasers by the desire to 'set an example'.
- Non-purchasers were concerned about poor aesthetics of SHW systems.

Compatibility

- Age of SHW purchasers: older adopters purchased system with shorter payback
- Type of education: professional vs. graduate degree
- Size of solar resource: PV purchasers had enough roof space for >2 kW
- Purchasers had more nuanced cognitions around the WISE than non-purchasers did.
- Values/priorities: non-purchasers assigned greater importance to improving local environment relative to global warming/climate change.
  => Solar energy systems may not have enough of an effect on local environment to persuade those who are looking for air quality solutions to purchase.
- Customer service was of greater importance to non-purchasers; (they may have had less positive/more negative experiences than purchasers of front-line sales staff).
- Direct vs. indirect benefits of adoption: purchasers were more motivated by direct benefits of solar energy systems, while non-purchasers were more motivated by indirect or contingent benefits.
- Non-purchasers perceived the SHW systems offered through the WISE to be cumbersome.

Communicability

- Purchasers talk more often to friends about energy issues.

Communication modes

- No purchasers mentioned hearing about the project through the media, while 18 percent of non-purchasers did.

Networks

- Purchasers were on more familiar terms with the local civic and environmental leaders who initiated the WISE.

In addition to the conclusions concerning adoption behaviour, there are a number of other conclusions that can be drawn from this study. These have to do with characteristics of WISE participants, i.e., both purchasers and non-purchasers (Section 5.2.4).

Recommendations to increase adoption of solar energy systems through CSEIs are offered in Section 5.3. These are oriented towards CSEI organizers and vendors. Opportunities for future research are discussed in Section 5.4. The chapter concludes with some final comments on solar energy adoption within the context of the WISE.

5.2 Conclusions Concerning Solar Energy Adoption in the WISE Case Study

This section answers the primary research question, drawing on relevant theories to link the characteristics and perceptions of respondents to their adoption behaviours. Conclusions are presented in the same sequence as was used in Chapter 4, i.e., those pertaining to household characteristics, to the community initiative, and to solar energy systems generally.

5.2.1 Compatibility of household characteristics with perceived innovation attributes

Small differences in average age were found with SHW purchaser respondents being on average five years older than PV purchasers, and three years older than non-purchasers. The small number of respondents means that the difference should be treated with caution, however the pattern of SHW purchasers being older than PV purchasers is consistent with the compatibility issue of older adopters being more likely to adopt innovations with shorter payback periods, because they are more likely to outlive the payback period, thus recouping their investment.

Planning to move is a moderately important barrier to adoption. Three-quarters of non-purchasers planned to move within 20 years (the length of the RESOP contract). Less than half of purchasers expected to move within 20 years. Hence, adoption decisions of both groups are consistent with the theory of planned behaviour.

Non-purchasers were found to share attitudinal and demographic characteristics of the 'pragmatic' early majority[164], while purchasers shared those of the 'visionary' early market[165]. (Both types of market participants are characterized by Faiers and Neame (2006), Egmond, Jonkers and Kok (2006) and Wieffels (2002)). Based on this finding, WISE purchasers could be expected to be more comfortable acting on intuitive knowledge, and therefore be more willing

[164] 34 percent of the market
[165] 2.5 + 13.5 = 16 percent of the market

to adopt despite uncertainty around climate change impacts and costs/benefits of installing a solar energy system. Later market adopters are characterized by a higher level of risk aversion, and a more pragmatic, conformist, and analytic mindset (Egmond, Jonkers and Kok, 2006). In this study, a respondent having a professional degree is taken as an indication that they tend to engage in rational-economic decision-making.[166] The characteristics of a 'pragmatic' early majority may be more prevalent among individuals who hold professional degrees, relative to individuals with graduate degrees outside of the professions.

Household behaviours

The higher frequency with which non-purchasers talk to co-habitants about energy issues, and lower frequency with which they talk to friends and neighbours, suggest that non-purchasers regard energy as more of a household expense than a topic of social/cultural interest. Respondents who are more engaged in energy issues on a cultural, rather than purely economic, level could be expected to be further along the awareness->attitude-formation curve, making them more likely to adopt.

Household electricity consumption of WISE PV adopters

WISE PV-adopting households consumed on average 7680 kWh of electricity annually. This figure includes both electricity generated by their PV systems, and electricity drawn from the distribution grid.

The PV systems procured through WISE produced 37% as much electricity as the households consumed during the period after the PV systems were installed (March 2008-December 2009). The "best-performing" PV purchaser household produced two-thirds (66%) as much electricity as the home consumed, while the "worst-performing" household produced only 18% as much as it consumed.

5.2.2 Conclusions related to the community initiative

Both purchasers and non-purchasers expressed similar positive perceptions of the initiative. The adoption decision variables that differed between the two groups had more to do with barriers external to the program, namely financial disadvantages and risk. Conclusions concerning external factors are offered in Section 5.2.3. However, certain notable differences

[166] Dalton (1986) reports that professional education and practice are dominated by rational decision-making. Bommer (1987) report efforts within the engineering community directed toward formulating a clear, "unified" code by which all engineers can easily regulate their professional conduct. These efforts are reported to have been motivated by logical conflicts in existing codes.

between respondent groups were found that help explain their purchase decisions. These differences in perceptions of the CSEI are discussed below. The framework based on CBSM and DoI theory, which was developed in Chapter 2, is used here to organize the conclusions into categories and themes. DoI categories—relative advantage, cost, risk, compatibility, complexity and observability[167]—are formatted bold and black. More complex themes relating to communication and characteristics of adopters are identified using grey headings.

Relative advantage

Purchasers were extremely positive about the benefits of the WISE. Non-purchasers were also positive, but appear to have had less confidence in the program. This was indicated by (1) their demand for a high level of 'customer service', (2) their rating 'payback too long'[168] 4X more important than did PV purchasers, and (3) their less enthusiastic descriptions of WISE's benefits. Reasons for non-purchasers' lower level of confidence in the WISE are further elaborated below in the section on communicability and networks.

Financial cost

Non-purchasers placed more importance on the "bulk purchase discount" as a motivating factor. This is consistent with the conclusion in Section 5.2.3 that non-purchasers placed a higher importance on cost as a barrier/hurdle relative to purchasers.

Perceived risk

Non-purchasers placed greater importance than purchasers on risks and uncertainties being resolved "prior to neighbourhood delivery" (resp. 43). The demand for a reliable, hassle-free process is typical of early majority adopters who tend to be more risk-averse than early adopters (Egmond et al., 2006).

Purchasers had greater confidence than non-purchasers in the WISE's ability to streamline the process of acquiring a solar energy system. While purchasers went ahead and then later complained of miscommunication, connection delays, and other hassles, non-purchasers were less willing to accept these problems. This agrees with LaBay and Kinnear (1981) who found that non-adopters tended to rate each factor to be of greater importance than adopters. The

[167] With one exception, the attribute category "trialability" was not found to be a useful for explaining adoption behaviour in this study. The exception was a SHW purchaser who stated: "we purchased the solar water heater but not the electicity panels....[our] decision was limited by money and wanting to first test on something managable (ie. hot water system)" (resp. 19).
[168] long payback was a barrier the WISE was not able to address

barriers to solar energy adoption were perceived by non-purchasers as beyond the WISE's ability to address.[169]

WISE's offer of reduced uncertainty was of most value to SHW purchasers, possibly because of uncertainty around city approvals and mechanical complexity of domestic SHW systems.[170]

Observability

All PV purchaser responses related to positive environmental action, notably to set an example for their children (n = 4 of 15).[171] SHW purchasers were somewhat more diverse in their motivations, the implications of which are explained below.

Compatibility and Communicability (modes, networks)

Importance of aligning adopter values with initiative's goals (social capital and cohesion)

It is important to align an intervention's goals with social norms in which the intervention is being implemented. Faiers, Neame and Cook (2007) argued that in an early stage market, adopters are committed to the concept of the innovation. The norm-activation model requires acceptance of moral norms as a pre-requisite for behaviour change (Joireman et al., 2001). Community energy initiatives require that participants be favourably predisposed to the concept of the innovation (however they perceive it) before proceeding to consider adoption. In the case of the WISE, if participants were not already concerned about climate change and air pollution, there would have been little interest in participating in a community initiative to address these issues.

Strong civic and environmental leadership

One very important way WISE was able to communicate its message to a receptive audience was through the regular communications of local community leaders. The involvement of Toronto City Councillor Joe Mihevc was important for diffusing awareness of the CSEI to potential adopters. The involvement of Jed Goldberg, President of Earth Day Canada, was also

[169] A fascinating outcome for PV purchasers is that by proceeding to purchase under the RESOP, they were well-positioned to capitalize on the FIT, being grandfathered into the new program in recognition of their pioneering efforts (personal knowledge, 2009).
[170] While the level of mechanical complexity of a solar hot water system is similar to that a water softener or gas water heater, such appliances are already in a majority stage of the diffusion process. Unlike PV, a SHW system is both mechanically complex, and in an early stage of diffusion. This implies that diffusion of SHW systems is hindered by greater perceived risk and uncertainty than common appliances like water softeners, and PV systems (which are at an early stage of diffusion too, but pose less mechanical risk).
[171] One of these responses pertained more directly to personal health than environment, i.e., "so I can breathe better" (resp. 5).

important for building trust in the initiative. Communications originating from a trusted, authoritative source may be effective for building trust about the project. Councillor Mihevc appears to possess a high degree of opinion leadership as defined by Robertson and Myers (1969).

Purchasers seem to have had a stronger personal connection with the people and organizations involved in the initiative than did non-purchasers. This could help explain the higher levels of trust and positive perceptions[172] of the WISE among purchasers relative to non-purchasers.

Complexity

The WISE was an enabler for homeowners who are committed to the concept of solar technology as a source of sustainable energy. As one SHW purchasers put it, “We were…believer[s], WISE made it easy”. This agrees with Faiers, Neame and Cook (2007) that innovators are more likely to put up with poor financial performance because they are committed to the concept of an innovation. WISE can be viewed as an agent, acting in residents’ interests to reduce the complexity of adopting a solar energy system. More purchasers than non-purchasers indicated that they would not have seriously considered purchasing without the help of the WISE. Hence, the WISE played a larger role in influencing purchasers to seriously consider purchasing a solar energy system than non-purchasers, i.e., in moving purchasers through the awareness -> decision -> adoption process.

Importance of possessing a cognitive dissonance that the innovation is perceived to be able to address

While solar energy systems were treated as “the innovation” in this study, it is difficult to fully explain adoption behaviour in the context of a CSEI without recognizing the innovative nature of the initiative itself. Of course residents were considering whether to adopt a solar energy system, however they were simultaneously considering whether to do so through the WISE, i.e., whether or not to pay attention to WISE communications (read emails, attend meetings), obtain services from one of the WISE’s “preferred vendors”, and otherwise participate in (i.e., “adopt”) the community initiative.

Responses from purchasers revealed certain well-developed social and ecological values, which appear to have had an important role in motivating their interest in the WISE, both as a social initiative, and as a means to procure a solar energy system. A theme in purchasers’ comments about the WISE was feeling good about taking socially and ecologically responsible action, i.e.,

[172] Both purchasers and non-purchasers had positive perceptions of the WISE, but non-purchasers were less positive. Evidence was provided in the paragraph on relative advantage (p. 127).

“doing the right thing”. Therefore the norm-activation theory and cognitive dissonance theory are highly applicable to the adoption behaviour of PV purchasers. Non-purchasers also indicated a desire to take positive social and environmental action, however typically not to the same degree, and concerning different issues (air quality rather than climate change), and as mentioned, possessed less confidence in WISE’s capacity to overcome perceived barriers (cost, risk). Hence, two core differences between purchasers and non-purchasers are the strength of their cognitive dissonances in respect of the issues WISE was able to address. This conclusion is supported by the assertion of norm-activation theory that for behaviour change to occur, an individual must perceive that they have both the responsibility and capacity to act.

Purchasers were found to possess both a greater sense of responsibility, a greater confidence in WISE in providing the capacity for effective action. Purchasers also possessed more nuanced cognitions around these issues than non-purchasers did. Together, these findings lead to the conclusion that the strength of moral norms concerning the issues WISE was (perceived to be) able to address, was an important determinant of adoption.

The reader is referred to Section 5.2.3 for conclusions pertaining to the relative importance of environmental vs. financial factors (independent of the community-oriented aspect of the WISE).

5.2.3 Conclusions related to solar energy systems

In the course of analyzing respondent answers, it was discovered that their perceptions could, with a few exceptions, be neatly separated into two categories, those having to do with the WISE as a community-based environmental initiative (i.e., not inherently having to do with solar energy), and perceptions of solar energy systems generally (i.e., irrespective of the community aspect). This section offers conclusions concerning respondent perceptions of solar energy systems, independent of the community initiative.

Relative advantage

The primary advantage of solar energy systems identified by WISE respondents is in relation to conventional energy sources, namely fossil fuels and nuclear power plants. The specific advantages of solar energy technologies relative to conventional energy technologies are elaborated below.

Compatibility

Ability of the innovation to directly address issue of primary importance to respondent

One of the more interesting conclusions of this study concerns the relationship between the primary issue motivating a potential adopter to consider an innovation and the innovation's ability to address that issue. To put this in more tangible terms, this study found that PV purchasers' primary interest in solar energy systems was to reduce the "energy footprint of their home", "climate change or global warming", and "negative impacts of carbon emissions". (These three considerations were rated of equal and highest importance.) These are also issues that can be directly addressed by the installation of a solar energy system, because, all else equal, installing a solar energy system on a house in Ontario can be expected to reduce carbon-emissions. However, in the case of non-purchasers, their primary motivations for considering the purchase of a solar energy system included "air quality", and to "help Ontario close its coal-fired power plants sooner". While the installation of a solar energy system has the potential to improve air quality and lead to the closure of Ontario's coal-fired power plants, note that the relationship is much less direct. Installing a solar energy system has a direct effect on mitigating climate change. However, installing a solar PV system may or may not improve air quality, depending on the location of the carbon emissions that the solar energy system is offsetting.

It can be concluded based on the findings of this study that purchasers and non-purchasers had somewhat different primary motivations, and that the primary motivations of purchasers concerned issues that the innovation could directly affect, while the primary motivations of non-purchasers tended to concern issues that solar energy systems had only the potential to effect. Whether this difference actually influenced adoption decisions would need to be determined through further research.

Coherence of motivations affecting the efficacy of an adoption decision to relieve cognitive dissonance

When asked to list the most appealing features of solar panels, purchasers tended to mention causal relationships. Responses from non-purchasers varied widely and were sometimes incorrect (9 responses from 17 respondents) or out of step with the project's goals (5 responses from 17 respondents), e.g. solar technology reducing dependence on hydro dams. Also, as was discussed earlier, non-purchasers' primary motivations included improving the local environment, while purchasers were primarily motivated by concern over global warming and climate change. On these bases, it is concluded that purchasers possessed more coherent causal constructs concerning the benefits of solar energy adoption than did non-purchasers.

Other compatibility issues

Aesthetics and physical incompatibility were found to be the largest barriers to solar thermal systems identified by WISE non-purchasers. The cumbersome nature of the WISE-procured DSHW systems was also a barrier. Barriers having to do with poor aesthetics, maintenance, constructability, inadequate information, and cost are all documented in the literature on barriers to solar energy use (Margolis, 2006). Margolis' barriers all fit within the six broader categories enumerated by LaBay and Kinnear (1982), relative advantage, perceived risk, complexity, compatibility, trialability, and observability. Aesthetics could alternatively be considered under the heading "observability".

Six non-purchasers indicated that appearance was a barrier to adoption of a solar thermal system. As one non-purchaser commented, "I really wanted the thermal power system to generate our hot water but was not comfortable with how it would look on our roof. We live in a lovely neighbourhood and I did not want to have my house have something on the roof that would be an eyesore" (resp. 40).

A small number[173] of respondents indicated that they decided not to purchase a solar PV system because they did not have enough roof space to install a large enough system to make it "worthwhile" (i.e., at least 2 kW).

Risk and uncertainty

PV purchasers are more motivated than non-purchasers by the reliability of the system to produce electricity.

Many of the design and performance disadvantages listed by SHW purchasers pertain to the particular systems procured through the WISE. The WISE selection committee appears not to have done an adequate job of assessing the technical characteristics of the SHW systems before recommending them to participants.[174] Many of the same design concerns mentioned by non-purchasers are present in SHW purchaser responses. Three SHW purchasers were unaware of design flaws in the WISE-recommended systems. However, four SHW purchasers knew about the external, electrically heated pipes, and yet proceeded to purchase.

[173] one SHW purchaser and three non-purchasers

[174] A member of the WISE steering committee revealed that it had been the steering committee's intention to rely on an impartial expert with knowledge of solar energy systems to review vendor proposals. However, this expert ultimately did not assist in the bid review, and so a subset of the steering committee volunteered to review the bids instead (anon., personal communication, 2011). This group became referred to as the WISE selection committee.

Financial cost

Initial cost was found to be the largest hurdle/barrier to the purchase of a PV system. For those who did purchase, initial cost was a far more important hurdle than payback period. Among non-purchasers, initial capital cost was not the only important barrier, but so too were "low payback" and "low [buy-back] rate". Non-purchasers rated all three of these measures of financial cost as greater barriers than did purchasers. The decision not to purchase can therefore certainly be attributed in part to the financial disadvantages of solar PV.

Among SHW purchasers, initial cost and payback period were found to be of almost equal importance. SHW purchasers also perceived the SOP rate to be too low, and somewhat of an inappropriate form of subsidy. These negative perceptions of the RESOP were stronger among non-purchasers vs. PV purchasers.

"Cost" and "cost for roof maintenance" were each mentioned three times by non-purchasers as barriers to adoption of a DSHW system.

Importance of environmental vs. financial considerations

While initial capital cost was found to be (by far) the largest barrier/hurdle to the purchase of a PV system for all WISE participants, the importance of financial cost relative to environmental considerations, namely climate change/global warming, air quality, and (to a lesser extent) reducing transmission corridors, was a notable difference between purchasers and non-purchasers.

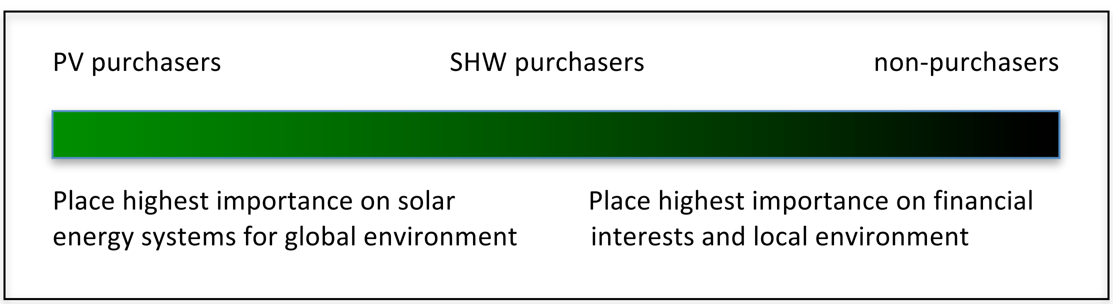
In addition to the above conclusion regarding moral norms (Section 5.2.2 - Compatibility and Communicability), SHW purchasers were found to be more motivated than PV purchasers by a desire to reduce household energy costs. Non-purchasers and SHW purchasers both placed more importance on financial disadvantages of solar PV adoption than did PV purchasers.

The above three findings--1) greater strength of moral norms among purchasers relative to non-purchasers (Section 5.2.2), 2) the relative strength of SHW purchasers' moral vs. financial motivations, and 3) the higher importance of financial disadvantages to non-purchasers and SHW purchasers vs. PV purchasers—taken together suggest an explanation of adoption behaviour that integrates the norm-activation, cognitive dissonance and rational-economic models. This is explained below.

All respondents place a high importance on reducing carbon emissions, global warming and climate change. All three respondent groups have high average household incomes. However, the SHW purchasers and non-purchasers rate the financial drawbacks of solar PV as much greater barriers than do PV purchasers. SHW purchasers and non-purchasers would therefore have been less willing to adopt a PV system, due to its financial drawbacks, namely a much higher initial capital cost (~$20,000 vs. ~$4000) and a longer payback period (~20 years vs. ~5 years). SHW purchasers opted for the less expensive of the two types of system, solar thermal rather than PV. Non-purchasers however were (1) slightly less motivated by the issue of global climate change (i.e., an issue of dire consequence which solar energy systems can directly address), (2) placed more importance on financial disadvantages of solar energy adoption than PV purchasers, and (3) were less confident than both SHW and PV purchasers in the ability of the WISE to overcome barriers. Hence, the conditions for behaviour change according to the norm-activation and cognitive dissonance models are not met as strongly in the case of non-purchasers as they are for purchasers. Also, according to the rational-economic model, the high importance that non-purchasers place on financial disadvantages as a barrier to adoption would tend to dissuade them from purchasing. In other words, non-purchasers expressed weaker motivations, and stronger attitudinal barriers than did purchasers.

The three respondent groups can be seen to lie along a continuum, from those who rated the importance of solar energy systems to address climate change and global warming relatively high compared to negative impacts on household finances, and vice versa (Figure 21). PV represented the highest financial cost, DSHW next highest, and not purchasing the lowest. PV purchasers were most willing to accept financial penalty in favour of positive action to address global warming and climate change, SHW purchasers less so, and non-purchasers even less so, requiring lower initial cost, shorter payback, and (in the case of non-purchasers) a higher rate incentive.

Figure 21 - Continuum of respondents' values affecting purchase decision



5.2.4 Characteristics of WISE participants (purchasers and non-purchasers)

Household characteristics

Compatibility

About half of WISE households consist of middle-aged couples with children. Recognizing that PV purchasers needed to own their own home while also being young enough to outlive a 20-25 year payback period, one would expect to find a higher percentage of middle-aged couples with children relative to the general population.

Complexity

WISE participants are far more educated than Ward 21 residents as a whole. This finding agrees with Lee, Lee and Schumann (2002), Hirschman (1980), and LaBay and Kinnear (1981) who also found that innovators are more likely than members of the general population to hold advanced degrees.

Cost

Income distributions of both purchasers and non-purchasers are centered much higher than the distribution of the ward overall. However, it is not possible to conclude that purchasers had higher incomes than non-purchasers. Indeed, the average income of respondents who chose to answer the question about income was almost $10,000 higher for non-purchaser vs. purchasers.

Communicability (networks)

Respondents appear to belong to a sub-community within Ward 21. Community belonging is evidenced by a variety of factors, including having lived in the neighbourhood for more than 10 years, receiving information from the same local community sources, expression of environmental values, use of common vernacular (though as noted earlier, differences between purchasers and non-purchasers were found in respect of these factors, indicating social distance between purchasers and non-purchasers, despite their belonging to a sub-community).

Household behaviours

WISE participant behaviours agree with findings from the broader environmental behaviour change literature that innovators are active information seekers (Lee, Lee and Schumann, 2002), and seek a sense of belonging to a broader group, i.e., identity formation (Jacobsson and Johnson, 2000).

Observability

Behaviour changes among neighbours in response to solar energy adoption, sometimes called "ripple effects", were described by two WISE purchasers. These ripple effects occurred among neighbours who, after seeing the installation and talking to a WISE purchaser, later signed up for a solar resource assessment, and in another case downsized from a SUV to a smaller vehicle. This demonstrates that residential solar energy systems can both create awareness and lead to environmental behaviour change, such as adoption of energy efficiency and conservation. This is consistent with results in the CBSM and DoI literature concerning awareness and attitude-formation as a precursor to behaviour change (Faiers and Neame, 2006; LaBay and Kinear, 1981).

Perceptions concerning RESOP incentive

The RESOP was found to be important for stimulating residents' interest in purchasing a solar PV system. It can be seen as a "catalyst" for PV purchasers, or a necessary but insufficient incentive for those who did not purchase a PV system.

Study findings are consistent with LaBay and Kinnear, while offering greater nuance

LaBay and Kinnear (1981) found that product-related and economic factors were of the highest concern to both adopters and knowledgeable non-adopters. In their study, social factors are uniformly evaluated by both groups to be of far less consequence in the adoption decision process. Findings from the present study of WISE participants support those of LaBay and Kinnear, since factors relating to system performance and costs were also found to be of primary importance to both purchasers and non-purchasers, based on importance-scale factor ratings. LaBay and Kinnear rejected the null hypothesis for differences between experimental groups on factor evaluation, for both product-related and economic factors. The present study found a similar difference between PV purchasers and non-purchasers ratings of these factors, specifically "reliability of PV", "ability to reduce electricity financial costs", and "payback improvements coming from the RESOP". SHW purchasers and non-purchasers were found to be nearly identical in their ratings of importance factors, except for the factor "reduced uncertainty through WISE's selection of preferred contractor", which SHW purchasers rated higher[175] than non-purchasers, indicating their higher level of trust in WISE's ability to select a competent contractor. The reader is referred to appendix A(IV) for a table of factor importance ratings for WISE participants which is similar to results reported by Labay and Kinnear's (1981: 276) .

[175] SHW purchasers rated "reduced uncertainty" 2.8 out of 3, while non-purchasers rated this factor 2.2 out of 3.

LaBay and Kinnear (1981) further found that attribute perceptions are more effective than demographic characteristics in predicting an individual's category membership (i.e., adoption behaviour). The present study supports this finding, with one caveat. LaBay and Kinnear looked only at education level, while the present study asked about education level and type. If LaBay and Kinnear’s methods had been applied to the WISE sample population, similar findings would have been produced. However, because the present study asked more specific questions about type of education—graduate degree vs. professional degree—a difference was detected in this study that may or may not have been present in LaBay and Kinnear’s respondent sample.

5.3 Recommendations

Recommendations are offered for increasing the adoption of solar energy systems by non-purchasers in Ward 21. Additional recommendations are offered to improve the design and implementation of CSEIs, and increase the uptake of solar energy systems generally.

The recommendations concern generally what needs to be done to increase residential solar energy adoption. In some cases, a recommendation will be directed to a specific stakeholder, e.g. CSEI organizers, vendors, and policy-makers. Other recommendations could be taken up by these or other CSEI proponents.

5.3.1 Recommendations to increase uptake of solar energy systems through CSEIs

Relative advantage

Non-purchasers' motivations to consider purchasing a solar energy system as part of the WISE can be divided into categories of "strong" and "weak". Six of the motivations belong in the "strong" category, and four in the "weak" category. This suggests that **six key messages** should be emphasized in promoting CSEI to non-purchasers. These six considerations are:

- air quality
- climate change
- energy footprint
- group discount
- reduced uncertainty
- reduced energy costs (or for PV, improved financial proposition resulting from the FIT)

Less important motivations are:

- leading by example
- sending a message to neighbours
- getting advice about solar energy retrofit projects
- learning about solar energy

Within each group, the considerations listed above are not in order of importance.

It is recommended that the four motivations (identified by all respondents) for joining the initiative be re-emphasized:

1. opportunity for help, facilitation, and information about solar energy systems
2. taking action to help the environment
3. send a political or social message
4. to be part of a great initiative

The community-building and neighbourhood identity benefits of WISE could be emphasized to further increase residents' perception of relative advantage over conventional approaches to energy generation.

Cost

Promotions of CSEIs in the presence of a FIT program should prioritize communication about the financial benefits of the FIT, even though financial benefits were not the strongest motivation for the WISE purchasers in 2007 (i.e., under RESOP).

Risk and uncertainty

CSEI proponents should continue to build trust and credibility among participants who have expressed interest, but have not yet purchased.

CSEI organizers and vendors should ensure that front-end customer relations are excellent to encourage more risk-averse market participants to purchase. Messages around price, company reputation and system reliability also require careful attention.

To reduce complaints, vendors should ensure prompt follow-up with specific information requested by homeowners.

Compatibility

CSEI organizers should approach respondents who said they would have liked to participate but for lack of solar resource on their own home, and develop "corporate" or community-owned systems.

Be careful not to disregard people's non-environmental core values in the design of the program, e.g. feminism or religious values. Organizers and sales people should be sensitive to participants' religious practices. For example, it's advisable not to schedule sales visits with Jewish participants on Saturday.[176]

Complexity and Observability

Emphasize CSEI benefits for reducing complexity in the adoption process.

The ability of CSEIs to create energy awareness as a precursor to environmental behaviour change is a major potential strength, and therefore deserves further research and policy support.

Communicability

Community organizers should build awareness of the project through trusted, authoritative communication channels originating from local opinion leaders. A broad base of support should be established among local politicians and other opinion leaders. This not only leads to greater message dissemination, but also lends credibility to the project as a whole. A non-exhaustive list of such channels includes newsletters, community events, environmental club meetings, social media and modern media.

WISE messaging should be sophisticated enough to appeal to participants with a professional degree, Master's degree, or higher level of education, without being overly complicated. Language, figures, and images should be used that appeal to norms within the professions, in particular, architects, lawyers, doctors, engineers, and business professionals. However, this messaging should be careful not to reinforce the perception of solar energy as being "only for the rich", or otherwise inaccessible to individuals with less formal education.

Tailor promotions to professionals by emphasizing values and norms common to their peer group, and using language and visuals similar to the literature they are familiar with and trust. More generally, communications should always, when possible, be tailored to appeal to values and norms within the community of interest. These would be communities with some appetite for solar energy adoption, e.g. those concerned about climate change, or energy security.

The frequency of communication should match participants' expectations. Vendors should follow-up as soon as possible before enthusiasm wanes and participants begin to doubt their decision. Language should be used at public meetings to instil confidence, but not over-promise (e.g. making guarantees that "no issues" will arise).

[176] 9.3 percent of Ward 21 residents report a Jewish ethnic origin. "Jewish" is also reported to be the most common single response. (City of Toronto, 2006)

5.3.2 Recommendations to increase the adoption of solar energy systems generally

Relative advantage

Potential adopters should be educated about the relationship between household use of fossil fuels causing carbon emissions, contributing to global climate change and the ability of solar energy to decrease reliance on carbon-emitting fuel sources. Education concerning this relationship may create a cognitive dissonance in the minds of potential adopters that can be resolved (in part) by installing a solar energy system.

Efforts should be made to improve residents' negative perceptions of the following issues: installation hassles, limited lifespan of PV, aesthetics, roofing complications, improving technology, lack of government support, permitting, administration, regulations, and return on investment.

Misconceptions concerning solar resource potential should be countered by citing Bradford's (2006) finding that 7 percent of the surface area covered by US cities and rural residences would be sufficient to provide an amount of electricity equivalent to US demand, using today's technology. Additionally, cite findings from this study such as: solar PV installed on 0.6 of the surface area of the GTA would generate an equivalent amount of electricity annually to a 975 MW natural gas plant.

Promoting PV with conservation

Non-purchasers' perception that PV cannot produce significant amounts of energy was found to be a moderately important barrier. Marketing PV together with conservation may help reduce this barrier. If homeowners conserve to the point that a PV system is generating a significant portion (>50%) of their household energy, this would achieve better environmental outcomes, and should also increase the appeal of PV to homeowners, leading to more sales of PV systems.

Educate participants about inefficiencies in the centralized electricity system, which results in more than half of the primary energy being wasted in generation and transmission losses.[177] Given the poor energy conversion efficiency of burning hydrocarbons to turn steam-driven

[177] Bradford (2006:41-42) notes, "Even though electricity comprises only 18 percent of the final consumption, it requires some 39 percent of the primary fuel supplied—losing some 65 percent of the energy content of its fuel during generation and transmission."

turbines,[178] this begins to build a convincing argument for PV as an alternative to "burning when smog is a major issue" (resp. 41).

Financial cost

Vendors could overcome "initial cost" barrier with a financing package that offers monthly instalments smaller than the FIT payments. This can be achieved with a 10-15 year amortization period, creating positive cash flow from "month one" (L. Allen, personal communication, May 2009).

Since non-purchasers are more highly motivated by "secondary attributes" of PV systems, such as financial benefits and reducing the need for "transmission corridors/high voltage power lines", vendors and CSEI organizers should emphasize these attributes, along with "air quality" (A6), in messaging to non-purchasers. The finding that payback improvements due to the RESOP were an important motivator supports the role of the FIT as a very important potential motivator.

The barrier, "plan to move and not sure if we will be able to recoup resale value" was found to be a barrier of moderate importance for non-purchasers (1.18 out of 4). This suggests that perceptions of resale value may need to improve before they proceed to purchase.

Risk and uncertainty

Non-purchasers ranked "reliability of PV technology" last. Therefore emphasize the low maintenance and high reliability attributes of PV in messaging to non-purchasers in order to improve their perceptions of this attribute.

Correct or address perceptions of hassles related to solar thermal systems (overheating if not used regularly, additional roof maintenance).

Vendors and CSEI organizers should respond to participant concerns that the technology is still changing, in particular when clients cite media articles about "breakthrough" technologies. Effective responses may include:

1) The media frequently sensationalizes new technologies, few of which reach commercialization (i.e., become available at a competitive price), and usually only after a long period of research and development.

[178] Amory Lovins (2004:2) notes, "Classical power stations that raise steam to turn turbines that run generators that ultimately deliver electricity through the grid necessarily consume 3-4 units of fuel per unit of electricity delivered, and even the most efficient combined-cycle plants decrease this ratio to only about 1.8".

2) The variables affecting the rate of return for a system purchased today are more or less fixed, and the feed-in-tariff rate (micro-FIT for small systems) is intended to achieve an 11 percent ROI, or <10 year simple payback (OPA, 2009).

3) The efficiency of market-grade solar panels has increased only two percent over the past 10 years (Green et al., 1998: 3; Green et al., 2008: 3). Explain that the industry is more focused on reducing the cost of manufacturing first-generation technology than raising efficiencies, and is unlikely to increase quickly because of (i) a theoretical maximum for photovoltaic efficiency and (ii) industry focus on low-cost, lower-efficiency technologies.

Compatibility, Complexity and Observability

Reasonable concerns should be addressed, such as those having to do with an extra hot water tank, and the complexity of using solar heated water.. Participants with irrational or peculiar conceptual barriers should perhaps be filtered out and targeted separately.

The simplicity of PV system operation should be emphasized.

The appearance of solar thermal systems should be improved. Alternatively, ways should be found to make them less visible.

Communicability

Recommendations for PV vendors: approach homeowners with a well-suited location and deliver the messages: "This site is ideal. This is how much it will cost. This is the IRR or ROI. The expected level of FIT revenue is X. These are the environmental benefits: X tonnes of reduced carbon emissions, improvements to air quality".

- Partner with an electrical utility or renewable energy services company to offer a power purchase agreement to homeowners. This recommendation is offered to overcome the barrier of physical incompatibility for households with inadequate solar resource.
- Sales messaging should be simple. Do not overwhelm with detail; offer more stream-lined and clearer information, written brochures would be especially helpful.
- Deliver a clear recommendation that the site is or is not suitable/ideal. These recommendations are offered in response to non-purchasers' request for simple, clear messaging.

Non-purchasers indicated that all motivations, except "reliability", were "important" or "very important". Therefore vendors may wish to familiarize sales staff with the seven motivations listed, as well as emphasizing reliability.

Public education around these eight reasons to adopt solar PV could be expected to move the market along the adoption curve.

Vendors may wish to have Bullfrog feature one of their solar energy systems in Bullfrog Buzz, or another Bullfrog promotion. Rooftop PV can be marketed as a complement to grid-sourced electricity from wind farms, micro hydro, biogas, and combined heat and power plants. Vendors may instead wish to distinguish their product from green retail electricity based on competitive advantages such as payback, and direct benefits[179].

5.4 Future research opportunities

A natural extension of this study would be to obtain data for a larger sample, to produce more generalizable results.

Further research could explore the relationship between an individual's education level and their likelihood to belong to any given adopter category with respect to solar energy systems. For example, a literature review might uncover personality or attitudinal traits that are more common among the professions. Knowing whether professionals, namely architects, doctors, engineers, lawyers, and business professionals,[180] are more likely to employ rational economic decision-making than the general population could be useful for predicting adoption behaviour among these groups, and improve marketing efforts.

In this study, nearly all households were found to have above-average incomes. Future research could explore differences in perceptions and characteristics of low-, medium-, and high-income households, as a step towards making solar energy more appealing/accessible to low-income households.

Finally, a methodology similar to the one used in the present study could be used to study the characteristics of a "culture of conservation". Such a study would build on those by Granzin and Olsen (1991), Shrum (1995), and Rowlands, Scott and Parker (2003) looking at the relationship of socialization characteristics to environmental attitudes.

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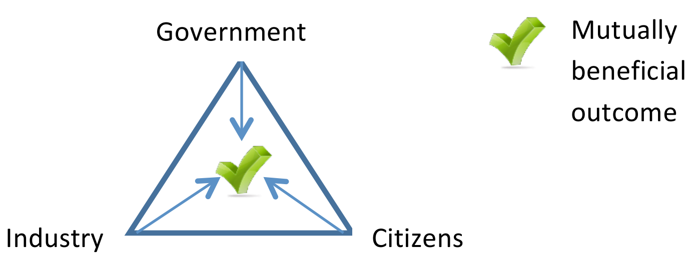
[179] confidence that every dollar spent is going towards the production of renewable energy

[180] While not a coherent group, these professionals are argued to be more likely than people educated in the liberal arts to apply rational-economic decision-making, since professional degree programs have been dominated by rational decision-making (Bommer, 1987).

5.5 Final comments

The sublime beauty in the WISE was that each stakeholder—government, industry, and citizens—went part of the way towards reducing barriers to solar energy adoption. Purchasers placed a very high value on solar energy systems' ability to reduce carbon emissions and mitigate global climate change, to the extent that they decided to adopt in spite of financial drawbacks, risk and uncertainty. Non-purchasers did not have a sufficiently positive view of solar systems to pass along the innovation decision process, but helped by taking part in this research and identifying important barriers to adoption. Leadership was shown by industry, in bidding on a project with some important unknowns (and offering a discount), and by government by creating a subsidy (RESOP) to build capacity for renewable energy procurement. This collaborative effort can be seen as a model of what our world needs much more of, if we are to meet the increasingly complex challenges presented by a globally integrated, technologically advanced culture.

Figure 22 - CSEI adoption triangle



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Appendices

Appendix A – Survey materials and supplemental analysis

Appendix A I - Recruitment materials

Sample Survey Information Letter (PV purchasers)

The following email was sent to half (eight) of the WISE PV purchasers. The email sent to the other half of the purchaser study population directed them to a web-based version of the survey, and included a link to the online survey.

Dear WISE participant,

I am an Environmental Studies student conducting research under the supervision of Dr. Paul Parker of the University of Waterloo. Our research is focusing on overcoming barriers consumers face when presented with the choice to purchase green durable goods, specifically solar power systems to generate electricity.

Solar power is an important way individuals can reduce their impact on the environment and it also provides income under Ontario's Standard Offer Program. Because of the West Toronto Initiative for Solar Energy (WISE), your neighbourhood is an important area in which to conduct this research. As a resident, your opinions are important to this study.

I have selected your home at random to participate in this study and will present my student identification card upon arrival at your home. I'd like to conduct this research as a door-to-door survey at a time of your choosing between the hours of 12 pm and 5 pm on the weekend of December 1st and 2nd, and on weeknights between 6 pm and 8 pm on November 28, 29, and 30 However, I would be happy to arrange another time, if you prefer. Your involvement in this survey is entirely voluntary and there are no known or anticipated risks to participation in this study. If you agree to participate, the survey should not take more than 45 minutes to complete and you will only be contacted once. The questions are quite general. For example, what were the major hurdles you had to overcome in the decision to purchase a solar power system through the WISE?

You may choose to decline answering any questions that you do not wish to answer. All information you provide will be considered confidential and will be grouped with responses from other participants. Further, you will not be identified by name in any thesis, report or publication resulting from this study. The raw data collected will be kept for a period of two years in my supervisor's office at the University of Waterloo and will be destroyed after that time.

Completed surveys will be entered in a draw for three $50 gift certificates to The Rushton, Ferro, and Atlas One.

If after receiving this letter, you have any questions about this study, or would like additional information to assist you in reaching a decision about participation, please feel free to contact Professor Paul Parker at 519 888-4567, Ext. 33404.

This project is sponsored, in part, by ARISE and with your permission ARISE provided me with your contact information. I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. Should you have comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519 888-4567, Ext. 36005.

Thank you in advance for your interest in this project.

Yours sincerely,

Ted Sherk – Student Investigator

Sample recruitment email (non-purchasers and SHW purchasers)

Below is the recruitment email that was sent to non-purchasers. The recruitment emails sent to SHW purchasers was similar.

Dear WISE Project participant,

I am sending you this email today to ask for your assistance in doing research about our renewable energy project. We are collaborating with researchers at the University of Waterloo to survey the views of the people who participated in the WISE project in order to understand how we can improve in the future.

As part of ongoing research into applications of solar energy for homes, researchers at the University of Waterloo are conducting a survey on barriers to the adoption of solar energy in residential settings. Solar power is one important way individuals can reduce their impact on the environment. Participation is voluntary; you may decline to answer any of the questions. The information you provide is strictly confidential and will be grouped with responses from other participants to provide the public's views on neighbourhoodsolar projects, household energy efficiency, deregulation in the energy sector, and climate change.

If you have any questions about the study or have an interest in the findings, please contact Dr. Paul Parker at the University of Waterloo (519-888-4567 - extension #32791). The survey work is being undertaken by Chris Adachi and Ted Sherk, Graduate students at U of Waterloo.

This project was reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo (519-888-4567 ext 36005).
To begin the survey please click on the link below or copy it into your browser
https://dogwood.uwaterloo.ca/securesurvey/sw/wchost.asp?st=wisestagetwo&cn=tsherk

Thank you in advance for your time. Your participation is greatly appreciated!

Ken Traynor
WISE Project Coordinator

Web Survey Info Letter

Dear WISE participant,

I am an Environmental Studies graduate student conducting research under the supervision of Dr. Paul Parker of the University of Waterloo. Our research is focusing on overcoming barriers consumers face when presented with the choice to purchase green durable goods, specifically solar power systems to generate electricity.

Solar power is one important way individuals can reduce their impact on the environment and it also provides income under Ontario's Standard Offer Program. Because of the West Toronto Initiative for Solar Energy (WISE), your neighbourhood is an important area in which to conduct this research. As a resident, your opinions are important to this study

If you decide to volunteer, you will be asked to complete a 4-page information questionnaire. The questionnaire will ask questions about your impressions of the West Toronto Initiative for Solar Energy (strengths and weaknesses), as well as a few general demographic questions (for example, you will be asked to indicate the highest level of education you have obtained).

The questionnaire is designed to be completed through the Web. Should this pose a problem, please contact us and we will make arrangements to provide you with another method of participation. Your participation in the study should take no longer than thirty minutes. Participation in this study is voluntary. You may decline to answer any questions that you do not wish to answer and you can withdraw your participation at any time by not submitting your responses. There are no known or anticipated risks from participating in this study.

It is important for you to know that any information that you provide will be confidential. All of the data will be summarized and no individual could be identified from these summarized results. Furthermore, the web site is programmed to collect responses on the questionnaire alone. That is, the site will not collect any information that could potentially identify you (such as machine identifiers).

If you wish to participate, please visit the Study Website at www.insertwebsite.ca. From the main page, click on the line marked "Partake in the study" and follow the instructions provided.

The data collected from this study will be accessed only by the two researchers named above and will be maintained on a password-protected computer database in a restricted access area at the University of Waterloo. As well, the data will be electronically archived after completion of the study and maintained for two years after the research study has been completed and any submissions to journals have been completed.

Should you have any questions about the study, please feel free to contact either Ted Sherk by email at tsherk@uwaterloo.ca or Professor Paul Parker at 519 888-4567, Ext. XXXXX.

Further, if you would like to receive a copy of the results of this study, please contact either investigator.

Completed surveys will be entered in a draw for three $50 gift certificates to The Rushton, Ferro, and Atlas One.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. Should you have comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes in the Office of Research Ethics at 519 888-4567, Ext. XXXXX.

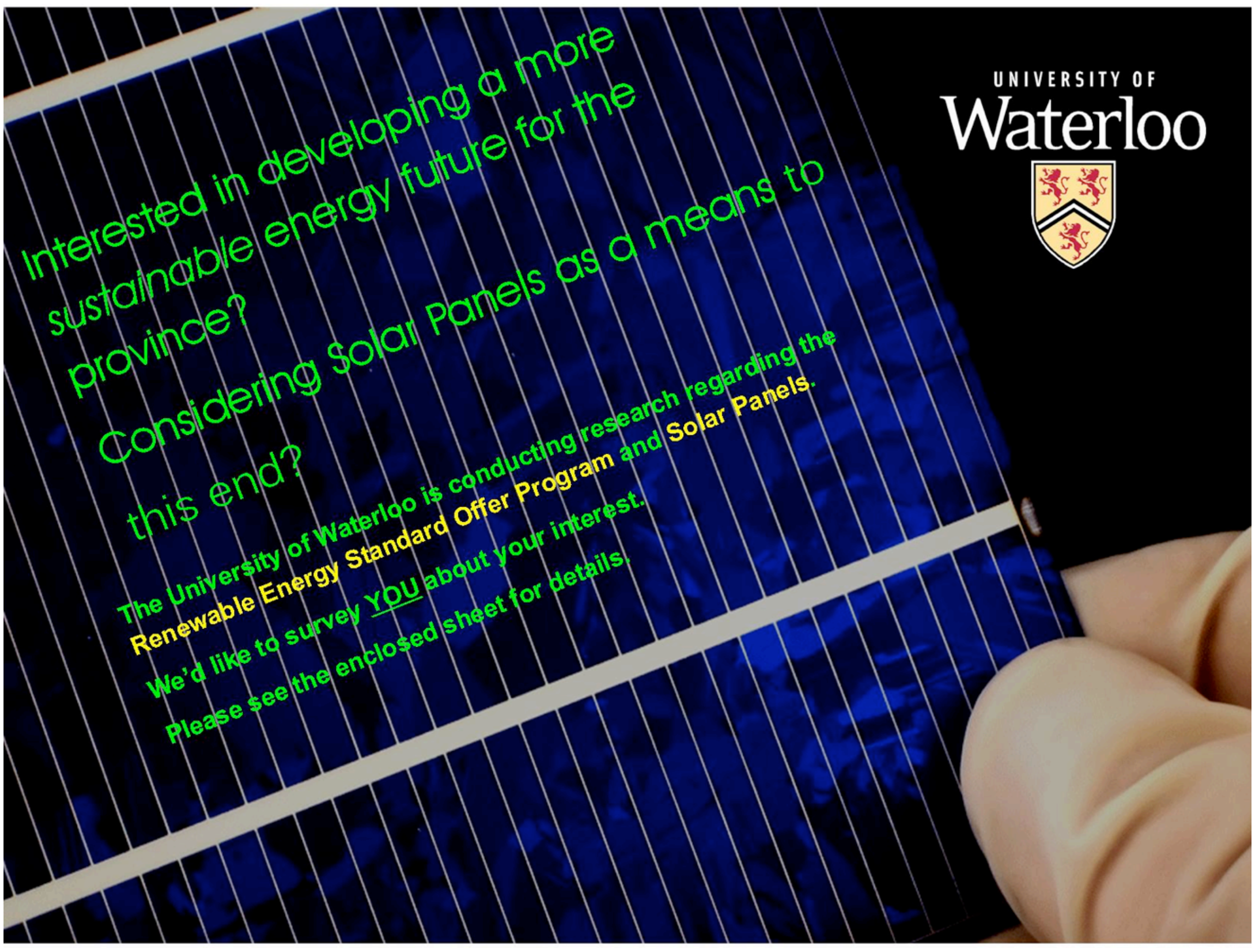
Thank you in advance for your interest in this project.

Yours sincerely,

Ted Sherk – Student Investigator

Recruitment Flyer and Cover Letter (SHW purchasers and non-purchasers)

The following two JPEG images were attached to the surveys emailed to WISE SHW purchasers and non-purchasers.



Research is currently being conducted regarding the role of the Renewable Energy Standard Offer Program and solar photovoltaic systems (solar panels). We would like to hear from you.

UNIVERSITY OF Waterloo

This research consists of two components.

- An **online survey**: the survey takes approximately 30 minutes and can be found at https://dogwood.uwaterloo.ca/securesurvey/sw/wchost.asp?st=wisestagetwo&cn=tsherk (click this link below in the email to be directed to this page).
- A **one-on-one interview**: interviews will last approximately 30 minutes and can take place at a time and location of your choosing. Interviews can take place in person or over the telephone.

Based on your willingness, participation would entail either i) completion of only one of the two components, or ii) participation in both components.

If you are interested in participating in the ***interview component****, please contact Chris Adachi at:*

cwadachi@uwaterloo.ca or **(519) 505-4194**

Further interview details are on the accompanying information sheet and consent form.

This study has been reviewed by, and received ethics clearance through the Office of Research Ethics, University of Waterloo.

Appendix A II – The Surveys

The surveys administered to each of the three respondent groups-PV purchasers, SHW purchasers, and non-purchasers, were identical except for some minor differences. Each survey contained a slightly different list of questions. The differences were of two types:

(1) those having to do with tailoring the question wording to each respondent group
(2) question topics that were investigated in some surveys and not others.

An example of a difference related to tailored wording is asking purchasers about "hurdles" but non-purchasers about "barriers".

Below is a copy of the survey that includes all questions that were administered. Each question was administered to all three respondent groups, unless otherwise noted.

University of Waterloo

WISE

ARISE TECHNOLOGIES CORPORATION

Residential Solar PV Project Questionnaire

As part of ongoing research into applications of solar energy for homes, the University of Waterloo is conducting a survey on barriers to the adoption of solar energy in residential settings. Solar power is one important way individuals can reduce their impact on the environment. The information you provide is strictly confidential and will be grouped with responses from other participants to provide the public's views on this project, household energy efficiency, deregulation in the energy sector, and climate change (global warming).

You may decline to answer any of the questions. The questionnaire has been reviewed by and received ethics clearance from the Office of Human Research at the University of Waterloo. If you have any questions about the study or have an interest in the findings, please contact Dr. Paul Parker at the University of Waterloo (519-888-4567 - extension #33404).

Thank you in advance for your time. Your participation is both necessary for the success of this project and greatly appreciated!

Additional Comments:

SECTION A - Community Solar Project EVALUATION

A1. How did you hear about the West Toronto Initiative for Solar Energy (WISE)?

A2a. Please list the 3 most appealing features of solar electric panels.
(You're welcome to list more if you wish.)
[This question was not included in survey of PV purchasers.]

A2b. Please list the 3 most appealing features of solar thermal panels.
(You're welcome to list more if you wish.)
[This question was not included in survey of PV purchasers.]

A2. Please list the 3 most appealing features of WISE. (You're welcome to list more if you wish.)
[This question was included in all three surveys. It was labelled as A3 in the surveys of SHW purchasers and non-purchasers]

A4a. Please list 3 disadvantages of solar electric panels. These could be related to the PV systems themselves, or the program overall, or other related factors.
[This question was not included in survey of PV purchasers.]

A4b. Please list 3 disadvantages of solar thermal panels.
(You're welcome to list more if you wish.)
[This question was not included in survey of PV purchasers.]

A3. Please list 3 disadvantages of the program. These could be related to the PV systems themselves, or the program overall, or other related factors.
[This question was included in all three surveys. It was labelled as A5 in the surveys of SHW purchasers and non-purchasers]

A4. Please indicate the importance of the following in your decision to purchase a solar photovoltaic system as part of the West Toronto Initiative for Solar Energy.

[This question was included in all three surveys. In the survey of SHW purchase and non-purchasers, it was labelled as A6 and read slightly differently: "…importance of the following in motivating your desire to purchase a solar photovoltaic system as part of the WISE".]

Circle your Response	Did Not Consider	Not Important	Somewhat Important	Important	Very Important
1) climate change or global warming	1	2	3	4	5
2) air quality or smog	1	2	3	4	5
3) taking ownership of energy footprint	1	2	3	4	5
4) reduce or eliminate net electricity financial costs	1	2	3	4	5
5) learn more about our electricity and its impact on the environment	1	2	3	4	5
6) take advantage of the WISE discount	1	2	3	4	5
7) reduced uncertainty through WISE's selection of preferred contractor	1	2	3	4	5
8) knowing that a significant number of other households had also decided to purchase systems	1	2	3	4	5
9) opportunity for advice on solar home retrofit projects	1	2	3	4	5
10) to send a message to your friends and neighbours that you are committed to environmental sustainability	1	2	3	4	5
11) to lead by example, and encourage friends and neighbours to adopt solar energy	1	2	3	4	5
12) other 1 (please specify): _________________	1	2	3	4	5
13) other 2 (please specify): _________________	1	2	3	4	5

A5. Were there were any situations where WISE did not properly or completely respond to any of your questions or needs? If so, please give particulars.

[This question was included in all three surveys. It was labelled as A7 in the surveys of SHW purchasers and non-purchasers]

A6. Please indicate how important each of the following factors would be to you when choosing the company to provide your PV system.

[This question was included in all three surveys. It was labelled as A8 in the surveys of SHW purchasers and non-purchasers]

Circle your Response	Did Not Consider	Not Important	Somewhat Important	Important	Very Important
14) price	1	2	3	4	5
15) quality of customer service	1	2	3	4	5
16) systems they sell are designed in Canada	1	2	3	4	5
17) systems they sell are made in Canada	1	2	3	4	5
18) reputation of the company	1	2	3	4	5
19) reliability of electricity	1	2	3	4	5
20) other _________________________	1	2	3	4	5

A7. Would you have installed solar PV without the Standard Offer Program, which pays 42 cents/kWh for solar electricity? Yes ____ No ____

[This question was included in survey of PV purchasers only.]

A8. If you answered "Yes" to the previous question, would you have installed a *smaller* system if the Standard Offer Program did NOT exist? Smaller ____ Same size ____

[This question was included in survey of PV purchasers only.]

A9. Do you think you would have installed a solar system (within the next 5 years) without help from WISE?

[This question was included in survey of PV purchasers only.]

PV	☐ Yes	☐ No	☐ Not sure
Thermal	☐ Yes	☐ No	☐ Not sure

A9. Do you think you would have seriously considered installing a solar energy system (within the next 5 years) without help from WISE?

[This question was included in survey of SHW purchasers and non-purchasers only.]

PV	☐ Yes	☐ No	☐ Not sure
Thermal	☐ Yes	☐ No	☐ Not sure

A10. Having met with a Globe Solar representative and decided not to purchase, what

if any feedback would you provide to the company to improve their overall products and services offered through the initiative?
[This question was included in survey of non-purchasers only.]

A10. Having acquired a solar thermal system from Globe Solar, what if any feedback would you provide to the company to improve their overall products and services offered through the initiative?
[This question was included in survey of SHW purchasers only.]

A11. Having acquired a PV system from ARISE Technologies, what if any feedback would you provide to the company to improve their overall products and services offered through the initiative?
[This question was included in survey of PV purchasers only.]

A11. Having met with an ARISE Technologies representative and decided not to purchase, what if any feedback would you provide to the company to improve their overall products and services offered through the initiative? Non-purchasers a
[This question was not included in survey of PV purchasers.]

A12. If you have any other comments about community solar initiatives in Ontario, please use the comment box below.

***Additional Comments*:**

A13. May we use anonymous quotations from open-ended responses in a thesis or any publications resulting from this research?

(y/n)

SECTION B - MOTIVATIONS & BARRIERS TO PARTICIPATION

B1. What motivated your interest in WISE? (please briefly describe)

B2. How difficult were the following hurdles to overcome in your decision to purchase a solar *electric* (PV) system?

[This question was included in all three surveys. In the survey of SHW purchase and non-purchasers, it read slightly differently: "How significant were the following barriers in your decision not to purchase a solar electric (PV) system?"]

Circle your Response	**Not a major hurdle**	←		→	**Major hurdle**
1) cost of system was too high	1	2	3	4	5
2) financial payback was too long	1	2	3	4	5
3) lack of confidence in PV technology	1	2	3	4	5
4) lack of confidence in the contractors	1	2	3	4	5
5) unconvinced PV can result in significant environmental benefits (emissions reduction)	1	2	3	4	5
6) unconvinced PV would result in significant energy generation	1	2	3	4	5
7) plan to move in the next few years and are not sure we will recoup the cost in resale value	1	2	3	4	5
8) lack of sufficient information to make an informed decision	1	2	3	4	5
9) other __________________	1	2	3	4	5

B3. How important have the following factors been in <u>motivating</u> your purchasing a solar energy system?

[This question was included in all three surveys. In the survey of SHW purchase and non-purchasers, it read slightly differently: "How important have the following factors been in motivating your desire to install a solar energy system?]

Circle your Response	Not Important	←		→	Very Important
10) concern about negative impact of carbon emissions	1	2	3	4	5
11) payback improvements coming from the Standard Offer Program	1	2	3	4	5
12) reliability of PV technology	1	2	3	4	5
13) reduce our home's net energy consumption (footprint)	1	2	3	4	5
14) reduce the need to build more power plants in Ontario	1	2	3	4	5
15) to help Ontario close its coal-fired power plants sooner.	1	2	3	4	5
16) access to sufficient information to make an informed decision	1	2	3	4	5
17) reducing need for transmission corridors (high voltage power lines)					
18) other __________________	1	2	3	4	5

B4. How did you first learn about the Standard Offer Program (RESOP)?

B5. If the RESOP were unavailable, would you have seriously considered purchasing solar panels in the next five years?

[This question was included in all three surveys. In the survey of SHW purchase and non-purchasers, it read slightly differently: "…would you seriously consider purchasing…"]

(y/n)

B6. How did you first learn about the Standard Offer Program (RESOP)?

SECTION C - HOUSEHOLD CHARACTERISTICS

These final questions will help us to analyze the survey.
Answers are not individually identifiable and are kept in strict confidence.

C1. Please indicate the decade you were born: _____

C2. Please indicate the number of people in each of the following age groups, that live in your household.

___ 10 years or younger
___ 11 to 20 years
___ 21 to 30 years
___ 31 to 50 years
___ 51 to 65 years
___ more than 65 years

C3. Please indicate how often you discuss energy issues with the following people:

Please circle response	Not Applicable	Not at All	Occasionally (every few months)	Frequently (every month)	Very Frequently (every week)
Spouse / Partner	1	2	3	4	5
Children	1	2	3	4	5
Friends / Family	1	2	3	4	5
Neighbours	1	2	3	4	5
Co-Workers	1	2	3	4	5
Trades person*	1	2	3	4	5

*heating and cooling contractor or insulation contractor

C4. Please indicate the highest level of education attained by someone in your household.

___ completed high school
___ college or technical diploma
___ some university
___ university (Bachelor) degree
___ graduate degree (Masters, Ph.D.)
___ professional degree (MD, LL.D., PEng, etc.)

C5. What is the approximate annual income (pre-taxes) of your household in 2006?

___ under $40,000
___ $40,000 to $79,999
___ $80,000 to $119,999
___ $120,000 to $159,999
___ $160,000 to $199,999
___ greater than $200,000

C6. How long have you lived at your current home? ______ years

C7. How long have you lived in a West Toronto neighbourhood? ______ years

C8. How long do you expect to live at your current home? ______ years

C9. What type of car do you own? (Please fill in the blank or strike through if you do not own a vehicle, or a second vehicle. Please indicate if you belong to a car sharing organization.)

Car 1: Make____________Model____________ **Car 2:** Make_________Model___________

I am a member of: 1. AutoShare___ **2.** Zipcar___ **3.** other__________________

[This question was included in the survey of PV purchasers only.]

C9a. Have you heard of Bullfrog Power? DSHW and non-purchasers only
[This question was not included in the survey of PV purchasers.]

(y/n)

C9b. Do you subscribe to Bullfrog Power? DSHW and non-purchasers only
[This question was not included in the survey of PV purchasers.]

(y/n)

Would you be willing to be contacted to consider participating in a follow-up interview with my co-researcher Chris Adachi? The purpose of his study is to improve the Renewable Energy Standard Offer Program (RESOP). Yes___ No___

Please enter your name, email address and/or phone number to allow Chris to contact you (unless already entered above.)
[This question was included in the survey of SHW and non-purchasers only.]

Draw for gift certificate:

Please enter your name, email address and/or phone number to allow us to contact you if you win.

Again, we greatly appreciate you taking the time to complete this survey!

If you have any additional comments, please use the space provided on the front cover.

Appendix A III - Summary tables to support discussion in Chapter 4

Content analysis of open-ended survey question data

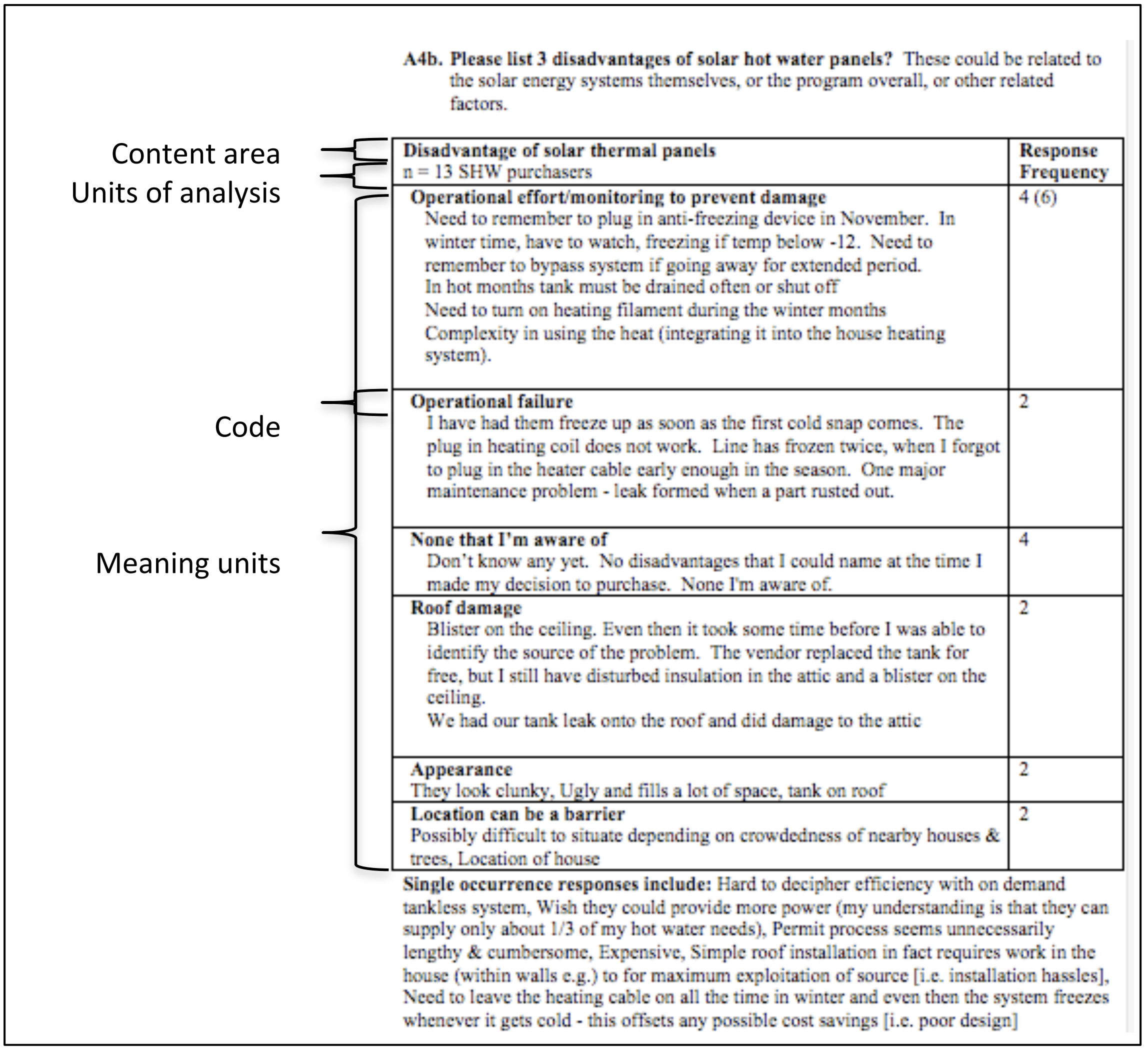
Content analysis was used to organize and condense responses to the open-ended questions into tables. Graneheim and Lundman's (2004) overview of terms and concepts in qualitative content analysis is used as a basis for the textual analysis on which findings from Chapter 4 are based. The concepts of manifest and latent content, unit of analysis, meaning unit, condensing, abstracting, content area, code, category, and theme have been used to organize respondent data. The reader is referred to Graneheim and Lundman's (2004) for definitions of these terms.

Content analysis tables were created based on responses to each of the open-ended questions. The content analysis tables present respondent answers verbatim, categorized according to the meaning units[181] and frequency of response. Some respondent answers were aggregated at a higher level of abstraction than others. For instance, while responses that mentioned "environment" were straightforward to categorize (under the heading "environmental"), other responses were grouped under headings that were more general than the terms necessarily implied, e.g. "carbon footprint" under the heading "environmental". Tables similar to the example in Figure 23 can be found below for each of the open answer questions in the survey (except B1, which was included in Chapter 4).

Summary tables of data from closed-answer questions are also included below.

[181] Graneheim and Lundman (2004: 106) define a meaning unit is the constellation of words or statements that relate to the same central meaning. In other words, a meaning unit is words, sentences or paragraphs
containing aspects related to each other through their content and context.

Figure 23 - Content analysis terminology applied to the present study



A4b. Please list 3 disadvantages of solar hot water panels? These could be related to the solar energy systems themselves, or the program overall, or other related factors.

Disadvantage of solar thermal panels n = 13 SHW purchasers	**Response Frequency**
Operational effort/monitoring to prevent damage Need to remember to plug in anti-freezing device in November. In winter time, have to watch, freezing if temp below -12. Need to remember to bypass system if going away for extended period. In hot months tank must be drained often or shut off Need to turn on heating filament during the winter months Complexity in using the heat (integrating it into the house heating system).	4 (6)
Operational failure I have had them freeze up as soon as the first cold snap comes. The plug in heating coil does not work. Line has frozen twice, when I forgot to plug in the heater cable early enough in the season. One major maintenance problem - leak formed when a part rusted out.	2
None that I'm aware of Don't know any yet. No disadvantages that I could name at the time I made my decision to purchase. None I'm aware of.	4
Roof damage Blister on the ceiling. Even then it took some time before I was able to identify the source of the problem. The vendor replaced the tank for free, but I still have disturbed insulation in the attic and a blister on the ceiling. We had our tank leak onto the roof and did damage to the attic	2
Appearance They look clunky, Ugly and fills a lot of space, tank on roof	2
Location can be a barrier Possibly difficult to situate depending on crowdedness of nearby houses & trees, Location of house	2

Single occurrence responses include: Hard to decipher efficiency with on demand tankless system, Wish they could provide more power (my understanding is that they can supply only about 1/3 of my hot water needs), Permit process seems unnecessarily lengthy & cumbersome, Expensive, Simple roof installation in fact requires work in the house (within walls e.g.) to for maximum exploitation of source [i.e. installation hassles], Need to leave the heating cable on all the time in winter and even then the system freezes whenever it gets cold - this offsets any possible cost savings [i.e. poor design]

A1. How did you hear about the West Toronto Initiative for Solar Energy (WISE)?

Purchaser Response n = 13 PV + 13 SHW	**Percent Frequency**	**Non-purchaser Response** n = 17	**Percent Frequency**
Joe Mihevc e-newsletter	62% 8 PV 38% 5 SHW	Joe Mihevc e-newsletter (12%) Councillor e-newsletter (12%)	24%
Community meeting organized by Joe Mihevc and at which Jed Goldberg spoke	23% 3 PV 23% 3 SHW	Community meeting (organized by Joe Mihevc and at which Jed Goldberg spoke)	24%
Neighbour	15% 2 PV 15% 2 SHW	Neighbour(s)	18%*
Media	0%	Media	18%
Mailbox flyer	15% 2 PV 0% 0 SHW	Mailbox flier	6%
Neighbourhood association newsletter	0% 0 PV 8% 1 SHW	Neighbourhood email group	6%
Through Green Neighbours 21	15% 2 PV 0% 0 SHW	Green Neighbours 21 e-newsletter	6%
Through a friend	15% 2 PV 0% 0 SHW	Resident in the area	6%
Through the RISE	8% 1 PV 0% 0 SHW	Relative who attended public meeting	6%
Through son who lived in the neighbourhood	0% 0 PV 15% 2 SHW		
"I was in at ground floor before the initiative had a name."	0% 0 PV 8% 1 SHW		
TOTAL	153%** PV 107%*** SHW	TOTAL	114%*

*At least one of these was a neighbour of Jed Goldberg
**Some respondents gave multiple answers.
***Among SHW purchasers, only one respondent gave more than one answer.

A2a. Please list the 3 most appealing features of solar electric panels? (You're welcome to list more if you wish.)

Appeal of solar electric panels (to Non-Purchasers[182])	Response frequency
Environmental Positive action for the environment. I don't have more than this Saving the environment, Good for the environment, Environmentally friendly, Provide environmentally sound power supply, help preserve the environment and minimize use of fossil fuels/nuclear	6 (23 if all answers with environmental connotation are included)
Carbon footprint, global warming Reduce contribution to greenhouse gases/global warming, Carbon footprint, Provide the opportunity to generate/offset what you consume, Lessen carbon footprint	5
Abstract appeal of renewable/sustainable energy Used to produce power from sunshine, Renewable energy, Renewal energy source, Sustainable source of electricity, Sustainable energy	5
Pollution Photons don't pollute the environment, Reducing pollution	2
Decrease environmental impact	1
Financial Save money, Lower electrical costs, Reduce costs of electricity, Money saving program in the long run, Save money in the long run, Perhaps reduce costs over long term, Potential to generate income	8 (12 if all answers with financial connotation are included)
Photons are cheaper than fossil fuels	1
Provide free energy once installed	1
Add value to home, Increase the value of the house	2
Autonomy Energy Autonomy, Provide some grid independence	2
Minimize use of fossil fuels/nuclear power plants Not depending on coal or nuclear power	2
I don't want another penny spent by my government on nuclear	
Reducing consumption from conventional energy sources Reducing consumption of limited fuel resources	

[182] This question was included in the 2008 surveys of SHW purchasers and non-purchasers. However, it was not included in the first survey, of PV purchasers. Please see question B1 for responses related to PV purchasers' motivations to adopt a PV system through the WISE.

Using less water, Dam potential	
Progressive You can be in the vanguard of progress, This is the 21st century not the 18th	
Good looks Appearance of solar panels on roof is acceptable and does not detract from the appearance of the house from the street	

Single occurrence responses: Long life span, Maintenance free, Utilizing a powerful energy source, Voting with my dollars, PV is like having a little business of selling the energy back to the grid, First to move means kudos for moving, [183] Participate in change that is necessary, Power produced, Works with existing power service instead of potentially switching to some new system, Provides a visible example to the community.

A2b. Please list the 3 most appealing features of solar electric panels? (You're welcome to list more if you wish.)

Appeal of solar electric panels (to SHW purchasers[184]) n = 12	**Response frequency**
Environmental Low environmental impact (only negative impact would be in their manufacture), Good for the environment	2 (16)
Alternative source of energy	3
Sustainable energy source	2
Clean "cleaner"	2
Environmental leadership "Demonstrate support for alternative energy generation" "Enjoy feeling like a leader"	2 (3)
"Good example for my kids"	1
Reduce emissions Reduce CO2 emissions, "Potential to reduce my use of greenhouse gas-emitting fuel"	2
Fuel switching "Diminishes my reliance on environmentally damaging fuel sources" "Potential to reduce my use of greenhouse gas-emitting fuel"	2

183 I.e., environmental prestige

184 This question was included in the 2008 surveys of SHW purchasers and non-purchasers. However, it was not included in the first survey, of PV purchasers. Please see question B1 for responses related to PV purchasers' motivations to adopt a PV system through the WISE.

Save the planet	1
Financial Save $$, Reduce bill, Financial savings, Potential to save money,	4
Electricity system improvement Some protection from power-outages, Reduces demand on grid	
Energy self-sufficiency Produce your own electricity, Makes me feel more self-sufficient, less dependent on hydro/gas companies,	2
Low maintenance	2 (3)
Durable	1

Note: interestingly, SHW purchasers did not mention carbon footprint, global warming, or climate change directly

Single occurrence responses: "They look compact, neat", "Less dependency on large corporations", "Very minimal effort on my part for big environmental & economic payoff", "Off the grid", "Right thing to do", "Local", "Expands the use of renewable energy"

Appeal of solar thermal panels (to SHW purchasers) n = 11	**Response frequency**
Positive financial Saves me money, Save money, Save on gas bills, Small investment on my part, Can recoup costs in about 5 years, Hopefully some savings, Financial savings, save $$, reduce costs, potential to save money (SaPV)	9 (10)
Availability of rebates Rebate from the Federal and Provincial governments	1
Positive environmental Good for the environment, Doing an extra effort for the environment, Low environmental impact (only negative impact would be in their manufacture) (SaPV), save the planet, Reduce CO2 emissions, Renewable, Alternative, more sustainable energy source	7 (11)
Fuel switching Diminishes my reliance on environmentally damaging fuel sources, potential to reduce my use of greenhouse gas-emitting fuel	2
Free/easily-accessible fuel "The water in my hot water heater is pre-heated by the sun, a free and renewable source of energy."	1
Very little maintenance Very little maintenance required, Low maintenance	2
Self-sufficiency	2

No need to bill hydro for the energy generated, Makes me feel more self-sufficient, less dependent on hydro/gas company	
Not as costly as PV Initial outlay is much less	2
Hot water	2

Single occurrence responses: Continuous supply of hot water, Some protection from power-outages, Good example for my kids, expands the use of renewable energy (SaPV), Coupled with on demand heating more efficient than a tank. Better space usage (tank is on otherwise unused roof), Efficiency

Appeal of Solar Thermal Panels (to Non-Purchasers)	Response frequency
Lower costs/save money Lower electrical costs (SaPV), Provide low cost power (SaPV), Lower electricity bills, Money saving program in 3 - 5 years, Save money in the long run (SaPV), Save on utility costs, Perhaps reduce costs over long term	7
Positive environmental Saving the environment (SaPV), Good for the environment, Environmentally friendly, (SaPV), Something we could do to help the environment, Positive action for the environment. I don't have more than this (SaPV)	6
Renewable/sustainable energy Renewable energy (SaPV), Used to produce hot water from sunshine, Sustainable source of heating, Sustainable energy	4
Carbon footprint/greenhouse gas/global warming Lessen carbon footprint (SaPV), Reduce contribution to green house gases/ global warming (SaPV), Carbon footprint	4
Pollution Photons don't pollute the environment. (SaPV), Reducing pollution	2 (3)
No burning when smog is a major issue	
Fuel switching To use a renewal resource instead of fossil fuels or nuclear energy Photons are cheaper than fossil fuels. (SaPV)	2
Not as costly as PV Is not too costly to purchase, Relative cost of implementation[185]	2
Not sure, but I imagine same as above, Don't know enough	2

[185] Respondents are referring to the relatively low initial capital cost of thermal as compared with PV.

Single occurrence responses: Using less water; dam potential (SaPV); This is the 21st century not the 18th. (SaPV); I don't want another penny spent by my government on nuclear. (SaPV); Reducing dependence on electricity; Utilizing a powerful energy source, Energy collected; [186] It is wonderful to create your own hot water; Unlimited hot showers[187]; If I had a pool it would be a no brainer; Maintenance free; [188] Allows you to get rid of your rental hot water heater; [189] Increase the value of the house.

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[186] Response is very vague.
[187] Response relates to low energy implying "guilt-free" consumption, however it lacks a holistic sense of the environmental impact of consumption, e.g., water consumption.
[188] Response is incorrect. Solar thermal is not maintenance free.
[189] Response is incorrect. WISE 2007-2008 solar thermal systems required additional water tank.

A3. Please list the 3 most appealing features of WISE. (You're welcome to list more if you wish.)

Appealing aspects of WISE to purchasers n = 13 PV + 12 SHW	**Response frequency** (# of times mentioned by respondents)
WISE organizational capacity makes the overwhelming prospect of acquiring a solar power system feasible (i.e., turnkey appeal, negotiating with corporate and government actors: vendors, municipality, utilities)	13 *"Fast and easy, didn't require lots of individual research and due diligence Savings in time and money by being a community initiative" -resp. 19*
Power of bulk purchase (quantity of systems, discount, assured quality)	8
Allows participants to off-load worry about the risk and complexity of acquiring solar power system	7
Informative (meetings / handouts / access to experts / website)	7 *""First meeting VERY informative" –resp. 7* *"Handouts were extremely useful" – resp. 8*
Vendor-neutral research done for us by trusted members of the local community with appropriate knowledge and experience / participation of respected local leadership / honesty and trustworthiness of WISE	6
Local community focus	5
Good communication / WISE was good about sending out updates	5
Creating a sense of community / building community / brings people together / people helping environment together	5
Pioneering spirit / ingenuity Collaborative effort Not-for-profit Taking action as a community Help/do good for the environment Reduces risk and perception of being unusual (normative) Win-win aspect: more business for solar enterprises, easier availability & affordability for homeowners / builds a sustainable	2 *"We're creating the momentum to get solar power taken more seriously." –resp. 14*

economy	
Reduce net consumption, produce clean energy WISE was a catalyst for decision to purchase Individual solution to oil dependence Individual environmental solution Improves air quality Sustainable living Reduce net consumption Locally organized Opportunity for community involvement Public meetings gave good impression Felt informed going into it Solar panels have direct environmental effect Save hydro through preheated water Built on prior success (RISE) Solar panel visibility -> positive effect Rewarding feeling seeing the growth of a movement Patting government on the back for the Standard Offer Program Responsible purchase, and will pay off in long run Good to be part of a knowledgeable group Ingenuity of neighbours getting together to pool resources & find creative solutions Saving time and money by being a community initiative Positivity: activist aspect without being against anything or anyone Introduces solar energy directly & indirectly to huge numbers of people who otherwise wouldn't have the opportunity or interest People have been friendly and helpful Dedication Integrity Responsive and interactive with community at large Grass roots	1 "Neighbours across the street from me signed up for WISE after seeing our panels installed, so the potential for growth was immediately rewarding." -resp. 218 "They handle the jaw-dropping bureaucracy of the permitting and related-processes." -resp. 7 "Tony the contractor was very willing to answer my questions." -resp. 14

Appeal of WISE to Non-purchasers	**Response frequency**
Community Grass root organisation, Local community-based group, Community initiative,[190] WISE is working with my community to effect change at the local level, Strengthening community approaches to environmental problems, Local initiative, Community based, Local	9
Information/Facilitation	
Good advice/information on solar energy	6 (11, 15, 16

190 "community initiative" mentioned by two respondents

A chance to learn before embarking on this initiative, Good reliable advice, Source of information on solar energy, Have regular informational sessions & e-news, To take advantage of the experience of others, To have access to the experts that WISE is able to bring in	if related categories below are included)
Organizers provide well-researched recommendation of vendor WISE has done the work of analyzed the products in the market and picked suitable products. They've done the research/homework & negotiation already with suppliers, Well informed/knowledgeable & helpful group, Seem to have good choices of suppliers, Found a supplier that I am assuming is a good one[191]	5
Research that facilitates process Leaders/ initiators had done the research for all of the participants, Facilitate the process **-** many members of the community would be too daunted to pursue this opportunity without the guidance and help from WISE. Has undertaken legal and other research to simplify the process of going solar for those who can afford it.	3
Appears unbiased	
I like the ability to keep up-to-date via their website and emails	
I like that I know the people involved somewhat; They seem to be my age and intellectual peer group	
Group discount Cost reductions because of group negotiation with solar providers, Group purchasing power, WISE has negotiated a good price, To minimize costs through group purchase	5 (7)
Lower price	2
I don't have 3 appealing features of WISE, ? ? ?, Not sure	3
Energetic and committed, The folks at WISE seem earnest	2
Promotes green energy policies and behaviours WISE is promoting solar, so making the neighborhood green**,** Strengthening community approaches to environmental problems	3
Ongoing opportunity	

[191] "assuming" connotes less trust than that expressed by purchasers

A4a. Please list 3 disadvantages of solar electric panels? These could be related to the PV systems themselves, or the program overall, or other related factors.*

Disadvantage of solar electric panels n = 17 non-purchasers + 9 SHW purchasers	**Response Frequency**
Initial capital cost Initial cost, Cost. cost. cost. Expensive capital outlay. Expensive! Prohibitive cost Very costly, High cost, Up front costs. Too costly to purchase without some government subsidy[192] Implementation cost, High price, High initial cost ($20,000?) to make it worth doing, especially for older people who will likely move within 5 years	19 (24) *"Hydro's purchase price of our solar energy is very low with a long term which has the potential to become a bad deal for the solar panel owner. The purchase price at the initial stage of the implementation may seem to be good, however over time with rising costs and inflation it has the potential to become an unwise contract to be locked into."* *-resp. 40*
Return on investment Return on investment is long after purchases (20years?), not a very good ROI, low rate of return	3 (5)
Rate of return Payback period is long, Low rate of return	2
High cost to connect to local utility. Additional fees wipe out solar savings,	3 *"In Toronto, this seems to require being another customer, and so face an additional monthly customer charge."* *-resp. 37*

* question only included in survey of non-purchasers

192 This respondent seems unaware or dismissive of the RESOP and ecoENERGY subsidy programs. In 2008, ecoENERGY grants up to $1250 were available for solar PV systems in Ontario. Further, the respondent may be referring specifically to capital subsidies.

Complicated arrangement with electrical utility company The complicated system to work with Ontario Hydro, Red tape/paperwork, need to deal with Toronto Hydro - bureaucracy, The complicated arrangement with the power company was a disincentive for me	4 (5) *"This was extremely off-putting."* *- resp. 43*
The permitting requirements of the City Permit process seems unnecessarily lengthy & cumbersome	2 *"This was off-putting. I just wanted to do something good for the environment; however, the restrictions and red-tape were more than I wanted to deal with." -resp. 43*
Not well supported by current government policies I'm reluctant to sign on to the SOP - I'm certain that a better deal may be on the way - now that the Ontario Green Energy Act has been released, it may change the equation	2
Technology still improving Technology relatively new, The solar panel technology is still maturing. Questions about changing technology -- Is it better to wait for improved solar panels?	5 *"The panels we looked at did not generate as much energy as some of the break throughs in technology I have[193] recently read about in the newspaper."* *-resp.40*
Inadequate solar resource May be difficult with roof construction, nearby buildings and trees.[194] Limitations of placement options (roof size, panel size) Our exposure and the situation of our roof might not allow us to take as much advantage of solar power as we'd like[195] Panels require access to direct sunlight[196]	5

[193] The respondent is comparing sensationalized reports of technology under development to existing technology.

[194] has to do with "compatibility".

[195] Such a respondent might invest in a community-owned project.

Possibly difficult to situate depending on crowdedness of nearby houses & trees	
Roofing complications Questions about putting them on an older roof. They have to go on my roof and I might need a new roof soon. So then what do you do. I can't afford to pay... I want to ..have them really... Require removing them when roof needs re-roofing and re-installing. Creates problem/additional cost for roof maintenance.	3
Unable to realize premium with resale value Once installed, can't take it if you move	2
Aesthetics Possibly ugly (although not uglier than electric transmission wires & poles) Unattractive. Appearance. Not very aesthetic	3
Efficiencies	2
Extra cost to go off grid	
Installation	
Limited lifespan	

Single occurrence responses: Extra cost to go off grid, Installation, Limited lifespan, size, panels require full sun, [sun] not always available

A4b. Please list 3 disadvantages of solar hot water panels? These could be related to the solar energy systems themselves, or the program overall, or other related factors.

Disadvantage of solar thermal panels n = 12 SHW purchasers	Response Frequency
Operational effort/monitoring to prevent damage Need to remember to plug in anti-freezing device in November. In winter time, have to watch, freezing if temp below -12. Need to remember to bypass system if going away for extended period. In hot months tank must be drained often or shut off	4 (6)

[196] This respondent may be unaware that PV generates at 20-60% of its optimal efficiency with diffuse sunlight (Stamenic et al., 2004:39) or may be unwilling to tolerate low energy conversion efficiency.

Need to turn on heating filament during the winter months Complexity in using the heat (integrating it into the house heating system).	
Operational failure I have had them freeze up as soon as the first cold snap comes. The plug in heating coil does not work. Line has frozen twice, when I forgot to plug in the heater cable early enough in the season. One major maintenance problem - leak formed when a part rusted out.	2
None that I'm aware of Don't know any yet. No disadvantages that I could name at the time I made my decision to purchase. None I'm aware of.	4
Roof damage Blister on the ceiling. Even then it took some time before I was able to identify the source of the problem. The vendor replaced the tank for free, but I still have disturbed insulation in the attic and a blister on the ceiling. We had our tank leak onto the roof and did damage to the attic	2
Appearance They look clunky, Ugly and fills a lot of space, tank on roof	2

Single occurrence responses: Hard to decipher efficiency with on demand tankless system, Wish they could provide more power (my understanding is that they can supply only about 1/3 of my hot water needs), Permit process seems unnecessarily lengthy & cumbersome, Expensive, Need to leave the heating cable on all the time in winter and even then the system freezes whenever it gets cold - this offsets any possible cost savings [i.e., poor design], Possibly difficult to situate depending on crowdedness of nearby houses & trees

A4b. Please list 3 disadvantages of solar hot water panels? These could be related to the solar energy systems themselves, or the program overall, or other related factors.

Disadvantage of solar thermal panels n = 17 non-purchasers	Response Frequency
Appearance is not very aesthetic (SaPV) Appearance (SaPV).[197] The tubular units are large, and not very attractive, Concern about putting tank on roof -- aesthetics as well as safety. Ugly, ugly, ugly. Looks like it could blow off the roof. We are	6

197 two mentions

quite close to our neighbours and are concerned about liability.[198]	
You have to pay a lot for them Initial cost.[199] Cost (SaPV)	3 (4)
Don't cover all the costs of water heating They don't really cover all the costs of hot water in my house.	
Creates problem/additional cost for roof maintenance (SaPV), They go on the roof and I might need a new roof soon (SaPV), Require removing them when roof needs re-roofing and re-installing (SaPV)	3
Cumbersome (limitations on placement, possible stress on roof) (SaPV) The tubelar units are large, and not very attractive, Bulky - I have limited space on my roof and they would compete with a solar electric system. Not efficient in energy conversion. Bulky. Expensive capital outlay. (SaPV) But I suppose it is a much less expensive system.	3 *"The options offered through the WISE program initially included putting the tank in the basement, but then this option was discouraged. (Some friends had to change their installation from the basement to the roof.) If tank in basement, then difficulties in connecting panels to tank in our older house because of the particular layout...." -resp. 39*
Concerns associated with extra tank More space needed in basement.[200] Still need a holding water tank. I'm concerned that a tankless system might be more efficient.	

Single occurrence responses:

"When I was told that the water pipes would be on the OUTSIDE of the building and might possibly freeze, I decided not to go with the project." -resp. 38

"None I'm aware of." "Complexity in using the heat (integrating it into the house heating system)." "The WISE supplier's equipment was listed on the Government of Canada EcoEnergy list of accepted solar collectors with a condition on acceptance that it not be used where ambient temperatures go below -10C. It stated that complete draining of outdoor plumbing (including collector will minimize the risk of freeze damage... This condition was never

[198] distrust of WISE's ability to competently vet suppliers

[199] no distinction between PV and thermal

[200] A single tank solution could address space in basement concern.

mentioned in the information provided by WISE or Globe Solar." "Difficulty in sorting out the best provider. Inconsistent answers from industry." "May overheat if not used regularly."[201]

A5. Please list 3 disadvantages of the WISE program. These could be related to the PV systems themselves, or the program overall, or other related factors.

Disadvantages of the WISE according to PV purchasers n = 15	**Response frequency**
Wait time for connection/metering delays	**7** "The process was extremely slow and cumbersome, although I suspect this is the fault of the regulators." –resp. 14
Communication PV vendor and SWH vendor Vendor and WISE Vendor and participants (purchaser) Vendor internal (installers/logistics/management)	6 "It doesn't appear that the solar water and solar electric folks really connect with each other." "All of our suitable roof space was taken up by the solar [PV] panels." –resp. 7
Vendor and utility	"There really was no communication as for what the nature of the delay…then to find out that the delay was due to insufficient number of meters in stock. The thing was the OPA granted approval for my system at the end of August. They had 2 months to know that they needed a minimum of 26 meters. To wait to find out that they ran out of meters 2 months later, I found to be unacceptable." –resp. 12
Initial capital / up-front cost / price Long payback	5 "Finances are outrageous, 26 k on something with no payback, SOP makes a huge difference b/c it shows government is taking it seriously, and willing to put money into it." -resp. 2

201 The researcher does not know whether Globe Solar's thermal system has such protections.

Lack of maintenance contract/training manual for SWH Inaccurate estimates of connection timelines Customers confused about "who's who", vendor/organizer Responsibilities unclear	3
"One-size-fits-all" lack of customization, especially battery back-up SWH requires a maintenance contract "Fly-by" assessment not sufficient, site surveyor needs to see the roof Confusion about tax implication	2
No financing incentives, low interest loans Paperwork Serious failure of thermal system Information about necessary roof upgrades came from roofer -> may reflect badly on vendor Lack of trained/skilled personnel is apparent to customers Monthly connection charge too high WISE targeted exclusively to private homes, so important opportunities are lost (small commercial roof space) Confusion about who is responsible to inform customers of the change in the Capital Cost Allowance interpretation Impersonal service	1 "My back deck overlooks the roof of a [large grocery] store and that vacant roof space could be exploited so much more easily and efficiently than roofs on homes. So, participation of private sector could be a major boon (e.g., partnering with neighbours like me to share power from panels that are installed at reduced rates because of ease of installation)." –resp. 9 "One can feel like WISE customer #x rather than a single client." –resp. 13

Disadvantages of the WISE according to SHW purchasers n = 11	**Response Frequency**
None Not aware of any disadvantage, None that I can think of....fabulous program, I can't think of any, I cannot think of any disadvantages of the WISE program.	**5**
Communication "The panel and hot water folks did not work together efficiently: we had a choice of where the panels could be placed eliminated because the hot water tank was already up but the tank could have gone some where else. We did not get panels. There should have been more WISE representation upfront. We met with both the panel and hot water folks before we could review their services as a package with WISE." Communication could be better & faster	**2 (4)**
Inadequately resourced Too small to be as responsive as [would be] ideal	**2**

The large number of installations was probably a strain on the small vendors. The result was a less-than-careful approach. Also, some discrepancies between what WISE said and what vendor said. If it was bigger, maybe systems could be more affordable?	
Difficulty obtaining permits Permits & bureaucratic process not yet efficient & easy "In our particular case, city of Toronto not ready for the technology -- building permits now required but not yet available -- something that is causing very frustrating delay and complications re claiming part of payment from two levels of govt." City has not yet approved [the system yet], so it is not functional.	**3 (4)**
Inadequate for dealing with City bureaucracy In our particular case, city of Toronto not ready for the technology -- building permits now required but not yet available -- something that is causing very frustrating delay and complications re claiming part of payment from two levels of govt.	

Single occurrence responses: "Perhaps got into it prematurely in that the original company that got the contract was not sufficiently experienced to handle any complexities." "It took a long time before things got started." "Too many people [i.e., stakeholders] involved." "Maybe a website already exists that would answer some of the above complaints, I will check!"

Disadvantages of the WISE according to non-purchasers n = 14	**Response Frequency**
None but I did not go all the way with the program.[202] No disadvantages that I can see. No disadvantages - it's very helpful. N/A	**5**

Single occurrence responses: "took an acronym used before by Women in Science & Engineering"; "No concerted political effort to tell all three levels of gov't that Canada is a is intellectually/ecologically like a turtle running from a forest fire." "1. cost of systems make it impossible for low-income families to implement 2. government should support this initiative more fully 3. limited communications with community." "we had an energy audit of our home October 2007. We are limited to get the rebate/grant within 18 months of the audit. We are running out of time to use the rebate/grant that the gov't would provide under the recommnedation of this audit." "Outdoor water pipes for solar water heaters. Sometimes I found the explanations so detailed I got confused." "We were actually outside of the core WISE program neighbourhood (although the organizers said this didn't matter). Perhaps for this reason, we appeared to be at the bottom of the list in terms of being contacted by Globe Solar. By the time we were contacted, it was clear that

[202] This non-purchaser found no disadvantages with the program, yet still didn't go ahead with a purchase. This implies that attention should be focused on non-program barriers.

> there were issues that hadn't been identified in the early meetings… [response truncated]" "1. It was sometimes difficult to tell the difference from the facts and what was just someone's opinion (i.e., members of the audience claiming to be experts)." "Globe Solar only one supplier choice." "The complicated and convoluted process should have been worked out with government levels prior to neighbourhood delivery." "Any disadvantages are due to having to live with the government legislation and regulation."

Supplemental discussion of the WISE's disadvantages according to non-purchasers

Three responses had to do with lack of government participation. "Government should support this initiative more fully" and "the complicated and convoluted process should have been worked out with government levels prior to neighbourhood delivery." These responses perhaps under-recognize the role of the community group in working *with* government, and participating in a social and political process. The demand for a reliable, hassle-free process is typical of early majority purchasers who tend to be more risk-averse than early adopters (Egmond et al, 2006). A third comment pertaining to government actually faulted existing regulations as a barrier. "Any disadvantages [to the WISE] are due to having to live with the government legislation and regulation" (resp. 44). Clearly these non-purchasers had high demands for government support and/or may not have been fully aware of the RESOP.

One respondent pointed out that WISE is an acronym that also stands for Women in Science & Engineering. The respondent seemed concerned that by using the acronym WISE, the solar initiative organizers transgressed another organization of importance to them. Diffusion theory recognizes that potential adopters will hold predispositions towards certain values, which must be accounted for in the design of an intervention (Green and Glasgow, 2006).

Another respondent pointed out that the cost of systems is prohibitive for low-income families. Faiers and Neame (2007:5) suggest that the adopters' economic situation may have a greater influence than innovation attributes on adoption decisions. The WISE did not make solar energy systems accessible to low-income households, but rather to homeowners with access to at least several thousand dollars of discretionary income.

Other concerns were "limited communication with the community", "outdoor water pipes for solar water heaters", "confusingly detailed explanations", and "limited time to use an EcoEnergy grant". These concerns are similar to those identified as barriers in the adoption and marketing literature, e.g. perception of limited choice (Mowen, 1988), reliability concerns, information overload, and grant structures (Margolis, 2006).

A6. Please indicate the importance of the following in your decision whether or not to purchase a solar photovoltaic system as part of the West Toronto Initiative for Solar Energy.

Consideration (PV purhasers)	Importance (0-3)	Consideration (Non-purchasers)	Importance (0-3)
1) climate change or global warming	2.81	1) air quality or smog	2.88
2) taking ownership of energy footprint	2.81	2) climate change or global warming	2.69
3) air quality or smog	2.44	3) taking ownership of energy footprint	2.60
4) reduced uncertainty through WISE's selection of preferred contractor	2.38	4) take advantage of the WISE discount	2.29
5) take advantage of the WISE discount	2.19	5) reduced uncertainty through WISE's selection of preferred contractor	2.18
6) opportunity for advice on solar home retrofit projects	1.81	6) reduce or eliminate net electricity financial costs	2.25
7) to lead by example, and encourage friends and neighbours to adopt solar energy	1.75	7) opportunity for advice on solar home retrofit projects	1.69
8) to send a message to your friends and neighbours that you are committed to environmental sustainability	1.38	9) to lead by example, and encourage friends and neighbours to adopt solar energy	1.80
10) knowing that a significant number of other households had also decided to purchase	1.31	11) knowing that a significant number of other	1.56

systems		households had also decided to purchase systems	
12) reduce or eliminate net electricity financial costs	1.00	13) to send a message to your friends and neighbours that you are committed to environmental sustainability	1.53
14) learn more about our electricity and its impact on the environment	.88	15) learn more about our electricity and its impact on the environment	1.31

Other considerations
"Light a fire under government's lazy ass."

SHW purchaser responses:

Consideration	Importance (0-3)
reduced uncertainty	2.82
CC/GW	2.75
WISE discount	2.36
air quality	2.33
energy footprint	2.17
reduce electricity financial costs	2.09
to lead by example	1.67
opportunity for advice	1.58
knowing other households had decided to purchase	1.42
to send a message	1.33
learn more about electricity and its impact on the environment	1.10

A7. Were there any situations where WISE did not properly or completely respond to any of your questions for needs? If so, please give particulars.

Response from SHW purchasers* n = 14	Frequency
No None, great product and great service. Not too much, no.	**8**

Single responses: "WISE said that the vendor would provide a free analysis of the suitability of a PVC system to my situation. The vendor said I needed to pay a deposit 1st before they would do analysis. Not sure this was WISE's fault. Just an example of miscommunication." "I was not informed of the discount before having the thermal system installed and therefore did not get it." "I would have liked to have known about the problem with the freezing pipes and that the heating coils did not work properly. I only learned about it when the contractor came out to look at it and explained the problem."

Response from Non-purchasers*	Frequency
No No they were very good at answering all the questions. No issues. Not at all. No (x2)	**6 (7)**
No. I think as a small volunteer community group, it probably has done all it can. I am still very interested in installing solar and I think the government needs to step in as they have done in many parts of Europe.	
Yes Yes, there were several re-schedulings of appointments. By the time we were able to meet I had been put off by the excessive obstacles of government regulations, permits, and fees. Never gave me a report on assessment of my house and non suitability for program.[203] Yes -- as mentioned above -- no response to an email expressing our concern about the Government of Canada condition on the use of the Globe Solar water system recommended by WISE Never got a freaking site assessment from Globe Solar[204]	**4 (6)**
Detailed information confusing, just because there was so much to learn.	
Available financing	
Misc. This is a problematic way of asking a question. The real question concerns my costs at every level.	
Is it possible to extend the energy audit deadline so that we can take advantage of the grants offered? If it can be extended, how long is the extension for?	

*Purchaser responses were similar to those concerning disadvantages of the WISE (question A5), and hence were incorporated into the summary tables for that question.

[203] This criticism is more relevant to the vendor, as the provision of a site assessment was the vendor's responsibility.

[204] The respondent may be unaware of the "fly-by" assessments. It appears there was a lack of follow-up.

A8. Please indicate how important each of the following factors would be to you when choosing the company to provide your PV system.

This table indicates the importance[205] of certain key factors in respondents' choice of PV vendor.[206]

Consideration (PV Purchasers)	Importance (0-3)	Consideration (Non-purchasers)	Importance (0-3)
7) reliability of electricity*	2.44	1) quality of customer service	2.82
8) reputation of the company	2.19	2) reliability of electricity	2.68
9) quality of customer service	2.06	3) price	2.65
10) price	1.56	4) reputation of the company	2.61
11) systems they sell are designed in Canada	1.44	5) systems they sell are designed in Canada	2.22
12) systems they sell are made in Canada	1.44	6) systems they sell are made in Canada	2.19

SHW purchaser responses:

Consideration	Importance (0-3)
price	2.54
customer service	2.54
reputation	2.54
reliability	2.54
Canadian made	1.62
Canadian designed	1.31

[205] The following formula was used to aggregate 16 importance-scale responses to a single number measuring importance on a scale of 0 to 5: importance of factor = ∑xf(x) = ∑weight(proportion), e.g., importance of air quality to PV purchasers = ∑x*p(x) = 0(.06) + 0(.06) + 1(0) + 2(.19) + 3(.69) = 2.38, where x denotes the level of importance, and p() is the (step-wise) probability density function for the distribution of respondent answers concerning a particular factor. For example, p(not important) = .06 is the proportion of respondents who indicated that "air quality" was not important.

[206] Note that this question is somewhat hypothetical, even for PV purchasers, since the WISE organizers had already selected ARISE Technologies as the CSEI's 'preferred vendor'.

A9. Do you think you would have seriously considered installing a solar system (within the next 5 years) without help from WISE?

		☐ Yes	☐ No	☐ Not sure	Choose not to answer
PV	Non-purchasers	35%	29%	35%	0%
	PV purchasers	25%	50%	20%	0%
	SHW purchasers	23%	38%	23%	0%
Thermal	Non-purchasers	47%	35%	18%	0%
	PV purchasers	19%	56%	25%	0%
	SHW purchasers	31%	54%	15%	0%

A10. Having met with a Globe Solar representative and decided not to purchase, what if any feedback would you provide to the company to improve their overall products and services offered through the initiative?

Feedback for Globe Solar n = 11 non-purchasers*	**Response frequency**
Offer attractive financing package For us it is a question of cost. If there was a way to get a financial institution involved it would be a great help. If materials were fabricated in Canada then cost would be lower. Cost was the prohibitive factor, (not because it was too high, but unaffordable)[207]	**2**
Improve return on investment The key issue is that I can't see a positive payback.	**2**
Work with government to stimulate domestic industry Get assertive with this government. Build all plants in Canada. Make this country the cutting edge of this blossoming industry. I think the whole industry needs more R&D to get the efficiency up. When I read that conversion rates are only 9-12% as an average, it is discouraging. To have to spend 26 thousand (the system that I was quoted) and still not be able to be fully off the grid...well, it just gets too expensive. See previous comments re: government red tape, fees, permits, etc.	**2**

*For related responses from SHW purchasers, the reader is referred to questions A4b concerning disadvantages of solar thermal systems.

There were six non-recurring answers:

(1) "I never met with Global Solar representative."

(2) "Is this really a university project or the company wanting feedback? They seemed fine to me..."

(3) "I did not have a problem with the products or implementation. My reason to not install solar panels is in part that my roof can only accommodate a 1 kW system, and there are large trees that would partially block it." There appears to have been a general consensus among WISE participants that a 1 kW system was too small to merit installation, since no 1 kW systems were sold through the program.

(4) "The reason not to install the solar heat is that there are only two of us in the household. Between us, we run the dishwasher once every 2-3 weeks, run the clothes washer 2-3 times per week (and mostly on cold). Further, we only take about half of our showers at home. From a cost-perspective I think there are other green energy systems that would make

207 This comment suggests that the respondent might have paid a high purchase price if financing were available.

more sense for us. NOTE: My house uses hot water radiators for heating. If I could tap the solar heat into the radiators then I would not have hesitated to proceed."[208]

(5) "It came down to being new home owners with a mountain of reno costs ahead of us. Solar would be great, but first we needed to fix our foundation. Supposedly 0% loans will be made available from the government. Information on this would be v. helpful."

(6) "Installation seemed potentially challenging."

Feedback for Globe Solar n = 3 SHW purchasers*	**Response frequency**
"I would have liked to know that the system needs to be heated during the winter."	**1**
"People who do the job have to be handyman"	**1**
"Our main criticism is lack of any means of delivering information on a coordinated and current basis"	**1**

*The researcher neglected to modify this question from the survey for non-purchasers. Hence, the SHW purchasers received a version of the question premised on them having not purchased. This meant that only 3 of 10 SHW purchasers who responded interpreted the question as the researcher had intended.

PV purchaser feedback to the SHW vendor, Globe Solar, was incorporated into content analysis tables for question

Feedback for Globe Solar n = 7 PV purchasers*	**Response frequency**
Training/maintenance manual "I could have used a more thorough explanation of which valves to switch open & closed when going on vacation. I followed the directions they'd provided in print, but these weren't sufficient because they resulted in gallons of hot water pouring off my roof when I turned the system back on after returning home. I did finally, through trial-and-error, as well as a bit of logic, figure out how to manage this on my own and avoid the waste of water." "Get has to be maintainence contract in writing that tells what's involved all the info when involved, do this wehn is leaks, too late, all that should have been told in teh beginning."	**2**

[208] DSHW did not fit this respondent's energy usage patterns. Standardized WISE packages did not allow for customized space heating systems.

Satisfied "Pretty happy" "I love my solar thermal system--I never seem to run out of hot, hot water."	**2**

Single occurrence responses:

"We have not acquired a system from Globe. We have been told by a reputable source that the tube system does not work effectively in cold climates. I am surprised that wise was not aware of this."

"Did not appreciate the sales effort when we did not plan solar thermal."

"We did not opt for thermal heating system because, in the long term, we suspect that on-demand water heating at the tap will be the preferred approach. Also, all of our suitable roof space was taken up by the solar panels."

A11. Having met with an ARISE Technologies representative and decided not to purchase, what if any feedback would you provide to the company to improve their overall products and services offered through the initiative?

Feedback for ARISE n = 12 non-purchasers	**Response Frequency**
There are many people who can't participate because of price barrier His approach is geared towards those with fabulous amounts of expendable cash. Every home owner I see thru my window has a roof. Many have garages which also have roofs. Am being a little too blunt?[209] Service and products are very good, but cost is prohibitive to a low income family. I just can't afford it that's all. It's the cost of the system that we cannot afford at this moment. Within the next 5 - 10 years we will install the system and hopefully the price may go down.	**4**
We are impressed with this company. Excellent	**2**
Keep messaging simple and compelling Less detail; more stream-lined and clearer information, especially written brochures would be helpful. More assertive recommendation that the site is or is not suitable/ideal. [For example] this site is ideal. this is how much it will cost. - here is the cost benefit - IRR or ROI...	**2**
Keep on the cutting edge of technology and improve the voltage output of the panels.[210]	

[209] The respondent means that despite available rooftop space, there are many people who can't participate because of price barrier.

[210] Respondent is confusing voltage with wattage.

Did not meet with an ARISE representative Never met with an ARISE technologies representative Did not meet with an ARISE representative. I have not met with an ARISE rep.	**3**
Improve the look of the thermal energy system.	

A12. If you have any other comments about community solar initiatives in Ontario, please use the comment box below.

Respondents' final thoughts about community solar initiatives in Ontario (final survey question)

General Thoughts from PV purchasers n = 6	**Response Frequency**
More government support "I hope that someday the government will be able to subsidize solar energy as a standard for all homes." "should be regulated by provincial government." solar equipment should be mandatory for all adequate rooftops in province." "the pieces are all there, only determination is lacking, as if there were options other than renewable energies?!"	3
Prevent further coal and nuclear development "action should be taken now to prevent further nuclear/gas/coal power plant developments." "all of this would be possible if the $27b that might be awarded for nuclear facilities (Gov. of Ontario for the next 20 years) be invested properly and if our leaders would be more pro-active instead of trying to support ancient technologies that are not sustainable."	2
"solar equipment should be manufactured locally."	1

General Thoughts from SHW purchasers n = 10	**Response Frequency**
Great, we need more of them Great. We need more of them. Good idea, we need more. Really great! more, more! I would like to get involved in promoting this in the future. "I hope they continue. I would like to look at PVC again once issues with Toronto Hydro, and partial shade of location, are resolved."	4

Expand to large roof applications "I hope they continue and expand! And I wish there was a way for communities to install PV panels as a collective (for example, across a group of buildings) to take better opportunity to generate electricity from solar energy. "I would like to see more community initiatives where PV units are placed on public buildings. It makes more sense to erect an array on a large roof than to have little ones here and there. We could all buy a share in the array as with Windshare."	2
Pressure government to remove barriers More pressure has to be applied to the municipal and provincial government to allow programs like WISE to be function effectively.	1
The issue of using the thermal system in this climate still hasn't been resolved.	1
[Apply concept to wind and micro-hydro applications]	1

General Thoughts from non-purchasers n = 10	**Response Frequency**
More government support We need more government subsidy to make it possible to undertake these initiatives Governments at all levels need to make this process easy - not difficult. I do not want to be in a private business of energy creation, pay permitting fees from Ontario Hydro, etc.[211]	2
My house uses hot water radiators for heating. If I could tap the solar heat into the radiators then I would not hesitate to proceed with solar panels.	
I don't understand how whole cities can have solar panels in Europe and in Canada, it is still a marginal thing. I WOULD do it immediately if the costs were not so prohibitive. I understand that there must be a larger market before the R&D and the efficiencies of scale come into play but when we[...] oil companies are spending ludicrous amounts of money to develop tar sands, why isn't there the same amount of time, money and energy to develop cleaner, sustainable sources of energy?	
It's a great initiative and much needed in every community. Thank you!	
I think the WISE initiative was well motivated, and I would have liked to participate -- but it probably needed more than volunteers doing the work. I would have been happy to contribute financially to a pool of money to hire someone for expert advice.	

211 Respondent refers to Ontario Hydro and may not know current institutional responsibilities.

A community initiative should outline the various options and the pros and cons of each, so that potential buyers can see what system might fit their needs.[212] We read something about a Toronto Solar Neighborhood Initiative which will, perhaps, provide this kind of comparative research.	
The long term deal with Hydro for the purchase of energy I generate must be improved and be more in line with some of the European deals.[213] The price of the energy that they purchase from me must increase at the same rate as the price I will be buying energy from Hydro in the future, otherwise it is a bad deal. This was the major factor for my husband to not install the solar panels on our roof.	
I really wanted the thermal power system to generate our hot water but was not comfortable with how it would look on our roof. We live in a lovely neighbourhood and I did not want to have my house have something on the roof that would be an eyesore.	
This is the way of the future of energy production in Ontario. As more people are affected by infrastructure failure distributed energy will become the standard.	

B1. What motivated your interest in WISE? (please briefly describe)

Motivation for participating in WISE (PV purchasers) n = 15	**Response frequency**
To set an example (for children) "Same as buying a Prius - to set example for kids, and the community. Obviously, it shows that we're taking a stand, of how to live, to provide better environment for kids." "To set example for children of personal action to effect change and taking responsibility" "Reduce my personal footprint. Able to do something without spending a zillion hours trying to find the best vendor. Wanted to give an example to my kids about lifestyle choices and making a real impact."	**3 (4)**
To lead by example by managing resources better "To lead by example; that for the same price as a mid size car, you can make use of wasted roof space. For almost zero maintenance you can have something that will keep paying everyone back for	**1**

212 Comment suggests a need for some tailoring/customization/product differentiation.
213 This is now the case with the MicroFIT.

many more years past when the car was sold and crushed into a cube." *	
To be part of the solution "To be part of a very worthwhile project, to contribute to reducing Canada carbon footprint, and the hope of reducing and eliminating more NUCLEAR power." "Wanted to be part of the solution." "Producing renewable energy. Being a small-scale provider. Leading the way as a community. Addressing climate change and taking the solutions in our own hands, (being the change we want to see in the world faster than the government is willing to). Fully providing for our home electricity needs."	**3**
To respond to global environmental challenges "Taking some responsibility for global warming" "I am daunted by the challenges that environmental protection faces. My understanding is that production of green house gases and other pollutants must be reduced by about 50% in the coming decades, and similar reductions in consumption of resources are surely also necessary. Rapidly increasing 3rd world consumption and continued wasteful practices in advanced countries are therefore very discouraging. Also, the world's population was 2.5 billion when I was a child (1950s) and now it is 6.6. If projections for slowing of population growth are not exceeded, and perhaps made negative, then it is difficult to see how critical targets can be met."	**2**
To make a difference "Makes me feel good in conversation with friends. It's almost like a hobby, something...I will have made an impact with my life."	**1**
To be ecologically responsible "To be ecologically responsible. We don't have children, but we are still concerned about the well-being of future generations. We hope over time we will also save ourselves some money, especially with approaching retirement and diminishing income (not that we earn a lot as it is)."	**1**
To do the right thing "The biggest motivation is that I wanted to do the right thing. I've long been concerned about environmental issues and talked a lot about what people and the government should be doing to solve these problems. When I heard about WISE, I figured it was time to put my money where my mouth was. I was also drawn to the idea	**1**

* emphasis added

of being somewhat independent of the power grid, until I found out that was not possible under this program. We didn't go into it with any expectation of saving money and don't expect we'll even pay it off for a long time yet. In the end, it was pretty much a leap of faith. I think more people may have been persuaded to sign up if there had been a much clearer picture of the cost, the benefits, the payback period and the drawbacks of solar power." *	
For many reasons, including local air quality "For a whole bunch of reasons, but mostly so I can breath better."	**1**
"My motivations were two-fold. 1. purely financial to cut cost of electricity. 2. generally to go green."* (non-purchaser)	

*One non-purchaser was included by accident in the purchaser sample frame. Their answers were removed from purchaser data, and analyzed along with the rest of the non-purchaser data. However, in the case of this particular question, their response offers remarkable. In contrast to all 13 purchaser responses, it mentions financial considerations before environmental considerations. Further it employs an abstraction not found in any of the purchaser responses, i.e., "go green".

Motivation for participating in WISE (SHW purchasers) n = 13 SHW	**Response** **frequency**
Existing interest in sustainable energy (predisposition) "Wanted independent energy from a renewable source" "Was interested in acquiring PVC and hot water system" "I have been in the saving and conserving energy for a long time. In 1975, I got the book from Energy, Mines and Resources Canada: 100 ways to save energy and money in the home. Since then, each house I have lived in, I have made improvements to save energy." "Sustainable energy, reduce footprint, and all the good points indicated earlier.... We were a believer, WISE made it easy" "I have always been concerned about the environment and my own negative impact on it, therefore was thrilled to have this means of reducing my consumption of damaging energy sources. Also love the fact that it will ultimately save me a lot of money, and love the fact that it is a community-based initiative that can bring neighbours together and contribute to a sense of engagement, connection and contribution to positive action that benefits everyone!"	5
Environment and economy Save the planet, reduce costs, easy to do, good people to work with Help the environment, save money	**3**

I wanted to reduce my carbon footprint and help the renewable energy movement by adding to the number of people involved and committed	
Reduce carbon footprint	**2**
Collective action for transitioning to renewable/sustainable energy "As a society we need to develop and invest in clean, renewable sources of energy." "We must reduce our dependence on unsustainable and polluting energy sources. We have to start somewhere	**2 (3)**
Support for seniors "Support and benefit from a group initiative that did prior groundwork thus saving us as seniors a lot of work"	**1**

Single occurrence responses: Support and benefit from a group initiative that did prior groundwork thus saving us as seniors a lot of work

B1. Please briefly describe your motivations for participating in the WISE.

Motivation for participating in WISE (non-purchasers)	Response frequency
Help/Facilitation/Information I was trying to get some help to make use of green technology I want to purchase a solar voltaic system. They made it easy. (except for the money part. I appreciate that they had financing in place, but it is still too expensive.) A learning experience that might have led to the installation of a system.[214] Easiest way to learn and talk with experts in person.	**5**
To be more environmentally friendly. I was very interested in taking action to support the health of the environment. Looking to be more environmentally friendly. To make a difference to the environment	**3 (5)**
Climate change/global warming Speed up our efforts to reduce our contribution to climate change, Global warning	**2**

[214] The learning experience can be a first step towards installation.

Sending a political or social message Environment Political Message to OPG and Energy Ministry. I would like to encourage the implementation of green energy sources and this seemed a good way to do it. To teach our children a different way to create sustainable energy and to take care for our environment I live on the same world as the frightened idiots and entrenched interests. Photons are not right or left wing.	**4** *"Since my 20's I have known and talked about solar panels. I remember telling my family about it and them laughing at me..... Now who is laughing...."* *-resp. 31*
To be part of a great initiative To be part of a great green initiative and lower our costs. It is a great community initiative and I support it. I hope to be able to utilize solar energy in the next 5 years. I am grateful for the research they have done to make it easy to implement the installation of these systems without being mired in bureaucratic and legal complications.	**2**
Save money and get a system installed. To cut cost of electricity	**2**

Question for non-purchasers:

B2. How significant were the following barriers in your decision not to purchase a solar *electric* (PV) system?

Answer scale: Not Important (1) to Very Important (5)

Question for purchasers:

B2. How difficult were the following hurdles to overcome in your decision to purchase a solar *electric* (PV) system?

Answer scale: Not a major barrier (1) to Major barrier (5)

n = 46 (15 PV purchasers + 13 SHW purchasers + 17 non-purchasers)

Hurdle (PV purchasers) (0-4)		**Barrier (non-purchasers) (0-4)**	
1) cost of system was too high	2.25	1) cost of system was too high	3.12
2) plan to move in the next few years and are not sure we will recoup the cost in resale value	0.75	2) financial payback too long	2.82
3) lack of confidence in the contractors	0.69	3) the Standard Offer Program rate of 42 cents/kWh too	2.00

		low*	
4) financial payback was too long	0.63	4) unconvinced PV would result in significant energy generation	1.29
5) lack of sufficient information to make an informed decision	0.56	5) the Standard Offer Program is an inappropriate form of subsidy*	1.29
6) unconvinced PV would result in significant energy generation	0.50	6) plan to move in the next few years and are not sure we will recoup the cost in resale value	1.18
7) lack of confidence in PV technology	0.25	7) lack of sufficient information to make an informed decision	1.18
8) unconvinced PV can result in significant environmental benefits (emissions reduction)	0.13	8) lack of confidence in PV technology	1.06
		9) unconvinced PV can result in significant environmental benefits (emissions reduction)	0.71
		10) lack of confidence in the contractors	0.53

Note: * SOP questions were not included in the survey given to purchasers.

Importance ranking of barriers to purchase of a solar PV system for SHW purchasers

Consideration	**Importance of barrier (0-4)**
cost too high	3.75
payback too long	3.73
SOP inappropriate form of subsidy	2.00
SOP rate too low	2.00
low energy generation capability	1.33
lack of information to make an informed decision	0.92
lack of confidence in technology	0.91
lack of confidence in contractors	0.73

plan to move	0.64
low environmental benefits	0.27

Hurdles (purchasers) and barriers (non-purchasers) identified in the open-ended "other" category

Hurdle	Frequency	Barrier	Frequency
Feeling resentment that we should have to invest our own money into this, and that the government isn't already doing so.	**1**	**Confidence in house suitability for solar** Got message it was not suitable for my house[215] Assertion and confidence that the site was ideally suited to Solar PV[216]	**2**
Financing was somewhat of a barrier	**1**	**Complexity of being a second Toronto Hydro customer.[217]** Ideally want to take advantage of Standard Offer, but only pay one customer charge to utility.	**1**
Payback longer, b/c CCA was disallowed by Rev Can	**1**	Along with 10) [SOP too low], the length of the 20 year SOP contract is ridiculous. The rate is generous for now, probably for the next few years, but over a 20 year term?[218] I want the ability to feed in to the grid and be guaranteed a profit for any electricity that I supply. I can easily imagine that 42 cents/kWh will be less than the market rates in short time.	**1**
Number of respondents: n = 7			

215 Respondent's home was classified as unsuitable for solar due to shading, orientation, or lack of roof space.

216 Obtaining the vendor's assertion that the site was ideally suited for PV was important.

217 Utilities could improve customer service by unifying the consumption/production billing.

218 Respondent is concerned about the affect of inflation on payback.

B3. (for purchasers) How important have the following factors been in <u>motivating</u> your purchasing a solar energy system?

B3. (non-purchasers) How important have the following factors been in <u>motivating</u> your desire to install a solar energy system?

Motivation (PV Purchasers)	Importance (0-4)	Motivation (Non-purchasers)	Importance (0-4)
1) concern about negative impact of carbon emissions	3.69	1) to help Ontario close its coal-fired power plants sooner.	3.47
2) reduce our home's net energy consumption (footprint)	3.69	2) reduce our home's net energy consumption (footprint)	3.41
3) reduce the need to build more power plants in Ontario	3.06	3) reduce the need to build more power plants in Ontario	3.41
4) to help Ontario close its coal-fired power plants sooner.	2.94	4) concern about negative impact of carbon emissions	3.35
5) reliability of PV technology	2.88	5) reducing need for transmission corridors (high voltage power lines)	2.71
6) access to sufficient information to make an informed decision	2.63	6) payback improvements coming from the Standard Offer Program	2.65
7) payback improvements coming from the Standard Offer Program	2.44	7) access to sufficient information to make an informed decision	2.53
8) reducing need for transmission corridors (high voltage power lines)	1.63	8) reliability of PV technology	2.06

Importance ranking of SHW purchaser considerations in participating in WISE

Consideration	Importance (0-4)
negative impact of carbon emissions	3.90
reduce the need to build more power plants in Ontario	3.80
reduce our home's net energy consumption (footprint)	3.78
to help Ontario close its coal-fired power plants sooner.	3.33
access to sufficient information to make an informed decision	3.11
reducing need for transmission corridors (high voltage power lines)	2.75
reliability of PV technologies	2.70
payback improvements coming from the Standard Offer Program	2.13

B4. How did you first learn about the Standard Offer Program (RESOP)?

This question was included in the surveys of SHW purchasers and non-purchasers only (i.e., was not included in the survey of PV purchasers).

How did you first learn about the Standard Offer Program? n = 17 non-purchasers	**Response Frequency**
Community meeting (x10) **Through WISE** (x4) WISE community meetings and presentations. WISE representatives.	**15**
Some one knocked on my door.[219]	**1**
Media	**2**

[219] Possibly a WISE volunteer.

don't recall -- probably the newspaper	
Neighbours[220]	**1**
I was at **the launch at the CNE**.	**1**
At a public consultation meeting in Ottawa a few years ago about Ontario's Energy Future where the agenda seemed stacked for nuclear.	**1**

How did you first learn about the Standard Offer Program? n = 12 SHW purchasers	**Response Frequency**
Through WISE	**5**
Community meeting	**2**
Can't remember	**2**
Media	**2**
Not heard of it, We didn't	**1**
Through Greensaver	**1**
Energy Probe newsletter	**1**

C1. Please indicate the decade you were born: _____

Decade	Proportion of PV purchaser responses	Proportion of Non-purchaser responses	Ward 21 Profile*
<1940	0.0	0.0	0.15
40s	0.19	0.35	0.11
50s	0.50	0.35	0.15
60s	0.19	0.18	0.16
70s	0.06	0.12	0.17
80s	0.06	0.0	0.12
≥1990	0.0	0.0	0.14
Total	1	1	1
Weighted Average [221]	1958	1955	1965*

[220] It would be helpful to know whether this neighbourly contact occurred via word of mouth, lawn signs, or some other channel.

* Age demographic categories differ by two years from WISE survey categories.

[221] Weighted average = ∑(decade mid-point)*(percent frequency)

C2. Please indicate the number of people in each of the following age groups that live in your household.

n = 17 non-purchasers

Answer options

___ 10 years or younger ___ 21 to 30 years ___ 51 to 65 years
___ 11 to 20 years ___ 31 to 50 years ___ more than 65

	Household Count		
Number code	PV purchasers	SHW purchasers	non-purchasers
Middle aged couple without children*	4	Did not calculate	3
Middle aged couple with children under 30	7	"	10
None of the above	4	"	4

*defined as couples with an average age of 30-60 years

C3. Please indicate how often you discuss energy issues with the following people:

Non-purchasers

	Spouse [222]	Child	Friends	Neighbours	Coworkers	Trades-person*
NA	18%	18%	0%	0%	24%	12%
Not at all	0%	6%	12%	18%	6%	12%
Occasionally	29%	24%	41%	47%	35%	65%
Frequently	18%	18%	35%	29%	24%	6%
Very frequently	35%	35%	12%	6%	12%	6%
No answer	0	0	0	0	0	0

* heating and cooling contractor or insulation contractor

[222] Almost all co-habiting couples listed on the WISE sample frame had different last names. This research assumes that respondents who answered "NA" in the "Spouse" category are not part of a co-habiting couple. It is also possible however that the respondent is part of a co-habiting couple, but answered "NA" because they do not regard their partner as a "spouse".

PV purchasers

	Spouse	Child	Friends	Neighbours	Coworkers	Trades-person*
NA	33%	20%	0%	0%	0%	0%
Not at all	0%	7%	0%	0%	40%	27%
Occasionally	7%	27%	46%	53%	13%	60%
Frequently	27%	20%	27%	40%	13%	0%
Very frequently	40%	33%	33%	7%	33%	13%
No answer	0	0	0	0	0	0

C4. Please indicate the highest level of education attained by someone in your household.

n = 17 non-purchasers

___ completed high school
___ college or technical diploma
___ some university
___ university (Bachelor) degree
___ graduate degree (Masters, Ph.D.)
___ professional degree (MD, LL.D., PEng, etc.)
___choose not to answer

	Graduate Degree (Masters, Ph.D.)	**Professional Degree (MD, LL.D., etc.)**	**University (Bachelor) Degree or lower**	**Choose not to answer**	**Total**
PV purchasers	50.0%	12.5%	37.5%	NA[223]	100%
SHW purchasers	23.1%	46.2%	7.7%	23.1%	100%
Non-purchasers	29.4%	47.1%	0%	23.5%	100%
Ward 21[224]	13.3%	6.6%*	80.1%	NA	100%

[223] Note on possible source of error: The lack of a "Choose not to answer" option in the survey delivered to purchasers makes the comparison of the two groups' answers less reliable.

[224] City of Toronto, 2009

* Sum of "Degree in medicine, dentistry, veterinary medicine" and "University certificate above bachelor level"

C5. What is the approximate annual income (pre-taxes) of your household in 2006?

	Response			
Income range	**PV purchasers**	**SHW purchasers**	**Non-purchasers**	**Ward 21**
< $40,000	6.3%	0.0%	0.0%	37.6%
$40,000 to $79,999	12.5%	15.4%	17.6%	27.6%
$80,000 to $119,999	43.8%	15.4%	17.6%	34.7%[225]
$120,000 to $159,999	12.5%	30.8%	11.8%	No data
$160,000 to $199,000	0.0%	15.4%	17.6%	No data
> $200,000	25.0%	0.0%	11.8%	No data
Choose not to answer	NA	23.1%	23.5%	NA

Appendix A IV - Table of (motivating) factor importance ratings for all WISE participants

Question A6 was used to quantify[226] the importance of certain key factors motivating respondents' desire to purchase a PV system as part of the WISE. Question B3 also asked about motivating factors, but did not frame the question in the context of the WISE.

Questions A6 and B3 both asked respondents to rate the importance of (motivating) factors in their decision to purchase a solar energy system. However, one question (A6) was in the context of the WISE, and the other did not ask specifically about WISE. A6 and B3 also contained different closed-answer options (with the exception of a question about "energy footprint", which was common to both questions. Though the answer options are distinct, they can be grouped into the five categories, "environmental", "social", "informational", "financial" and "technical", with a few questions straddling two categories. Asking about related topics in separate questions was used to enrich researcher understanding of the relationship between factors (e.g. "air quality" and "coal plants"), as well as a validity check for the same factor

[225] Includes all households with income greater than or equal to $80,000.

[226] The following formula was used to aggregate 16 importance-scale responses to a single number measuring importance on a scale of 0 to 5: importance of factor = ∑xf(x) = ∑weight(proportion), e.g., importance of air quality to PV purchasers = ∑xf(x) = 0(.06) + 0(.06) + 1(0) + 2(.19) + 3(.69) = 2.38

(“footprint”). Using different methods to study the same topic has been referred to in the social sciences as “triangulation” (Jick, 1979).

Table 29 merges the importance factors from both questions across all WISE respondent groups. This table is similar to Labay and Kinnear’s (1981: 276) and can be used for comparison.

Informational considerations

A positive relationship can be observed between “importance” and the degree to which information is general or specifically directed towards the purchase decision. (In the “Information” category, importance scores increase (in a downward direction) from “chance to learn” -> “advice” -> “info to make decision” -> “reduced uncertainty”.) This suggests that specific, directed information was more valuable to purchasers than just general information/education. The same pattern appears across all three respondent groups.

Financial/Technical considerations

We see a reversal of importance between purchasers and non-purchasers concerning payback vs. reliability of PV. The RESOP was more important to non-purchasers than purchasers (2.19 vs. 1.6), yet still not enough of an incentive for them to adopt. The importance of these factors is nearly exactly opposite between purchasers and non-purchasers, with purchasers rating reliability at 2.3 and SOP payback at 1.6, while non-purchasers rate these factors at 1.8 and 2.19 respectively.

Table 29 - MEAN FACTOR IMPORTANCE RATINGS

Consideration	Question	PV purchasers	SHW purchasers	non-purchasers	Category
CC/GW	(A6)	2.8/3	2.8/3	2.7/3	ENVIRONMENT
Air quality	(A6)	2.4/3	2.3/3	2.9/3	
Help close coal plants	(B3)	2.4/3	NA	2.7/3	
Carbon emissions	(B3)	2.8/3	2.9/3	2.6/3	
Reduce net energy consumption	(B3)	2.8/3	2.8/3	2.6/3	
Take ownership of energy footprint	(A6)	2.8/3	2.2/3	2.6/3	
Reduce need for more power plants	(B3)	2.4/3	NA	2.6/3	
Transmission corridors	(B3)	1.6/3	NA	2.2/3	
Send message	(A6)	1.4/3	1.3/3	1.5/3	SOCIAL / ENVIRONMENTAL
Lead by example	(A6)	1.8/3	1.7/3	1.8//3	
Chance to learn	(A6)	.9 / 3	1.1/3	1.3/3	INFORMATIONAL
Advice	(A6)	1.8/3	1.6/3	1.7/3	
Info to make decision	(B3)	2.2/3	2.3/3	2.1/3	
Reduced uncertainty	(A6)	2.4/3	2.8/3	2.2/3	
Peers purchasing (relates to risk/uncertainty)	(A6)	1.3/3	1.4/3	1.6/3	SOCIAL
Group discount	(A6)	2.2 / 3	2.4/3	2.3/3	FINANCIAL / SOCIAL
Reduce costs	(A6)	1.0 / 3	2.1/3	2.3 / 3	
SOP-improved payback	(B3)	1.6/3	1.9/3	2.2/3	FINANCIAL
Reliability of PV	(B3)	2.3/3	2.3/3	1.8/3	TECHNICAL

Appendix A V - Table identifying which types of data were collected on which study cohorts

	Self-reported perceptions	Self-reported behaviour and characteristics	Electricity performance
WISE PV adopters	✓	✓	PV production and consumption
WISE SHW adopters	✓	✓	-
WISE non-adopters	✓	✓	-
Ward 21 households	-	data sourced from municipal government rather than self-reported	-

Appendix B - Measurement of household electricity performance

Appendix B I - Recruitment materials used in the electricity performance study

Initial recruitment email to WISE PV purchasers

Subject: Request for permission to access RESOP production and Toronto Hydro consumption data

Dear [recipient name],

I am an Environmental Studies student conducting research under the supervision of Dr. Paul Parker of the University of Waterloo. Our research is assessing whether the relatively high financial cost per unit of production in residential applications of solar photovoltaic (PV) systems is justified by associated social and environmental benefits.

Solar power is an important way individuals can reduce their impact on the environment. It also provides income under Ontario's Standard Offer Program. Because of the West Toronto Initiative for Solar Energy (WISE), your neighbourhood is an important area in which to conduct this research. As a PV system owner, the production data from your system is very important to this study. Your consumption data is also important to this study, as it will allow us to test hypotheses about the relationship of solar energy adoption to conservation. For example, this research is interested in answering the question, “Do home owners consume less electricity after purchasing a solar PV system through the WISE?”

The Ontario Power Authority has provided me with a Form of Authorization (i.e., consent form) that I will ask you to sign. Conditional on having your signature, the consent form authorizes Toronto Hydro to provide electricity production and consumption data for your account to the University of Waterloo.

All data provided by Toronto Hydro will be considered confidential and will be grouped with data from other participants. Further, you will not be identified by name in any thesis, report or publication resulting from this study. The raw data collected will be kept for a period of two years in my supervisor's office at the University of Waterloo, after which it will be destroyed.

You have three options for receiving and returning the Form of Authorization: email, fax, or in-person drop-off and pick-up. If you choose the in-person option, I will present my student identification card upon arrival at your home.
Please email or contact me by phone at (XXX) XXX-XXXX to inform me of your preferred option and I will follow up accordingly.

Your involvement in this survey is entirely voluntary and there are no known or anticipated risks to participation in this study.   If you agree to participate, you will only be contacted once.

If after receiving this letter, you have any questions about this study, or would like additional information to assist you in reaching a decision about participation, please feel free to contact Professor Paul Parker 519 888-4567, Ext. XXXXX.

The organizers of the WISE endorse this project, and with your permission WISE provided me with your contact information. I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo (Dr. Susan Sykes in the Office of Research Ethics at 519 888-4567, Ext. XXXXX.)

However, the final decision about participation is yours.

I hope you agree to participate.

Thank you in advance for your interest in this project.

Yours sincerely,

Ted Sherk

--
Ted Sherk, BMath
M.E.S. Candidate
Faculty of Environment
University of Waterloo

Follow up email

Subject: WISE Survey - Final Reminder

Dear [recipient name],

We are conducting a survey on behalf of the West Toronto Initiative for Solar Energy as part of research on barriers to solar adoption in Ontario.

As a participant in the WISE your opinions are very valuable to our assessment of the project. Recommendations from this study will be made to regulatory agencies, industry, government, and the WISE volunteer organizers to guide future policy, regulations, incentives, and community initiatives.

To begin our survey please click on the link below or copy it into your browser
http://dogwood.uwaterloo.ca/securesurvey/sw/wchost.asp?st=wisestagetwodshw&cn=tsherk

If you have any questions about the study or have an interest in the findings, please contact Dr. Paul Parker at the University of Waterloo (519-888-4567 - extension #XXXXX). The survey work is being undertaken by Chris Adachi and Ted Sherk, Graduate students at U of Waterloo.

This project was reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo (519-888-4567 ext XXXXX).

Thank you in advance for your time. Your participation would be greatly appreciated!

Ted Sherk

--
Ted Sherk
M.E.S. Candidate
Faculty of Environment and Resource Studies
University of Waterloo

Email to WISE PV purchasers who agreed to participate in the electricity performance study

To begin the survey please click on the link below or copy it into your browser
https://dogwood.uwaterloo.ca/securesurvey/sw/wchost.asp?st=wisestagetwo&cn=tsherk

If you are unable or do not wish to complete the survey, please consider sending us a brief reply with one or two sentences explaining why, which we will use to guide further research.

If you have any questions about the study or have an interest in the findings, please contact Dr. Paul Parker at the University of Waterloo (519-888-4567 - extension #XXXXX). The survey work is being undertaken by Chris Adachi and Ted Sherk, Graduate students at U of Waterloo.

This project was reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo (519-888-4567 ext XXXXX).

Thank you in advance for your time. Your participation would be greatly appreciated!

Ted Sherk

Appendix B II - Consent form administered to PV purchasers to obtain household electricity data

OPA Renewable Energy Standard Offer Program
Program Rules, version 2.0

EXHIBIT “B” – FORM OF AUTHORIZATION LETTER

TO: __Toronto Hydro Corporation___ (the “LDC”)

AND TO: University of Waterloo (the “U. of W.”)

RE: Disclosure of Information

_____ [insert Applicant’s full legal name] (the “Generator”), as the owner, developer and operator of the embedded electricity generation facility located or to be located at __ [particiapnt’s full address]___ [insert Contract Facility Address] and connected or to be connected to the LDC’s electricity distribution system at _______ [insert description of connection point] (the “Generation Facility”), hereby irrevocably authorizes and consents to your releasing, disclosing, providing, delivering and otherwise making available to the U. of W. or to its agents, successors and assigns, any and all such information relating to the connections, proposed connections, meters, meter data, testing data pertaining to commercial operation, billing data and LDC account of the Generator or the Generating Facility as the OPA, its agents, successors or assigns may advise is required in connection with the evaluation, offer and administration of a contract under the OPA’s Renewable Energy Standard Offer Program.

And, if connecting to a Load Customer:

______ [insert Load Customer’s full legal name] (the “LDC Customer”), as a customer of the LDC with account number ___[to be obtained]___ [insert Load Customer’s LDC account number from most recent electricity bill] relating to the property located at ______[participant’s full address]________________ [insert Load Customer facility Address] (the “Account”) and connected to the LDC’s electricity distribution system, hereby irrevocably authorizes and consents to your releasing, disclosing, providing, delivering and otherwise making available to the U. of W. or to its agents, successors and assigns, any and all such information relating to the connections, proposed connections, meters, meter data, testing data pertaining to commercial operation, billing data and LDC account of the LDC Customer or the Account as the U. of W., its agents, successors and assigns may advise is required in connection with the evaluation, offer and administration of a contract under the OPA's renewable Energy Standard Offer Program.

DATED as of the ___ day of _______________, 200__.

GENERATOR: Per:_______________________________________

Name: [First name, last name]

Title: [Mrs., Ms., Mr.]

I have authority to bind the Generator.

LDC CUSTOMER: Per:_______________________________________

Name: [First name, last name]

Title: [Mrs., Ms., Mr.]

I have authority to bind the LDC Customer.

Appendix B III - Description of methods used for the weather normalisation

Weather data were collected by Milton Hydro staff under the supervision of Ron Brajovic, Manager of Engineering at Milton Hydro. The data were provided to the researcher by Andrew Peers, Applications Analyst at Milton Hydro. The data spanned a period from January 2001 to December 2009 and was provided in monthly intervals. Parameters used in the analysis included "date", "heating degree days", "cooling degree days", "# of days in month".

The data were checked for gaps and outliers. No gaps were found and so estimation of missing data were unnecessary. Annual totals were calculated. Since the Toronto Hydro extended back in time only as far as January 2005, the Milton Hydro data prior to this date were deleted and analysis carried out over the period January 2005 to December 2009.

To adjust the consumption data of the eight WISE PV-adopting households to control for annual weather variation, it was decided to calculate adjustment coefficients based on annual deviation of heating degree days (HDDs) and cooling degree days (CDDs) from corresponding 5-year averages. These coefficients were then used to multiply annual totals of electricity consumption, thereby removing the effects of weather variation on the household consumption data.

Plots were created of the adjusted and unadjusted annual consumption totals from the eight PV purchaser households. Plots of HDD and CDD were plotted next to the consumption data and inspected for correlation. Pearson correlation coefficients were calculated, as reported in Section 4.2.2.

Appendix C - Miscellany

Appendix C I - Transcript of interview with Jed Goldberg

An interview was conducted with Jed Goldberg, President of Earth Day Canada on November 9, 2007. The purpose of the interview was to gain insight from the founder of the WISE into reasons for its origins, structure, reasons for success and ways subsequent similar projects might be improved. Interview questions are provided, followed by a partial transcript of the interview.

Full list of questions

1. How do you develop credibility with your neighbours, particularly around environmental issues?

2. How do you talk to people in a way that engages rather than overwhelms?

3. What are your strategies to communicate a sophisticated understanding of environmental stewardship, and the benefits of sustainable living for quality of life - clean air, safe communities, social and economic benefits?

4. What are the sources of information, on the environment, on current events, public opinion, that you used to stay staying fresh and relevant?

5. What is your history of working on community-based green projects?

6. PV initiatives require an enormous amount of cooperation between various actors and stakeholders in order to be successful. Please talk about some of the lessons you've learned in bringing stakeholders together to make community solar a reality.

7. How have you seen these projects mature from the early days of Green *Peace's Solar Pioneers* program and visionaries like Tooker Gomberg, to solar becoming 'big business' and potentially going mainstream.

8. Do you have a 'grand vision' for the next generations of community power projects, or do you prefer to re-evaluate incrementally - 'a journey of a thousand miles begins with a single step'

9. Who were the key players in the early phases of WISE (i.e., pre-RFP)? Who was instrumental in getting the word out to the neighbourhood?

9a. Can you talk about the various levels of support, or the circles of involvement, that you and Ken relied on through the planning and early implementation of WISE? I'm thinking of the selection committee to volunteers, relatives, local home owners or others. Who were they (if you are able to speak to that), and what was their role?

10. Can you talk about the various levels of support, or the circles of involvement, that you and Ken relied on through the planning and early implementation of WISE? I'm thinking of the selection committee (Chris Chopik, etc.), to volunteers, relatives, local home owners or others.

11. Please take me through the process of public engagement that led to the RFP.

I understand that there were 2(?) public meetings and that you were able to compile a list of 300 homeowners (with support of a local riding association?) I'd like to clarify the key steps that led to the RFP.

12. What do you see as being the main strengths and weaknesses of the "bulk purchase" model?

13. What are some concrete ways to improve bulk purchases in the short term, or is there a new model that is more promising?

14. Is there anything you would like to speak to that I haven't asked about?

Interview transcript

Ted: Jed can you offer some advice on how you develop credibility with your neighbours in talking about environmental issues?

Jed: as a result of the fact that my occupation is environmentally oriented, I've been involved in the environmental community now for probably twenty five years. I have been involved in a, (.) in a range of different projects within my own community (.2) so there is sort of a tacet understanding that, you know, environmentally directed information from me is likely fairly credible.

Ted: Credible already

Jed: yeah, so, I'm known in the community, so that's helpful.

Ted: (.9) OK, so your history (.) kinda

Jed: Ya (.4) my background, my history (.) other projects I've been involved with (.) all of this stuff

Ted: what are your strategies for engaging with people in a way that engages them rather than overwhelming them on some complex environmental issues?

Jed: Well the point is that you don't want to guilt them, or scare them. Those kinds of tactics are outdated and ineffective. It's sort of a forgone conclusion in any intelligent person's mind that the issues we're facing environmentally are staggering and need immediate attention. So the point is, sort of, to refer to that as a forgone conclusion. People understand that we have these issues. They don't need to know the detail of what the issues are. They already understand that we are sort of backed into a corner and need to react. What they're looking for is focus, direction, and specific action items that they have the ability to have some control over. So, if you present opportunities to them with some specific, tangible, and measurable benefits. Then, that's something that I think many people will respond to. They certainly wouldn't respond to scare tactics or shaming them or guilting them or... any of those kinds of things.

Ted: OK, can you talk a little bit about the strategies that you have both as the President of Earth Day Canada, and just in relating to your, your neighbours at home as friends and neighbours...kind of the difference in, sort of, the mechanism that you have of engaging with people.

Jed: Well in the office we have a lot of technology, and resources at our disposal, so we can convey an offer in a very sophisticated way. So, we have the ability to spend money on advertising. Uh, we have (.) the resources to have professional marketers put our materials together. We have in-house web people that do design work and use some of the most current technological advances in, in helping us communicate this things. SO the organization Earth Day Canada is quite sophisticated from a communications and marketing point of view.

Community initiatives, uh, unfortunately don't have those resources. (.9) uh, so, we have rely much more on, on some basic social marketing techniques. (.7) Uhh, it's (.) extremely helpful (.) when you're doing these kinds of community projects (.3) that the project is led (.) and involves (.) uh, people in the community (.5) working with other people in the community. (.8) So that relationship, eh, uh, is, is sort of the key to some success. Umm

Ted: I touch on that a little bit later in some of my questions

Jed: Oh OK

Ted: kind of the people, for instance, who you relied on in the community for the WISE .hhh

Jed: OK

Ted: Um, but I'll get there. (.7) The next question is, what information sources do you rely on to stay current on environmental issues?

Jed: .hhh Well as an environmental organization, uh, [we have a range of different sources

[phone rings]

Ted: I can pause this

Jed: Can you?

[phone rings]

(recording stopped while Jed answers the phone)

(recording starts as Jed wraps up his call)

Jed: OK, bye. [thud/click]

Ted: Great (.7) so you were talking about the, uh, sources of information that you rely on.

Jed: Right, uhh (.5) again it's a situation where we have (.5) sophisticated resources at our disposal. We do have people who do research. (.5) Uh, the people here in the office all have environmental backgrounds. (.5) uh, aside from that we're connected to a whole community. 171

[transcription has been truncated]

...

Immediate reflections on the interview

I thought I had focused too much on certain aspects of the project, and not on others. For instance, I realized at the end that I had not mentioned zero-interest loans, or other bank financing. I was glad that he said my questions were comprehensive and that he didn't have much to add. I wish I had asked for him to expand more on his support people, e.g. Joe Mihevc. I should have asked about Michael Bryant, whether he had a role. Amazing that so many people attended the meetings.

Appendix CII - Michealsen's (2007) comparison of exploratory (inductive) approaches vs. confirmatory (deductive) approaches to research

This thesis used two different approaches to data analysis. The surveys used an exploratory approach, while the analysis of household electricity data used a confirmatory approach. Both approaches have been characterized by Michaelsen (2007) below. Respondent answers to the survey were used to suggest meaning units and codes for categories (Appendix A III) before considering the categories identified by the theory of diffusion of innovations. This approach is consistent with Michealsen's (2007) characterization of an exploratory vs. confirmatory approach.

Confirmatory vs. Exploratory Data Analysis

Confirmatory Analysis

- Inferential Statistics - Deductive Approach
  - Heavy reliance on probability models
  - Must accept untestable assumptions
  - Look for definite answers to specific questions
  - Emphasis on numerical calculations
  - Hypotheses determined at outset
  - Hypothesis tests and formal confidence interval estimation
- Advantages
  - Provide precise information in the right circumstances
  - Well-established theory and methods
- Disadvantages
  - Misleading impression of precision in less than ideal circumstances
  - Analysis driven by preconceived ideas
  - Difficult to notice unexpected results

Exploratory Analysis

- Descriptive Statistics - Inductive Approach
  - Look for flexible ways to examine data without preconceptions
  - Attempt to evaluate validity of assumptions
  - Heavy reliance on graphical displays
  - Let data suggest questions
  - Focus on indications and approximate error magnitudes
- Advantages
  - Flexible ways to generate hypotheses
  - More realistic statements of accuracy

Does not require more than data can support
Promotes deeper understanding of processes
Statistical learning

Disadvantages

Usually does not provide definitive answers
Difficult to avoid optimistic bias produced by overfitting
Requires judgment and artistry - can't be “cookbooked”