A Canadian Smart Grid in Transition:

A Case Study of *Heat for Less*

by

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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.

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Abstract

Energy supply is a major contributor to global greenhouse gas emissions. Smart grids, technologies which integrate information and communication components into the electricity grid, have emerged as a cost-effective means of mitigating energy supply emissions, optimizing the integration of intermittent renewables and creating new opportunities for demand side management.

Smart grid projects have been launched in many Canadian provinces, however few of these projects have succeeded beyond the pilot stage. In order to learn and benefit from these smart grid experiments, the literature suggests documenting these projects in detailed case studies.

This paper presents a case study of *Heat for Less*, a smart grid project in Summerside, Prince Edward Island that links the City's excess wind capacity to smart appliances, sold and installed in the homes of residents, which store electricity in the form of heat. Drawing on desktop research and semi-structured interviews, this paper details how and why *Heat for Less* moved beyond the pilot stage and into wide-scale deployment. Additionally, this paper analyzes these findings by applying three frameworks from the sustainability transitions literature: strategic niche management, the multilevel perspective, and the transition pathways.

This research found that context is critical to understanding how this project moved along the innovation chain. In addition to the technological aspects of *Heat for Less*, the politics and social dynamics at play in the City of Summerside significantly contributed to the success of this project.

Future researchers might consider expanding upon this study by surveying the early-adopting homeowners who purchased smart appliances. Further, researchers might also consider transferring the methodology used in this paper to a similar smart grid project for comparative purposes.

Acknowledgements

First, I would like to acknowledge my fiancée Danai Kusikwenyu for providing me with support, encouragement and love throughout this entire process. I couldn't have done it without you.

Second, I would like to thank my supervisor, Ian Rowlands. Ian proved to be an invaluable guide on this journey, sharing his insights on critical points and providing guidance whenever I felt unsure of myself. (One day I will learn to properly conjugate the word "data" ☺). Further, Ian was supportive and accommodating when life circumstances caused me to move across the country midway through writing this paper. For all this, I thank you.

Third, I would like to acknowledge all my friends from the Sustainable Energy Policy Research room. Writing a thesis can be an isolating undertaking. Being able to discuss ideas and challenges with such great officemates (you know who you are!) made this project far less daunting.

Fourth, I would like to acknowledge all the City of Summerside and Summerside Electric staff who participated in this study. This thesis would not have been possible without these interview data.

Finally, I would like to thank James Meadowcroft and Ian Rowlands, the co-directors of the "Unlocking the Potential of Smart Grids: A Partnership to Explore Policy Dimensions", a project supported by the Social Sciences and Humanities Research Council of Canada, for funding this research.

Dedication

This thesis is dedicated to my parents who have been incredibly supportive of me throughout my university career, always encouraging me to pursue my interests.

Table of Contents

Chapter 1: Introduction

1.1 Introduction

The Intergovernmental Panel on Climate Change (IPCC) has stated, in no uncertain terms, that climate change is happening, and that action is required to mitigate against and adapt to anticipated impacts (IPCC, 2014). In its summary for policymakers, the IPCC notes with high-confidence that adaptation and mitigation choices in the near-term will affect the risks of climate change throughout the twenty-first century (2014).

Energy supply –that is, the burning of coal, natural gas, and oil for electricity and heat– is the largest single source of global greenhouse gas emissions, responsible for 26% of global emissions (IPCC, 2007). Energy supply, therefore, represents a focal point for scientists, policymakers and civil society concerned with addressing the risks of climate change. The question these concerned parties ask is how best to 'decarbonize' this system.

In addition to education programs, government regulations and financial incentives, many innovative technologies have been developed and deployed over the last 30 years to reduce energy supply emissions (GEA, 2012). Smart grids, or the integration of information and communication technology into the electricity grid, have emerged as a cost effective means of facilitating demand response and integrating intermittent renewables and energy storage systems (IEA, 2012).

While smart grid technologies have made great strides, the rate of deployment and integration of these technologies remains relatively slow. A global smart grid survey conducted by the European Union's Joint Research Committee found that only 5% of the surveyed smart grid projects have reached the deployment phase (JRC, 2011). In terms of project maturity, the Canadian context conforms to this trend, with only a limited number of projects having succeeded beyond the R&D and demonstration phases (CanmetENERGY, 2013).

What policies and actions, then, might spur further integration of smart grids into the electricity grid? My study explores this question by studying a critical case: a Canadian smart grid project that has successfully transitioned into the mainstream. By exploring this case, and seeking to understand the transition process, I may gain insight into how best to foster the integration of smart grids, and by extension quicken the decarbonisation of Canada’s electricity sector.

1.2 Barriers to Canadian smart grid development

As scholars have argued (e.g. Unruh, 2000, 2002; Berkhout, 2002; Markard, 2011), part of the challenge of integrating smart grids into existing electricity infrastructure is attributable to the ‘lock-in’ phenomenon. Though technology is commonly thought of in terms of individual artifacts, energy technologies are better understood as parts of larger technological systems that provide energy services to consumers (Unruh, 2000). These systems are composed of “inter-related components connected in a network that includes physical, social and informational elements” (Ibid., p.819). For example, a gas-fired generating station is not only dependent upon transformers and transmission lines, but also on non-physical elements, such as government policies and priorities, legal frameworks, consumer expectations and demands, and dominant engineering designs. Particular technologies become ‘locked-in’ when the non-physical elements of this system work to reinforce the need for specific physical elements. The ‘lock-in’ phenomenon is particularly problematic in the energy sector, as large (and expensive) physical infrastructure, institutions, legal regulations, political priorities, and consumption patterns have evolved and bonded together over time, making system transformation difficult (Rip & Kemp, 1997).

In Canada, another barrier to national progress toward smart grid integration relates to the fractured and heterogeneous nature of Canada’s electricity landscape. As the governance of electricity is a matter of provincial jurisdiction (s.92A of the Constitution Act), there has been limited effort to advance any kind of national smart grid strategy or roadmap. Moreover, there is heterogeneity *within* many provinces, with regional or municipal utilities managing their assets differently (CanmetENERGY, 2013). The result is that Canada’s smart grid landscape is a diverse patchwork of projects, with little sign that a national consensus will emerge.

This lack of uniformity among Canadian smart grids is to be expected. As each utility is faced with different circumstances (e.g. supply mix, consumption profile, status of existing assets, access to markets, political priorities, etc.), it is natural that Canadian smart grids have developed in ways that reflect and respond to local characteristics and priorities. This diversity, though, may be a blessing of sorts. At a 2011 US-Canada smart grid conference, Ontario's International Electricity System Operator noted that diversity among smart grid projects is to be welcomed, as each experiment contributes to the overall understanding of smart grids (IESO, 2011).

1.3 Background and need

If provincial, regional and municipal utility managers are to benefit and learn from this experimentation, information regarding experiences and best practices must be shared. This raises yet another question: how best to disseminate the lessons that result from local smart grid experimentation?

As will be discussed in Chapter 2, there are a number of existing platforms designed to promote the sharing of smart grid experiences among Canadian utility operators. Many of these platforms, though, provide limited case information, and focus almost exclusively on the technological features of the profiled smart grid projects. As noted in section 1.2, it is important to recognize that smart grid technologies do not exist in a vacuum, and thus project descriptions should strive to report on the aspects of a smart grid that extend beyond its technological components. As the IEA put it in its 2011 report on smart grids, there is a need to create an inventory of "*detailed* case studies to gather the lessons learned from such projects, *particularly in the areas of policy, standards and regulation, finance and business models, technology development, consumer engagement and workforce training*" (IEA, 2011, p. 20 emphasis added).

Therefore, there is a need to document smart grid experimentation in detailed case studies, so as to contribute to the collective understanding of how these technologies have and can be operationalized to achieve social, environmental, and economic objectives. As is noted in Chapter 2, government agencies (e.g. Natural Resources Canada) have conducted commendable case studies on Canadian smart grid projects. However, few academic researchers have contributed to this effort. This absence is disconcerting as academics, conducting critical, methodologically rigorous, peer-reviewed analyses of smart grid case studies could potentially contribute to this discourse in important ways.

Social scientists have long studied the subjects of innovation and sustainability transitions. Given that many Canadian projects struggle to move beyond the R&D and demonstrations phases, these theories which examine how and why technologies *transition* into the mainstream could provide much needed insight into how the barriers which have slowed or prevented the integration of smart grids into the electricity system might be overcome. In this way, by conducting a case study of a Canadian smart grid project, and by making use of select social science theories, this thesis strives to make a small contribution to the Canadian smart grid literature.

1.4 Purpose of the study

The purpose of this study is to better understand how and why smart grids transition into the mainstream. The underlying idea being that such knowledge might benefit future smart grid development and deployment. To this end, I will conduct a case study of a smart grid project that has *transitioned*. By this, I mean a project that has successfully moved through the "innovation chain" (JRC, 2011), from R&D to demonstration to deployment. Here, the measure of "success" is whether the project is no longer considered a pilot project and is integrated into the regular operations of an electricity utility. It could be argued that there is as much to be learned from "failed" cases as there is to be learned from "successful" cases. I concede this point, though as my purpose is to better understand how and why smart grids transition into the mainstream, it is more appropriate to select a case that has reached the deployment phase.

1.4.1 Case selection: Heat for Less

As discussed in section 1.1, relatively few Canadian smart grids have transitioned into the mainstream. Those that have, then, are exceptions to the rule. The exceptional quality of these cases is precisely what makes them instructive, revealing insights that might not have been captured by studying a more representative or "average" case.

Summerside Electric's *Heat for Less* is one such case. The project, which has been lauded on the national level, winning the Federation of Canadian Municipalities' Sustainable Communities Award, is based in Summerside, Prince Edward Island, a community of approximately 15,000 people. This adds yet another facet to this case: how and why did this small city, operating with limited capacity and resources, launch a successful, nationally-recognized smart grid project? By conducting a case study on *Heat for Less*, my thesis aims to shed light on this question.

1.4.2 Overview and research question

Summerside is located in Prince County, Prince Edward Islance (PEI). As the sole shareholder of Summerside Electric, the City of Summerside enjoys a close relationship with its electricity utility. In 2009, the City of Summerside commissioned a 12 MW wind farm (City of Summerside, 2012a). Between this wind farm and the Summerside Electric's existing power purchase contracts, the utility found itself sometimes over-supplied with electricity; which is to say, the supply of electricity outstripped local demand. Unable to store this electricity, Summerside Electric began exporting this power to New Brunswick Power, a large utility based in neighbouring New Brunswick.[1] This arrangement was not ideal, as the excess power was sold to New Brunswick Power at a rate of \$0.04/kWh despite having been purchased from the City of Summerside at a rate of \$0.08/kWh (City of Summerside, 2012a, 2012b).

Figure 1 Summerside, PEI (Image credit: Google Maps)

To avoid incurring losses on exported electricity, Summerside Electric piloted *Heat for Less*, a program in which smart electric furnaces and hot water tanks, sold to community residents, are "charged" when excess electricity is available. These appliances, linked to the utility via a fibre

[1] These events are detailed in Chapter 4, and have been well documented in news media. See, for example, http://www.cbc.ca/news/canada/prince-edward-island/summerside-seeking-more-wind-energy-profits-1.1284049 (accessed 10 April 2014).

network, receive and transmit signals, enabling the utility to track appliance use and determine when charging is required (City of Summerside, 2012c; Hughes, 2012).

In addition to providing program participants with a low-cost[2] heating option, *Heat for Less* has provided Summerside Electric with a new, more favourable market for its excess electricity. Further, *Heat for Less* has worked to significantly curb the carbon footprints of program participants, given that participants, now heating with electricity, consume up to 80% less oil (the heating fuel used by the majority of Islanders) (City of Summerside, 2012b; Hughes, 2012).

Following its initial pilot phase, City Council voted in favour of a city-wide project roll-out. The program is capable of sinking up to 8,500 MWh annually. As of October 2013, Summerside Electric had deployed enough smart appliances to absorb approximately 4,000 MWh annually (Interview: 1). Looking more closely at this smart grid project, my thesis asks how and why did *Heat for Less* transition into the mainstream?

1.5 Chapter outlines

Following this chapter, in which I discussed the background of and rationale for my thesis, and stated my research question, I review the literatures on Canadian smart grids and sustainability transitions. Noting the gaps in the current discourse on Canadian smart grid case studies, I discuss how incorporating frameworks from the sustainability transitions literature could bring new insights to Canadian smart grid case study research. Further, in reviewing the literature on sustainability transitions, I arrive at my three sub-questions.

In Chapter 3, I discuss my research method: the case study. Here, I introduce this method, and respond to common criticisms. In this chapter I also discuss my research design, discussing my phased approach to data collection and analysis. Finally, I close this chapter by discussing how I have taken steps to ensure my research is both valid and reliable.

My results are presented in Chapter 4. As I outline in Chapter 3, the case study *is* the result of my study, insomuch as it is presented in narrative form, using data collected through semi-structured interviews and document analysis. These original findings situate *Heat for Less* in the broader historical context of electricity and electricity policy on PEI and in the Maritimes.

[2] Relative to the price of furnace oil (City of Summerside, 2012c).

Chapter 5 reflects on the results presented in Chapter 4, applying a suite of theoretical frameworks from the sustainability transitions literature to this case. Using these frameworks, I answer the sub-questions introduced in Chapter 2. In analyzing the results presented in Chapter 4, I discuss how these complementary frameworks contribute to my understanding of the *Heat for Less* case.

I present my conclusions in Chapter 6. Here, I briefly review my findings, discuss the various implications that flow from these findings, and offer recommendations for future research.

Chapter 2: Literature review

2.1 Introduction

As discussed in the previous chapter, my research is interested in examining how and why Summerside Electric's *Heat for Less* transitioned into the mainstream. This question is interesting to me because this case stands as an anomaly in many ways. As will be reviewed later in this chapter, there are many ongoing smart grid projects in Canada. However, relatively few of these projects have 'graduated' from the pilot stage and been integrated into the regular operations of electricity utilities (CanmetENERGY, 2013). Why is this? Conversely, what lessons might *Heat for Less*, as a smart grid that has transitioned into the mainstream, hold for budding Canadian smart grid projects?

This question touches upon two areas of study. The first concerns itself with Canadian smart grids. The second concerns itself with technology transitions – the study of how technologies modify or supplant each other. Anchored to these two areas of study, I will conduct a literature review, highlighting key texts and debates. The literature reviewed will ultimately inform how I approach my research question.

This chapter is organized as follows. First, I will review the literature on smart grids, beginning broadly then focusing on the Canadian smart grid landscape. In addition to outlining the state of smart grids in Canada, this section will pay attention to how these smart grid projects have been studied, so as to provide insights into how I might proceed in my study of *Heat for Less*. I will also be interested in identifying gaps in the research.

Second, I will review the literature on technology transitions, focussing on theories that examine or model transitions in the energy sector. With regards to these theories, I am particularly interested in frameworks that cast light on the features and processes that promote technology transitions, so as to better understand how *Heat for Less* transitioned into the mainstream. Here, too, I will be interested in identifying gaps in the research.

Finally, this chapter will close by discussing how my study might address the identified research gaps, contributing original and valuable insights to both of these literatures.

2.2 Smart grids: an overview

Smart grids have been defined in different ways. A definition commonly put forward in European circles characterizes smarts grids as "electricity networks that can intelligently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies".[3] The Ontario Smart Grid Forum explains smart grid as a systems that uses "communications, sensors, automation and computers to improve the flexibility, security, reliability, efficiency, and safety of the electricity system".[4] By contrast, the United States Department of Energy, in its definition of smart grids, provides a list of system features, stating that smart grids "self-heal from power disturbance events; enable active participation by consumers in demand response; operate resiliently against physical and cyber attacks; provide power quality for 21st century needs; accommodate all generation and storage options; enable new products, services, and markets; optimize assets and operate efficiently".[5] Natural Resources Canada (NRCan) avoids the trap of trying to precisely define a smart grid by laying out the challenge: "[t]he very definition of smart grid requires a conversation because it is not a specific system design. A common way of describing smart grid is through applications that deliver services to operators and users of smart grid systems" (NRCan, 2012). NRCan goes on to list the following applications as the most common component technologies present in Canadian smart grids (Ibid., p.1):

- Advanced metering;
- Dynamic pricing;
- Wholesale demand response;
- Direct load control;
- Fault detection, isolation and restoration;
- Planned islanding; and
- Voltage control

[3] This quote comes from the Smart Grids: European Technology Platform, a public-private stakeholder group funded in part by the EU's framework Programmes 6 and 7, which conducts research on smart grid technologies. See http://www.smartgrids.eu/ETPSsmartGrids (accessed 21 February 2014). http://ieso-public.sharepoint.com/Documents/smart_grid/Smart_Grid_Forum-Report.pdf (accessed 19 May 2014).
[4] See the Ontario Smart Grid Forum's report entitled Enabling Tomorrow's Electricity System.
[5] United States Department of Energy: Smart Grid Primer. http://www.doe.energy.gov.smartgrid.htm (accessed 21 February 2014).

Applications such as those listed above are made possible by an electricity system upgrade. This upgrade, the so-called ‘smartening’ of the electricity grid, refers to the introduction of information and communication technologies (ICT) onto the electricity grid. These technologies are typically used to enable the measuring of actual upstream output and downstream consumption in real-time (Clastres, 2011; Faruqui, Harris, & Hledik, 2009; Johnson, 2010; Stephens, 2013). This new capacity to monitor grid activity in real-time has been put to use to achieve different ends.

In the United States, smart grid development has been framed as a means of enhancing grid reliability and resilience in the face of aging infrastructure (Chopra, 2011; Giles, 2010). Furthermore, US grid modernization efforts are often framed in terms of job creation; smart grid projects being a major recipient of post-2008 US fiscal stimulus spending (Giordano et al., 2011). By contrast, in developing countries, smart grid development is driven by a need to keep pace with rapid urbanization and as a means of improving reliability. These drivers, for example, incited Brazil to invest US$204 million in smart grid development in 2010, while China, in the same year, invested US$7.3 billion in national smart grid projects (Giles, 2010). Further, smart grid investments are also pitched as cost-saving measures. The Electric Power Research Institute estimated that an investment of $338 billion for a fully functional smart grid could result in benefits of up to US$2 trillion in the US (2011). Faruqui et al. (2009) also estimated that €67 billion for building and running peak infrastructure could be avoided if dynamic pricing was adopted in the EU.

Aside from the drivers listed above, many instances of smart grid development are driven by a desire to make energy systems more environmentally sustainable (Chopra, 2011; Giordano et al., 2011; IEA, 2011, 2012). In addition to creating a more economically efficient and reliable electricity system, system operators (and the states which sometimes fund them), led by one or more of corporate social responsibility, national environmental agendas, international commitments and public pressure, are driven to modernize electricity systems in ways that minimize greenhouse gas emissions. Real-time signals enable operators to optimize the use of intermittent renewables, immediately feeding energy into the grid as it becomes available (IEA, 2011). Across North America, Western Europe and South-east Asia, smart grids figure strongly into the national policies of countries intent on improving system efficiencies and the integration of renewables in state electricity grids (CRE, 2010).

The International Energy Agency is supportive of such 'green' agendas, stating that smart grids have the potential to contribute to significant direct greenhouse gas reductions (IEA, 2010). These reductions are related to changes in the way electricity is used, lowering grid losses and facilitating the deployment of energy-efficiency schemes such as peak-hour demand management. As well as reductions directly related to smart grids, other indirect cuts may be achieved thanks to the integration of plug-in electric vehicles, storage and renewable-energy sources (IEA, 2010, p.153). Given this potential for increased sustainability in the electricity sector, the IEA has incorporated widespread smart grid integration into its scenario modelling,

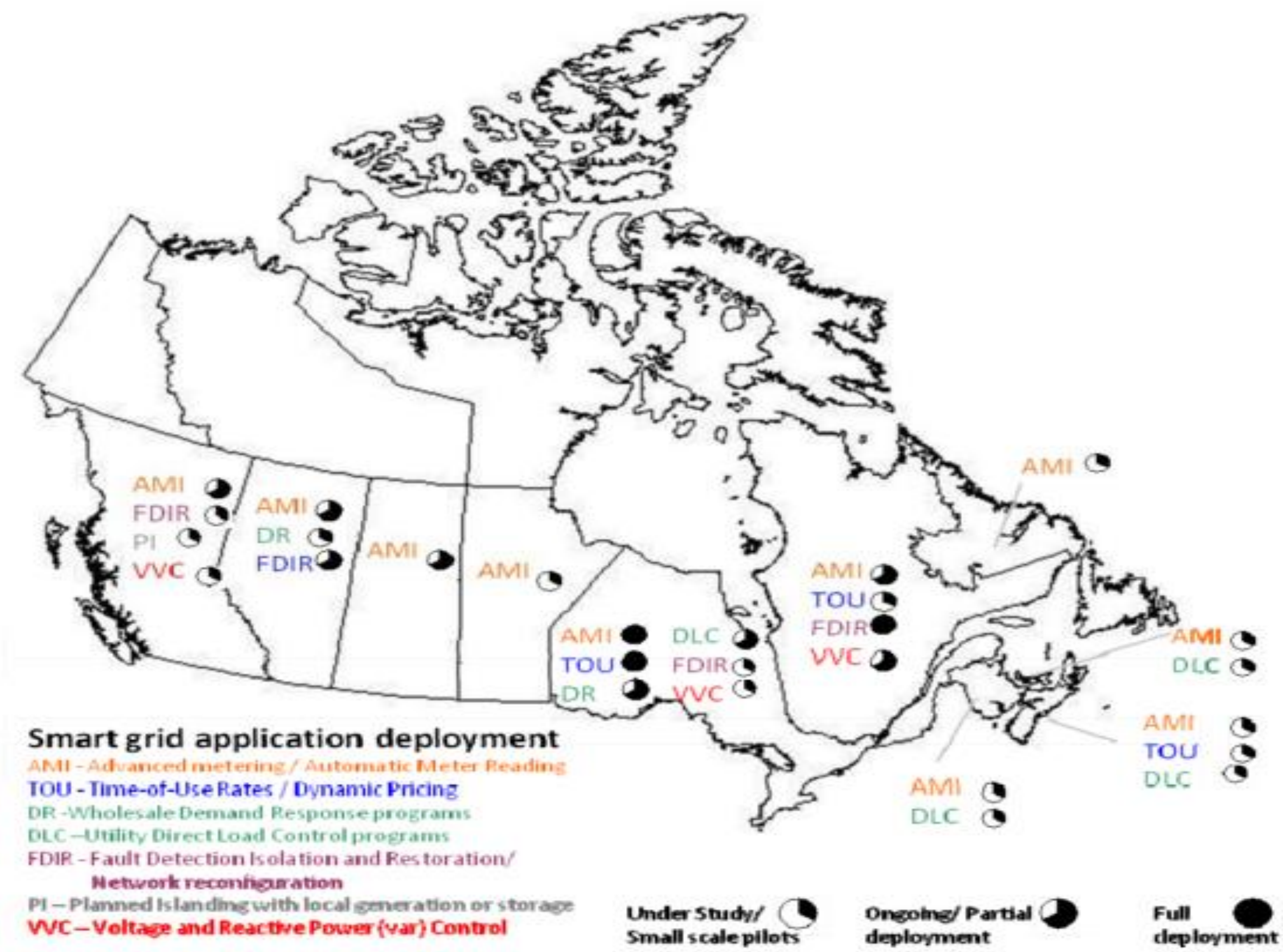

Figure 2 Smart grid deployment in Canada (CanmetENERGY, 2013)

and has urged world leaders to continue investing in the development and deployment of these technologies so as to reap the projected benefits (IEA, 2012).

2.3 Canadian smart grids

CanmetENERGY reports that every Canadian province is home to at least one smart grid project (2013). There is considerable variety among these projects. As the governance of electricity is a matter of provincial jurisdiction in Canada (s. 92A, Constitution Act), there is no national smart grid strategy or roadmap. (This said, the federal government is an important funder of smart grid projects; through the Clean Energy Fund and the ecoEnergy Innovation Initiative, the federal government has contributed millions of dollars to advance smart grid research and development in Canada (CanmetENERGY, 2013).) Nor is there a consensus model of what a smart grid 'looks like' in Canada. This reality may be a reflection of the immaturity of this technology in Canada, in that many actors in the electricity sector have not moved beyond the experimentation phase, and therefore have not committed to one particular smart grid application over another (NRCan, 2012). Further, smart grids, in that they are add-on technologies, are designed to respond to (or enhance) a particular aspect of an electricity system. In this way, the diversity among Canadian smart grid projects is reflective of the diversity that exists among Canadian electricity grids in terms of supply mix, geography and climate, status of existing infrastructure, provincial organizational structures and legislation, and political and business priorities (IESO, 2011).

The map above (Figure 2) illustrates how project 'types' differ from province to province. Note also the diversity in terms of project maturity, with some projects having reached full deployment while others (the majority of projects) remain in the pilot stage. One constant on this map, though, is advanced metering (AMI) – a smart grid application present in every province. This should not come as a surprise in that advanced metering (sometimes called 'smart meters') provides utilities with real-time electricity consumption data, a capacity that underpins many other smart grid applications (IEA, 2011). The widespread deployment of advanced metering across Canada should not be conflated with national consensus on or public acceptance of this technology. Not all provinces, for instance, have made use of advanced metering to implement time-of-use schemes (compare, for instance, Ontario and Quebec, or

Ontario and British Columbia). Further, research indicates that public perception of advanced metering differs significantly across Canadian provinces, and is at least partially tempered by how the roll-out of these projects is reported and framed by the media.[6]

As noted above, beyond advanced metering, smart grid projects have developed in different ways across Canada, responding to the needs and priorities of local systems. For reasons of experimentation and learning, this emerging patchwork of experiments is to be welcomed (IESO, 2011). Lessons, it can be assumed, will be learned as utility operators experiment with and engage in a variety of smart grid research & development and demonstrations. However, without adequate means and ongoing efforts to share best practices, the lessons learned from smart grid experimentation risk benefiting only those directly involved.

In most free market contexts this would not be problematic. Indeed, a level of secrecy typically surrounds corporate research & development, as the fruits of these processes sometimes translate into competitive advantage in the marketplace. I would argue that this approach and attitude is inappropriate in Canada's electricity sector for two reasons. First, Canada's electricity landscape is characterized by natural monopolies – with one utility per service area, Canadian electricity service providers enjoy very little (if any) direct competition.[7] As such, there is little to be lost (in terms of market share) from sharing lessons learned from smart grid experimentation amongst electricity utilities.[8] Second, insomuch as smart grids can create economic efficiencies *and* reduce environmental impacts (by facilitating energy conservation via demand management, for example), the value of the smart grid extends beyond the private realm and into the public sphere, placing a special responsibility or social obligation on

[6] For comprehensive analyses of Canadian perceptions of advanced metering, see the research of Derek Peters; Xavier Deschenes-Philion and Maya Jegen; and Alexandra Mallett, Ryan Reiber and Danny Rosenbloom. https://uwaterloo.ca/sustainable-energy-policy/projects/unlocking-potential-smart-grids-partnership-explore-policy (accessed 24 February 2014).

[7] "Direct" is taken to mean that there are no competing electricity service providers. This is not to say that there are not competing *energy* service providers that compete in the same market. For example, natural gas providers compete with electricity utilities in many provincial residential heating markets. This blurring of traditional market delineation is discussed in relation to *Heat for Less* in subsequent chapters.

[8] Who, then, should bear the costs of research & development if 'freeloaders' could potentially reap the rewards of these investments? This question, too, will be examined in the subsequent chapters as *Heat for Less* was financed through a combination of municipal, provincial and federal funds.

electricity utilities. For these reasons, there is a need to disseminate the results of smart grid experimentation.

2.4 Canadian smart grid research

There are platforms designed to share smart grid experiences in Canada. To date, though, academics have not positioned themselves as leaders in terms of reporting on Canadian smart grid projects. The few published academic studies on Canadian smart grids tend to pre-date the actual project, modelling potential outcomes should the project move forward.[9] The lack of peer-reviewed research conducted on Canadian smart grids might be due to the relative novelty of this area of research; as 90% of Canadian smart grids were launched after 2009, Canadian smart grid research remains a relatively new area of study (CanmetENERGY, 2013).

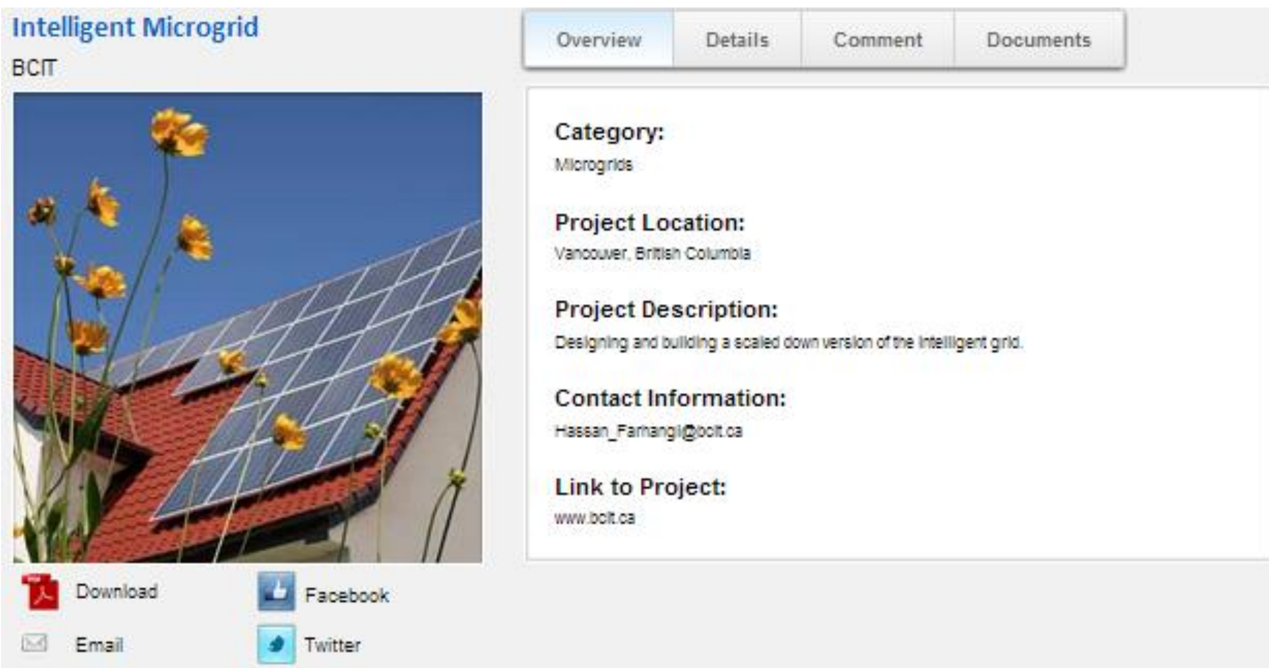

Figure 3 Screenshot of SmartGrid Canada's repository (http://sgcanada.org/repository/)

Not-for-profits, on the other hand, have made efforts to build networks and share knowledge among actors involved in Canada's burgeoning smart grid sector. SmartGrid Canada is Canada's

[9] See, for example, Paull, L. et al., "A Novel Domestic Electric Water Heater Model for a Multi-objective Demand Side Management Program" or Moffet et al., "Études de cas: L'équilibrage de la production éolienne à l'aide d'accumulateursthermiques et de chauffe-eau électriques," two academic studies which model smart grid applications currently being piloted in New Brunswick and Ontario, respectively.

foremost national industry organization that works to promote smart grid development and deployment in Canada.[10] To this end, SmartGrid Canada holds an annual smart grid conference which is described as "[a] place and a time for utilities, industry, policy makers and regulators to come together to discuss the challenges and opportunities in modernizing Canada's electricity infrastructure".[11] In addition to organizing this conference, SmartGrid Canada also hosts a smart grid repository on its website which profiles an array of Canadian smart grid projects. This repository, in that it centralizes information on Canadian smart grids, is an important resource insomuch as it facilitates knowledge sharing, providing interested parties with a survey of the Canadian smart grid landscape (for an example of a repository entry, see Figure 3 above). Repository entries, however, tend to be brief, making the repository into more of a Canadian smart grid directory than a comprehensive case book.

Similarly, Quality Urban Energy Systems of Tomorrow (QUEST), a not-for-profit that specializes in community energy planning, has profiled numerous Canadian smart grid projects.[12] In the case of QUEST, smart grids are among the organization's field of interests, but not to the exclusion of other non-smart grid community energy projects, such as innovative waste and water treatment plants. Similar to SmartGrid Canada, the profiles of smart grids on QUEST's website are brief, sometimes consisting of only a few sentences.

Some private firms have also documented Canadian smart grid projects, such as IBM. IBM, a longstanding leader in the technology hardware sector, contributed to the planning and deployment of portions of Ontario's advanced metering infrastructure. A summary of this work is available on IBM's website.[13]

Government agencies have conducted detailed case studies of Canadian smart grids. CanmetENERGY, a division of NRCan, has published several Canadian smart grid case studies.[14]

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[10] SmartGrid Canada. http://sgcanada.org/info/about-us/ (accessed 24 February 2014).
[11] SmartGrid Canada. http://smartgridcanadaconf.ca/2014/ (accessed 24 February 2014).
[12] See http://www.questcanada.org/themap for a map of the projects profiled by *QUEST* (accessed 28 February 2014).
[13] For a review of the *IBM-Hydro One* advanced metering project, see http://www.ibm.com/smarterplanet/ca/en/smart_grid/examples/ (accessed 28 February 2014).
[14] For a list of these case studies, see http://www.nrcan.gc.ca/energy/offices-labs/canmet/publications/13607 (accessed 26 February 2014).

These case studies include, among others, analyses of PowerStream's fault detection, isolation and restoration (FDIR) project; and Powershift Atlantic's virtual power plant. These two case studies are representative of CanmetENERGY's research on Canadian smart grids in that they are similarly organized: introduce a project, list its main features, discuss lessons learned and best practices – all within five to ten pages. CanmetENERGY's case studies also feed into the IEA's efforts to aggregate smart grid case studies from around the world into a casebook, a key part of the work of the Agency's International Smart Grid Action Network project.[15] These case studies, though, are not publicly accessible.

Each of these platforms for Canadian smart grid knowledge-sharing is important and valuable, however the above review reveals the limitations of this literature. First, aside from the few government case studies, the literature on Canadian smart grids does not offer in depth analysis of ongoing projects. Rather, the majority of these "case studies" might be better characterized as project profiles, listing basic features without rigorous analysis of why these features are appropriate or how they function. While government case studies are certainly more thorough than those offered by the not-for-profits, these reports are not methodologically rigorous insomuch as little in the way of *how* case studies are carried out is relayed to the reader. Not being forthcoming with regards to how case studies are conducted compromises the rigour of these studies and makes comparison challenging (Yin, 2003).

Second, the literature on Canadian smart grids is marked by a focus on technology. This should not come as a surprise as the electricity sector is typically examined from an engineering perspective. Though this perspective may speak to the professional make-up of this sector, this approach neglects the many aspects of smart grid development that fall outside the realm of technical performance, such as political considerations and business case development. The IEA, in its 2011 report on smart grids, called for the creation of an inventory of "*detailed* case studies to gather the lessons learned from such projects, *particularly in the areas of policy, standards and regulation, finance and business models, technology development, consumer engagement and workforce training*" (IEA, 2011, p. 20, emphasis added). By focusing

[15] For a list of the countries contributing case studies to ISGAN, see http://www.iea-isgan.org/?c=2/27/29 (accessed 28 February 2014).

exclusively on the technical aspects of Canadian smart grids, these case studies, perhaps inadvertently, dismiss a range of other non-technical factors that affect smart grid development.

Third, the literature on Canadian smart grids focuses on the 'present-state' of projects, forgoing the examination of the transitional process projects undergo: research & development and demonstration (or piloting). While there is a natural inclination to capture a project 'as it is', it is equally important to understand how it 'got to be that way'. It has been argued that this early transitional period is very important as new innovations typically encounter many barriers to growth, such as low (or no) market demand, public unfamiliarity with the new technology, and lack of institutional and regulatory support (Geels, Hekkert, & Jacobsson, 2008). As few Canadian smart grids have transitioned into the mainstream, a stronger understanding of the transitional process could prove insightful to utility managers and policy makers. Yet case studies which examine the historical trajectory of Canadian smart grids are absent from the literature.

Academic research on Canadian smart grids could potentially contribute to the current discourse in important ways. As the literature on Canadian smart grids is dominated by grey literature (i.e. non-peer reviewed content), in depth, methodologically rigorous, critical analysis would be a potentially useful contribution to this area of study. As identified above, the technological focus of the existing literature presents an opportunity for interdisciplinary or multidisciplinary researchers to bring new perspectives to the study of Canadian smart grids. Following the suggestions put forward by the IEA, these new perspectives might broaden the discourse so as to include aspects of smart grid development that have been neglected, such as policy consideration, finance and business models, and consumer engagement. The final identified gap – the focus on the 'present-state' – could also be studied more closely by academic researchers, as there are many theoretical frameworks used to study technology transitions. As the majority of Canadian smart grids remain in the demonstration phase (CanmetENERGY, 2013), a firmer understanding of this transitional process (i.e. how and why transitions occur) could be of great value to utility managers and provincial governments interested in developing and scaling smart grids.

By seeking to understand how and why Summerside Electric's *Heat for Less* transitioned into the mainstream, I am responding to the gaps identified above. My study will make use of theoretical frameworks to better understand the transitional process. Which framework(s) is/are best suited to this task? The following section seeks to answer this question by reviewing the literature on sustainability transitions, focusing on frameworks that have been used to examine the energy sector as well as the methodologies used by researchers who have 'operationalized' these frameworks so as to examine real world events.

2.5 Sustainability transitions

We face complex sustainability challenges in many domains, including depletion of natural resources, ocean acidification, declining biodiversity and climate change (UNEP, 2012). In light of these so-called wicked problems, researchers have grown increasingly interested in sustainability transitions: long-term, fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption (Markard et al., 2012).

Energy systems have been made the focus of many sustainability transitions studies. The transitions approach to energy planning has been endorsed by national governments in the Netherlands, Finland, the United Kingdom and Austria (Patwardhan et al., 2012). International energy research organizations, such as the International Institute for Applied Systems Analysis (IIASA), have also begun appreciating the usefulness of the frameworks developed by sustainability transition scholars. The IIASA's Global Energy Assessment (GEA), for instance, devotes a chapter to energy transitions, noting that energy systems are "as much affected by policy and institutional issues as they are by technological and systemic ones" (GEA, 2012, p.1193). As the report states, the study of energy transitions is an active area of study, and many conceptual frameworks have been developed for the study of these processes.

In a systematic review of the literature on sustainability transitions, Markard et al. (2012) identified the four most prominent frameworks used by sustainability transitions scholars. These include transition management (Kern and Smith, 2008; Loorbach, 2010; Rotmans et al., 2001), strategic niche management (Kemp et al., 1998; Raven and Geels, 2010; Smith, 2007), the multi-level perspective on socio-technical transitions (Geels, 2002; Geels and Schot, 2007;

Smith et al., 2010) and technological innovation systems (Bergek et al., 2008; Jacobsson and Johnson, 2000; Hekkert et al., 2007).

As Figure 4 shows, there is a great deal of overlap and interconnectedness among these frameworks. A concept that is central to all of these frameworks is that of the socio-technical regime. Drawing on insights from history, economics and sociology of technology, this idea highlights the notion that scientific knowledge and engineering practices are intertwined with the expectations and skills of technology users, with institutional structures, and with broader infrastructures (Kemp et al., 1998). The core idea behind the regime is that it imposes a logic and direction for incremental socio-technical change along established pathways of development. Given the interest in disrupting these regimes, much of the early research sought to better understand regime transitions (Kemp, 1994; Schot, 1992; Schot et al., 1994). Here, another key concept emerged – that of the niche. Niches are "protected spaces in which radical innovations can develop without being subject to the selection pressure of the prevailing regime" (Kemp et al., 1998 quoted in Markard et al., 2012, p. 957).

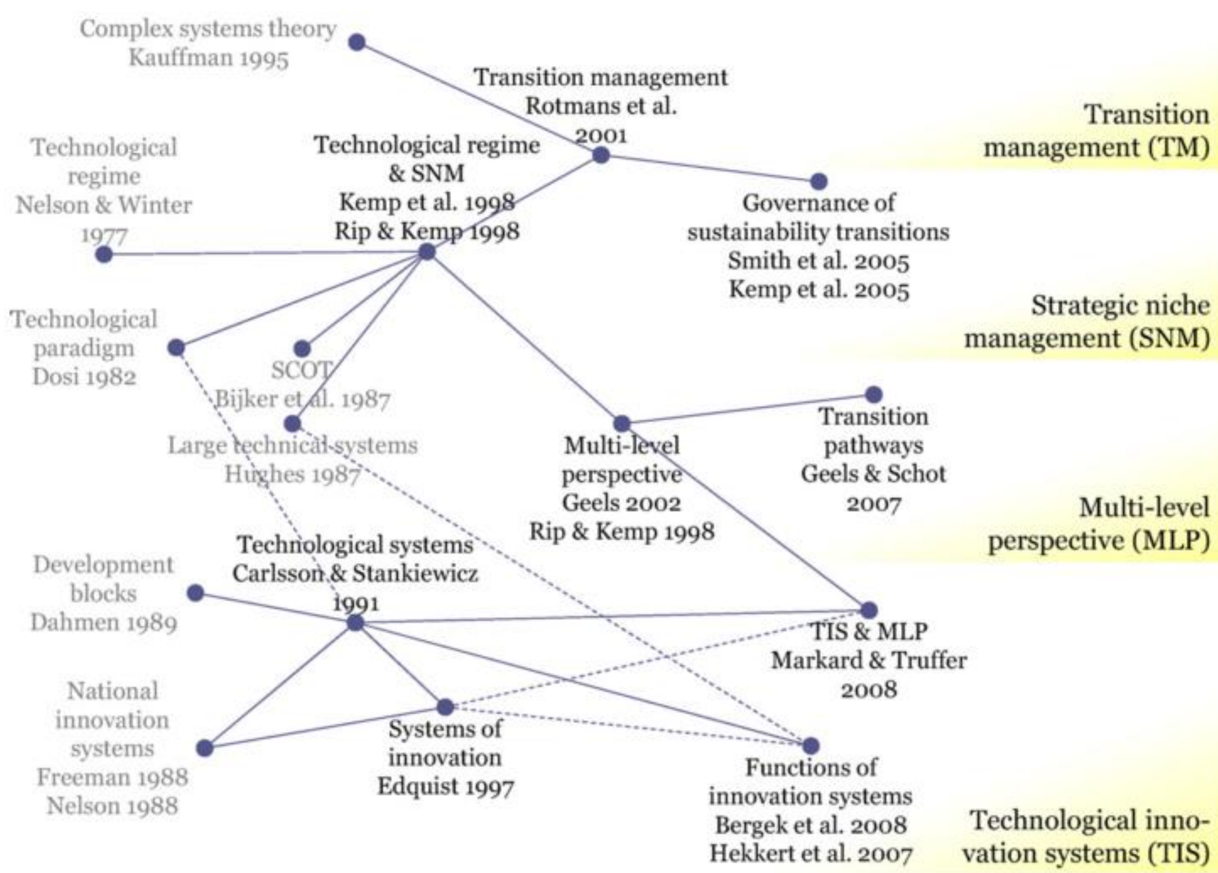

Figure 4 Map of key contributions and core research strands in the field of sustainability transitions (Markard et al., 2012)

The idea that regime shifts (transitions) result from the emergence of niche alternatives was the impetus behind the development of strategic niche management (SNM), a framework that examines how particular actions and processes (called "internal niche processes") influence the development of a niche. In relation to the three other frameworks identified by Markard et al., the SNM framework is best suited to my purposes in that it focuses on how and why niche technologies transition into the mainstream, aligning with my research agenda of studying how and why Summerside Electric's *Heat for Less* (a niche project) transitioned into the mainstream.

While it could be argued that *Heat for Less* was created as a post facto strategy designed to minimize operational losses, the project ultimately acquired sustainability-oriented dimensions. As such, the sustainability transitions frameworks described below will be used as heuristic devices: assisting in the analysis of a phenomenon through theoretical constructions developed through the literature. The following section reviews the literature on SNM in greater depth, relating it to my analysis of the *Heat for Less* case.

2.6 Strategic niche management (SNM)

As discussed above, SNM was proposed as a means of actively fostering particular internal niche processes so as to enable niche technologies to proliferate (Kemp, Schot, & Hoogma, 1998). In its earliest iteration, Kemp et al. (1998) defined SNM as,

> the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the further development and the rate of application of the new technology (Kemp et al., 1998, p.186).

Through the creation of such protected spaces, Kemp et al. (1998) argued, promising technologies are given the chance to develop from an idea or pilot project into a technology that is actually used. This final piece –the actual *use* of the technology– was critical for Kemp et al. (1998) as it was argued that through the use of niche technologies (e.g. demonstration in a pilot project) expectations would be articulated, networks would begin to be established, and learning would occur – all of which would contribute to the transition of the niche technology into the regime.

While early SNM scholars (e.g. Kemp et al., 1998) conceived of it as a future policy tool, later researchers (e.g. van der Laak, 2007; Konrad et al., 2008; Verbong et al., 2013) built off of the identified niche processes –articulating expectations and visions, networking, and learning– as means of understanding (and evaluating) niche development. These internal niche processes were later refined (Elzen, Hoogma & Schot, 1996; Schot & Geels, 2008, p. 540), and expressed as follows:

1. The articulation of **expectations and visions**. Expectations are considered crucial for niche development because they provide direction to learning processes, attract attention, and legitimate continuing protection and nurturing.
2. The building of **social networks**. This process is important to create a constituency behind the new technology, facilitate interactions between relevant stakeholders, and provide the necessary resources (money, people, expertise).
3. **Learning** processes at multiple dimensions:
    a. Technical aspects and design specifications
    b. Market and user preferences
    c. Cultural and symbolic meaning
    d. Infrastructure and maintenance networks
    e. Industry and production networks
    f. Regulations and government policy
    g. Societal and environmental effects

The internal niche processes listed above can be thought of as hypotheses: should these processes occur, the more likely it is that the niche will experience development, moving from the technological niche to the market niche and finally to regime shift (Figure 5).

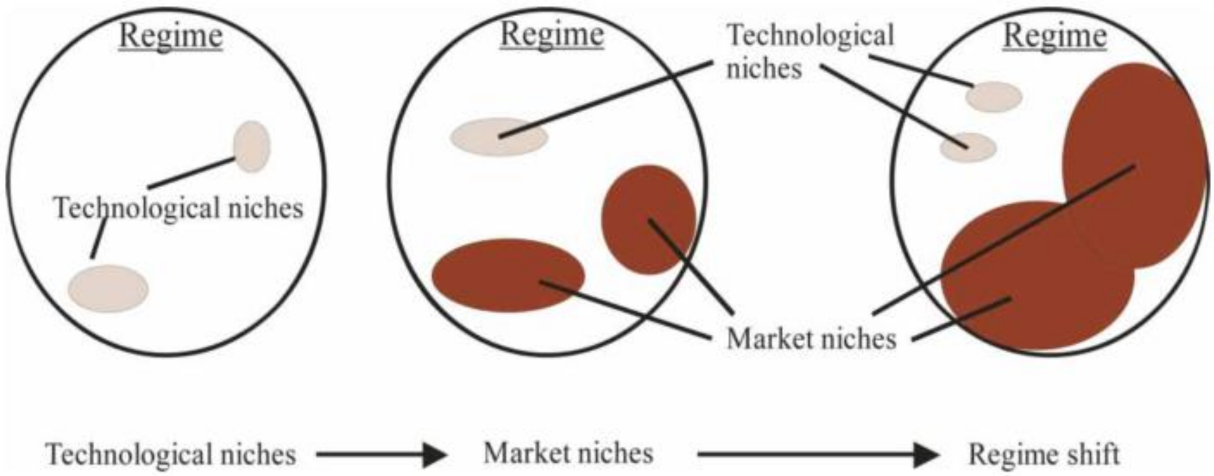

Figure 5 From niche dynamics to regime shift (Schot & Geels, 2008)

Subsequent SNM studies have largely been interested in testing (and then refining) these hypotheses by conducting empirical case studies. Important studies in this field include the case book edited by Hoogma et al. (2005) on sustainable transport, the research of van der Laak et al. (2007) on biofuel use in Western Europe, the research of van Eijick & Romijn (2008) on biofuel use in rural Tanzania, and finally the research of Verbong et al. (2013) on smart grids in the Netherlands. In all of the studies cited above, data are collected by conducting semi-structured interviews so as to gather information pertaining to whether, how, and why project insiders fostered or inhibited internal niche processes, and the resulting outcomes.

Interestingly, the findings from many of these studies focus on explaining the limited success of the experiments studied. This, according to Schot & Geels (2008), is not to say that the hypotheses regarding internal niche processes are necessarily flawed, but rather that by focusing exclusively on the niche, the researcher neglects the other levels of activity that influence niche development. For this reason, Schot & Geels (2008) suggest pairing SNM with a framework that was developed in parallel: the multi-level perspective.

2.7 Multi-level perspective (MLP)

As Figure 4 (p.19) shows, the multi-level perspective (MLP) was developed shortly after SNM, drawing on the same foundational literature. The idea of the regime and niche are preserved, but in the MLP these ideas are conceptualized as distinct levels existing in a nested hierarchy (Geels, 2002, 2005). Further, the landscape, a macro-level beyond the direct influence of niche and regime actors (e.g. macro-economics, deep cultural patterns, macro-political developments) is added to the framework. The core notion of the MLP is that "transitions come about through interactions between processes at different levels: (a) niche innovations build up internal momentum, (b) changes at the landscape level create pressure on the regime, (c) destabilisation of the regime creates windows of opportunity for niche innovations" (Schot & Geels, 2008, p.545, see Figure 6 below). The problem with the strict use of SNM, proponents of the MLP argued, is that it ignores (b), neglecting the activity occurring outside of the niche that might influence the stability or 'receptiveness' of the regime to socio-technical transitions (Ibid., 2008).

Geels, the creator of the MLP, is careful to note that this framework is a heuristic device, rooted in the interpretive tradition, meaning the MLP should not be understood as a deterministic "machine" (Geels, 2011). Instead, the MLP is meant to "guide the analyst's attention to relevant questions and problems… appropriate application [therefore] requires both substantive knowledge of the empirical domain and theoretical sensitivity (and interpretive creativity) that help the analyst 'see' interesting patterns and mechanisms" (Ibid, p.34).

Many researchers have made use of the MLP to 'see' and discuss patterns and mechanisms that affect sustainability transitions. Early MLP studies focused on historical transitions, relying on document analysis and archival research to analyze past socio-technical transitions, such as the transitions from sailing vessels to steamships (Geels, 2002), and from cesspools to sewer systems (Geels, 2005).

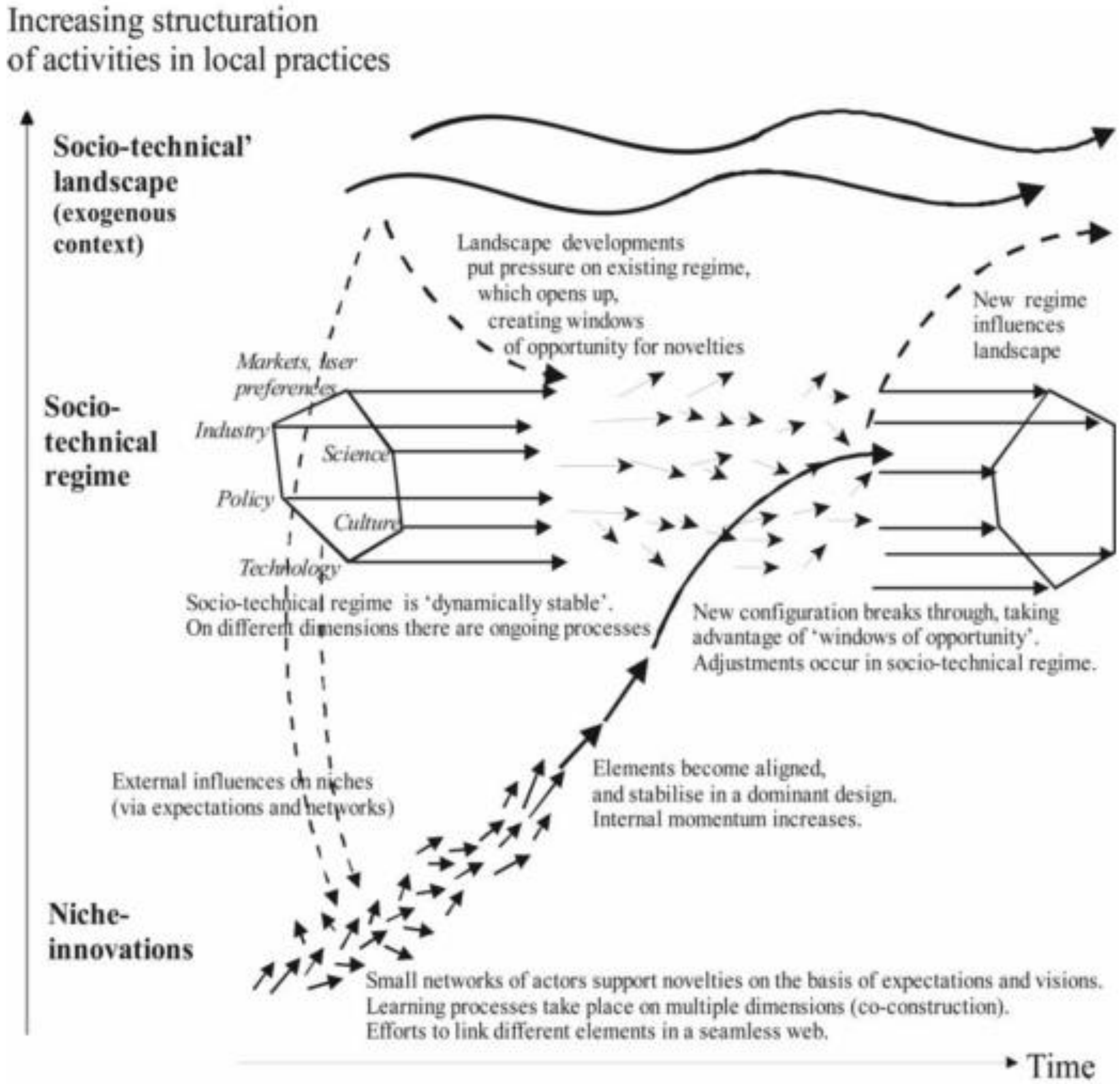

Figure 6 The multilevel perspective on transitions (Schot & Geels, 2008)

In this respect the work of Verbong and Geels (2007), having used the MLP to analyze the Dutch electricity system (1960-2004), marked an important development in MLP research in that it demonstrated how the framework could be used to examine relatively contemporary sustainability issues. In a similar vein, Rosenbloom and Meadowcroft (2014) used the MLP to conduct a historical analysis of Ontario's electricity sector (1885-2013). Here, too, historical study is pushed toward the analysis of contemporary, and ongoing, events and policies.

Noting this contemporary push, researchers began experimenting with new methods in order to incorporate new types of data into MLP analyses. For example, van Bree et al. (2009) used the MLP to analyse the European automobile market, focusing on the electric and hydrogen vehicle niche. Based on these findings, van Bree et al. (2009) created scenarios, forecasting how these markets might develop. Semi-structured interviews have also been used by researchers interested in incorporating 'live' data into MLP analyses. For example, Mah et al. (2012) conducted interviews with electricity sector stakeholders to inform an MLP analysis of smart grids in South Korea. Similarly, Hiscock (2012) used interview data to inform an MLP analysis of electricity storage in Ontario.

In the above cases, the MLP was used as a heuristic device to frame an investigation into the experiences of niche technologies. A quick review of the subject matter analyzed in the articles cited above reveals a propensity for using the MLP to study the energy sector, and in particular the electricity sector. Reflecting on this, Verbong & Geels (2010) expanded on the MLP framework by proposing a typology of 'pathways', or ways that transitions tend to occur in the electricity sector. The literature on these pathways is detailed in the following section.

2.8 Transition pathways

The notion of transition pathways emerged as a means of expanding upon the bottom-up (see (a), (b), (c) on p.22) transition process early MLP researchers tended to favour. Geels & Schot (2007) observed that this sequence does not adequately explain the types of transitions that occur in large infrastructural systems characterised by stability and lock-in. This idea was later expanded upon by Verbong & Geels (2010), relating it specifically to the electricity sector. "The sunk investments in technologies (power plants, cables and lines, transformer stations etc.), skills, social networks and belief systems," argued Verbong & Geels, "complicate a swift shift to completely new systems" (2010, p.1214).

This said, transitions *do* occur in these types of systems; but they tend to do so in ways that do not match the bottom-up narrative associated with early MLP research. In light of these differences, Verbong & Geels proposed a typology of transition pathways that distinguishes four ideal-typical paths, based on different *kinds* and *timing* of multi-level interactions. Here, the kind refers to the relation between niche-innovations and landscape pressures with the regime (reinforcing or disruptive). On the other hand, timing refers to whether niche-innovations are fully developed when changes at the landscape level affect the regime. Verbong & Geels define the four pathways as follows:

1. **Transformation path**: This occurs when actors in the existing regime modify the direction of development paths and innovation activities in response to moderate landscape pressures and niche-innovations are not yet sufficiently developed
2. **Reconfiguration path**: This occurs when groups of innovations, developed in niches, are initially adopted in the regime to solve local problems, and subsequently trigger further adjustments in the basic architecture of the regime
3. **Technological substitution**: This occurs when a disruptive change or shock(s) at the landscape level destabilizes the existing regime, and enables previously developed niche-innovations to break through and replace the existing regime
4. **De-alignment and re-alignment path**: This occurs when divergent, large and sudden changes at the landscape level lead to de-alignment and erosion of the existing regime, but niche-innovations are not sufficiently developed, and so multiple niche-innovations co-exist and compete for resources until one becomes dominant (Ibid, p.1216)

Verbong & Geels are careful to stress that these pathways are meant to be understood as non-deterministic ideal types, allowing that particular cases may exhibit the characteristics of more than one pathway, or a sequence of pathways (2010).

Scholars have made use of this typology to analyse sustainability transitions. Bree et al. (2009) used this typology to build scenarios for the development of hydrogen and battery-electric vehicles in the Netherlands. Foxon et al. (2010), in turn, used this typology to explore both what a low-carbon electricity sector might look like in the UK, and what steps would be necessary in order to realize this objective. In Canada, Hulbert et al. (2011) used the transition pathways to analyze Saskatchewan's transitioning electricity sector.

In each of these cases, the typology of transition pathways is used in combination with the MLP, serving as a kind of add-on lens. In some cases, as in the work of Bree et al. (2009) and Foxon et al. (2010), the pathways are used to delineate scenarios, or possible pathways into the future. Here, the typology assists researchers interested in projecting into the future, outlining how a system could develop given the presence of particular variables. In other cases, as in Verbong & Geels (2010) and Hulbert et al. (2011), the typology is used to bring new explication to past or ongoing transitions. In both of types of study, the researchers are interested in introducing a theoretical perspective to socio-technical transitions, so as to begin making sense of emerging patterns. Further, the typology is always used as a descriptive tool, not a prescriptive one. In relation to Canadian smart grids, such a tool could provide insights into past or ongoing smart grid transitions, adding sector-specific sharpness to an MLP analysis.

2.9 Synthesis

In the three preceding sections, I reviewed the literature on the suite of frameworks that will inform my analysis of the *Heat for Less* case. These frameworks were selected because they align closest with my research agenda of better understanding why and how *Heat for Less* transitioned into the mainstream. SNM, in that it provides criteria for evaluating the decisions, actions and policies undertaken by actors directly involved in the development of a niche technology, will help me better understand the internal niche processes that propelled *Heat for Less* into the regime. The MLP, in turn, will broaden my scope of analysis, incorporating a greater focus on both regime actors and landscape pressures. In this way, my use of the MLP can be read as a corrective measure, responding to the criticism that SNM studies are overly niche-focused (Genus & Coles, 2008). Finally, the transition pathways work as an add-on lens, providing electricity sector-specific insights into the transition process. Here, too, my incorporation of this framework responds to the criticism that MLP studies betray a bottom-up bias (Berkhout et al., 2003).

As the literature reviewed above shows, each of these frameworks provides insights into the nature of sustainability transitions. While not typically used in conjunction with one another, using these frameworks to conduct a three-part analysis is in keeping with the arguments advanced in the literature: the MLP responding to a shortcoming of the SNM, and the transition pathways adding depth to the MLP. In this way, the frameworks complete each other, creating a more comprehensive view of socio-technical transitions in the electricity sector.

Though I am treading into new ground by using these frameworks together as a package, this three-part analysis will be informed by the methodological traditions present in the literature.

In this way this research builds upon existing research, bringing related traditions together, so as to contribute new insights to the study of socio-technical transitions in the energy sector. The particulars of my methodological approach are detailed in Chapter 3.

2.10 Summary

This chapter has reviewed the literature on smart grids, focusing on studies conducted on Canadian smart grids and identifying gaps in this literature. The gaps in the literature on Canadian smart grids pertain to a need for in depth and methodologically rigorous analytical work on smart grids; a need to broaden the scope of study beyond the current technology focus; and a need to examine the 'micro-histories' of Canadian smart grids, so as to cast light on the transitions that occur in this sector.

These gaps can be addressed by pairing the study of Canadian smart grids with theoretical frameworks that respond to the shortcomings described above. To determine which theoretical frameworks are best suited to this task, I reviewed the literature on sustainability transitions, a growing field that uses theoretical approaches to bring new understanding to socio-technical transitions. My review found that strategic niche management is most suited to my research agenda, as this framework focuses on the actions and policies which propel niche innovations into the regime. As noted in the literature, the multi-level perspective (MLP), a related framework, works to broaden the view of SNM by further highlighting how landscape pressures affect the 'receptiveness' of the regime to niche innovations. Further, the literature discussed how the transition pathways, a kind of companion framework of the MLP, brings yet more depth to the MLP analysis by providing a typology of ideal-type transitions that occur in infrastructure-heavy sectors, such as the electricity sector.

In this way my study of the *Heat for Less* case represents an attempt to bring these two literatures together, pairing the empirical study of an ongoing Canadian smart grid with analytical frameworks that have evolved in the literature over the last 10-15 years so as to gain new insights into the Canadian smart grid landscape. This study, then, aims to contribute to both of these literatures.

In using these frameworks to advance my research agenda, I will refine my question by adding framework-specific sub-questions:

1. How and why did Summerside Electric's *Heat for Less* transition into the mainstream?
    a. How does strategic niche management contribute to my understanding of this transition?
    b. How does the multi-level perspective contribute to my understanding of this transition?
    c. How do the transition pathways contribute to my understanding of this transition?

Given the novelty of this approach, my research stands to contribute to the evolving methodologies used in both the Canadian smart grid literature and the sustainability transitions literature. The following chapter describes my methodology in detail.

Chapter 3: Methodology

3.1 Introduction

The objective of my thesis is to better understand how and why smart grid projects transition into the mainstream in Canada. Toward this end, my study analyzes *Heat for Less*, a Canadian smart grid project that has transitioned from the pilot phase into the mainstream, so as to glean a better understanding of how this transition occurred.

As was argued in Chapter 2, there are gaps in the literature on Canadian smart grids. My thesis seeks to address the identified gaps by conducting a rigorous, in depth case study of a Canadian smart grid, using theoretical frameworks to analyze the transitional process. This chapter details how this research will be conducted.

This chapter is organized as follows. First, I discuss my research method: the case study. In this section I briefly discuss the literature on academic case studies, examining why this method aligns with my research objective. Here, I draw upon the sustainability transitions literature detailed in Chapter 2, linking this research approach to the traditions in this field. Second, I discuss my research design. In this section I present my research setting, research procedures, and my data analysis approach. Finally, I discuss the validity and reliability of my research design, noting the limitations of my approach.

3.2 The case study: an introduction

To collect data for analysis I will conduct a case study. Robson (1993, p.146) defined a case study as “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence.” Yin (2009, p.3), building on this definition, stresses that the value of case studies is in their capacity to retain the “holistic and meaningful characteristics of real-life events - such as individual life cycles, *organizational and managerial processes*, neighbourhood change, international relations, and the *maturation of industries*” (emphasis added).

Yin (2009) notes that case studies suit particular types of research questions. As Table 1 illustrates, “what,” “who” and “where” questions (or their derivatives – “how many” and “how much”) are likely to favour survey strategies or the analysis of archival records. The goal of these studies is to *describe* a phenomenon. On the other hand, case studies are well suited to answering "how" and "why" questions – questions that seek to *explain* a phenomenon. Conducting an explanatory case study, then, is in step with my objective of understanding how and why *Heat for Less* transitioned into the mainstream.

METHOD	Form of research question	Requires control of behavioural events?	Focuses on contemporary events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/no
History	How, why?	No	No
Case study	How, why?	No	Yes

Table 1 Relevant situations for different research methods (adapted from Yin, 2009).

While case studies might rely on many of the same techniques as historical studies, the strength of case studies is this method's ability to deal with a full variety of evidence –documents, artifacts, interviews, and observations– beyond what might be available to a conventional historical study (Yin, 2009). This is fitting, given that my research could be conceptualized as a historical study that leans into the present, in the sense that it will be necessary to conduct historical research so as to better understand the history of Summerside Electric and the origins of *Heat for Less*, while incorporating other techniques (interviews, observations), so as to collect information regarding the present-day status of the project, managerial relationships, processes, and motivations. As my interest is in capturing and analysing motivations and processes currently underway that are beyond my control, it is appropriate to make use of the case study research method.

Moreover, as Flyvbjerg argues, case knowledge, in that it provides an opportunity for context-dependent learning (as opposed to context-independent knowledge, such as that derived from analytical rationality), is central to human learning (2006). As stated in Chapter 2, there is a need to better understand how and why Canadian smart grids take root and transition into the mainstream. The case study, in that it lends to learning and knowledge construction, is an appropriate research method toward this end.

3.3 The case study: responding to the critics

Despite these redeeming features, the case study is held in low-esteem in some academic circles. The conventional wisdom in this camp revolves around variations of the four following concerns: that the findings of case studies cannot be generalized; that case studies serve merely as pilot studies carried out in advance of more rigorous research; that case studies suffer from subjective bias; and that case studies take too long to conduct and, when complete, result in massive documents (Flyvbjerg, 2006; Yin, 2009). I examine and respond to these critiques below.

Perhaps the most common critique of case study research is that these studies are not generalizable, and therefore produce findings of limited value. A classic example of this view comes from Giddens (quoted in Flyvbjerg, 2006) who claimed that case studies, such as the small scale ethnographic research carried out by anthropologists, only gained validity "if carried out in some numbers, so that judgements of their typicality can justifiably be made" (p.26). To a certain extent, proponents of the case study method agree with this assertion, pointing out that multiple-case studies (that is, a case study that studies more than one case to enable comparison) adhere to Giddens' position. However, other proponents of the case study have responded to this critique by emphasizing that the investigator's goal is to "expand and generalize theories (analytical generalizations) and not to enumerate frequencies (statistical generalization) – even in the case of a *single* case study, the goal is to do a 'generalizing' and not a 'particularizing' analysis" (Yin, 2009, p.11, emphasis in original).

Others have argued that single case studies, while not formally generalizable, can be used to make generalized arguments through the process of falsification. As famously observed by Karl Popper, one observation of a black swan is sufficient to prove false the proposition that 'all swans are white' (quoted in Flyvberg, 2006, p.11). In this way, the case study, because it provides in-depth analysis of a phenomenon, can be used to identify so-called black swans, complicating or adding nuance to theoretical propositions. In the case of my study, I am bringing theoretical tools (the three frameworks introduced in Chapter 2) to the study of a real world, context-dependent phenomenon. By conducting a case study, I am not only gaining first-hand knowledge of a contemporary phenomenon, but I am also looking for 'black swans' by testing the propositions advanced in the literature.

Another critique levelled against the case study is that it is most useful for generating hypotheses in the first steps of a larger research process, while hypothesis-testing and theory-building is best carried out by other methods later in the process (Flyvberg, 2006). This belief could be considered an extension of the previous critique, in that it is based on the assertion that one cannot generalize on the basis of individual cases. Having already dismissed this argument, its extension can be seen as flawed. In fact, some scholars have argued the exact opposite: that case studies are actually *most* valuable during the stage at which candidate theories are tested (Yin, 2009).

There are two reasons for this. First, as Yin notes, the prior development of theoretical propositions can be used to guide, or focus, data collection and analysis (2009). By beginning with a set of propositions or parameters, the researcher gains a sense of 'where to look' in order to confirm, disprove, or complicate hypotheses. Meaning, the 'how' or 'why' questions studied by a case study do not point to what should be studied. Rather, it is the propositions put forth in the literature that provide the researcher with a starting point (Yin, 2009). Failing this, the case study can only be *exploratory* (as opposed to *explanatory*), and may in turn suggest propositions or hypotheses.

Second, part of this argument equates *larger* samples as being *better* samples. While larger samples may be more representative, studying the 'average' instance of a phenomenon is not necessarily more instructive than studying extreme or critical cases. Consider the extreme cases detailed in Freud's 'Wolf-Man' or Foucault's 'Panopticon'; while unordinary, these well-known cases are nonetheless highly instructive, and have proven to be iconic in their respective areas of research. Similarly, critical case studies, defined as having strategic importance in relation to a general problem, can be instructive in ways that an 'average' case might not be (Flyvberg, 2006). As discussed in Chapter 2, the majority of Canadian smart grid projects have not moved beyond the demonstration phase. It could be argued that *Heat for Less*, in that it has transitioned beyond this phase, stands as a critical case, and may offer insights that could not be gleaned from the study of a larger, more representative sample. In this way, case studies should not be considered a necessary precursor to a more representative study. Instead, the case study, in its own right, has proved capable of ‘speaking back’ to theory in ways that are unique to this method.

A third critique charges the case study of suffering from a subjective bias. Critics in this camp assert that the case study maintains a bias toward verification, understood as a tendency to confirm the researcher’s preconceived notions, so that the study therefore becomes of doubtful scientific value. This criticism is not new, nor is it unique to the case study. In the nineteenth century, Francis Bacon noted that, “when any proposition has been laid down, the human understanding forces everything else to add fresh support and confirmation. It is the peculiar and perpetual error of the human understanding to be more moved and excited by affirmatives than negatives” (quoted in Flyvberg, 2006). While Bacon is almost certainly correct in his observation, it does not follow that the only means of correcting this human tendency is by applying quantitative, deductive methods. For example, the element of arbitrary subjectivism will be significant in the choice of categories and variables for a quantitative structural investigation, such as a questionnaire to be used on a large sample case. The answer to this type of bias, therefore, is not necessarily in the application of quantitative methods or by studying larger samples.

As discussed above, it is falsification and not verification that characterizes the case study. As Geertz (1995) argued, ‘the field’ can be underestimated, but it cannot be evaded. Meaning that the in-depth study of a phenomenon forces the researcher to confront and grapple with realities that do not necessarily match preconceived views, assumptions, and hypotheses. In “large-*N*” studies, though, the researcher is further removed from the data, and may be less likely to falsify or “talk back” to conventionally held propositions. In relation to SNM research, for example, rather than confirm and verify, many studies add nuance or bring new perspective to central propositions, such as the impact of the internal niche processes (e.g. Homels et al., 2007; Raven, 2005; Van Mierlo, 2002).

Further, there are techniques and strategies available to researchers designed to ensure that case studies maintain rigour. Yin (2009) discusses the four tests that should be applied to every case study design to guard against bias: construct validity, internal validity, external validity, and reliability. These tests are discussed in relation to my study later in this chapter. In this way, the case study is still liable to suffer from subjective bias, but no more so thanquantitative social science methods.

Finally, the case study has been criticized for taking too long to conduct and, in turn, producing lengthy documents that resist summarization or reformulation into new theoretical propositions. In some regards, I would agree with this assessment, though I do not view these characteristics as drawbacks.

Regarding the length of time it takes to conduct a case study: a case study may indeed require a substantial time investment when compared to administering a survey, for example. While survey respondents might respond within a short period of time, providing the researcher with data, a case study, in that it might involve different modes of evidence collection, such as interviews, document analysis and archival research, is likely to prove more tedious and time consuming. On the other hand, the case study should not be confused with ethnography, which typically involves long periods of field work, in which direct and participant observations are recorded. Rather, a case study could theoretically be conducted entirely at a desk over the course of a few days, using a telephone to conduct interviews and a computer to review and analyze documents available on the internet (Yin, 2009). The value derived from this time investment is in the collection of interesting data that are otherwise impossible to access.

This brings me to the second point regarding the lengthy documents case studies sometimes produce. While case studies may indeed tend toward the production of long documents, they also tend to reveal the rich and complex nature of a phenomenon (Yin, 2009). In defense of lengthy case studies, Flyvberg (2006, p.22) quotes Nietzsche who said, “Above all one should not wish to divest existence of its rich ambiguity.” The world is complex, and as such, difficult to capture succinctly lest important details be lost. Noting this, Peattie (2001, p.260) warns against summarizing case studies: “It is simply that the very value of the case study, the contextual and interpenetrating nature of forces, is lost when one tries to sum up in large and mutually exclusive concepts."

Following Peattie's direction, my case study will be presented in full in the Results chapter. The case study is in itself the result. Analysis will be reserved for the subsequent Discussion chapter, in which I reflect upon my findings using the theoretical frameworks discussed in Chapter 2.

3.4 Research design

Having introduced my research method and responded to common critiques, I will now discuss the particulars of my research design. In this section I explain how I will collect the data that will inform my case study.

3.4.1 Overview

To answer my research question (and sub-questions) I will conduct semi-structured interviews of key Summerside Electric and City of Summerside employees involved with the conceptualization, launch, and ongoing operation of *Heat for Less*. Data collected from these interviews is complemented with document analysis. These two types of evidence are used to inform my Results chapter, in which I present a narrative account of how and why *Heat for Less* transitioned into the mainstream. This chapter is followed by my Discussion chapter, in which I analyse this account using the three frameworks discussed in Chapter 2. Separating the narrative from the analysis is consistent with the format recommended by Flyvberg (2006), who argued that the case narrative should first be told in all its complexity, without theoretical analysis, so as not to conflate the two. Sustainability transitions scholars also adhere to this approach, describing the case in its entirety prior to analysing these data through the lenses of SNM, the MLP or the transition pathways (e.g. Hurlbert et al., 2014; Mah et al., 2012; van der Laak et al., 2007). Figure (below) shows the sequential process of this research design.

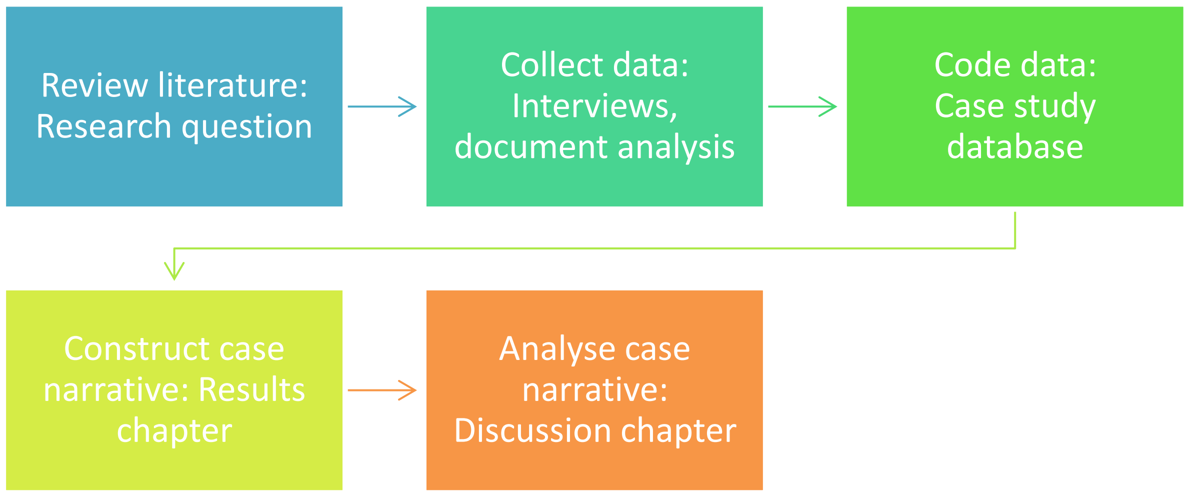

Figure 7 Research design sequence

3.4.2 The semi-structure interview

As I am interested in answering 'how' and 'why' questions, to which data are not readily available (no prior research), it is necessary to conduct original research to gain insight into my case study. The semi-structured interview is the most appropriate means of collecting the type of data required for this study, that is: data that will cast light on the motivations and processes at work throughout the development of *Heat for Less*. Semi-structured interviews are appropriate when the interviewer is informed about the topic (to the extent that he or she can form propositions) but nevertheless is intent on allowing interviewees leeway to discuss subjects that the interviewer might not have considered. By asking questions to explore specific topics, interviewees are also permitted freedom to provide insights into issues and processes that might not have been gleaned from a survey that provides subjects with a set of answer choices that betray the researcher's assumptions and biases (Bernard, 2000). Further, semi-structured interviews allow for probing. While structured interviews bind interviewers to a list of set questions to be asked to each interviewee, semi-structured interviews allow the interviewer to ask for elaboration, allowing the interviewer to pursue ideas or request additional details whenever necessary (Barriball & While, 1994).

This style of interview fits well with my case in that I have conducted a preliminary investigation into the *Heat for Less* case prior to beginning my original research. This preliminary information gathering, or background research, allowed me to form some initial impressions of the case, helping me locate areas of interest and better formulate relevant questions. However, as much of the pertinent information (the type of information that would allow me to answer my research question) about *Heat for Less* was not available, a set of semi-structured interviews would provide me with the data necessary to begin answering my research question. A similar research approach is used in numerous sustainability transitions studies, particularly in those where the subject is an ongoing technology transition (e.g. Foxon, Hammond, & Pearson, 2010; Hiscock, 2012; Ngar-yin Mah et al., 2012; Geert P.J. Verbong, Beemsterboer, & Sengers, 2013).

Having elected to use SNM as my initial theoretical framework, I used this framework to "guide" (as Yin suggests (2009, p.13)) the creation of my research protocol. In my case, this meant dividing my questions into themes, so as to probe into the interviewee's experience vis-à-vis the three internal niche processes (i.e. articulating a vision, networking, learning) (see Box below). This research protocol was reviewed by the University of Waterloo's Office of Research Ethics and was found to be in compliance with its guidelines (ORE# 19297).

1. **Questions**
    a. Introductory question
        i. How long and in what capacity have you been involved with *Heat for Less* (*HL*)?
    b. Articulating a vision
        i. How did *HL* get started? Tell me about why and how *HL* came to be, and what were the key motivators of this project?
        ii. How do you expect *HL* to grow/change in the future? Why do you expect it to advance in that particular direction?
        iii. Would you say that different people involved in this project have differing visions for it, or is there a common vision?
            1. To what extent do you think these mixed expectations have affected the success of HL?
            2. OR, what is the source of this common vision?
    c. Networking
        i. In the course of a regular day of work, would you say you mostly work (a) individually, (b) with other Summerside Electric or City of Summerside employees, or (c) with other non-municipal public bodies and private firms?
        ii. If (c), please describe your experiences working with other public bodies and

private firms in relation to the advancement of *Heat for Less*.

iii. To what extent have these extra-municipal partnerships been a priority for the *HL* team; and how have these relationships affected this project (be it positive or negative)?

d. Learning

i. Over the course of this project, have there been opportunities to 'take stock' and learn from what is being done? Please explain (frequency, individual v. cross-team, mandated in regular team procedures).

1. Can you give an example of how you have made changes to this project based on something you've learned? Describe this process.
2. Is there a protocol to communicate such lessons to other members of the *HL* team?

ii. In your own experience, have you made efforts to learn from the experiences of other Canadian or international smart grid pilot projects? And have any of these lessons been incorporated into the project?

3.4.3 Participants

My strategy to recruit interview participants combined the gatekeeper approach and snowballing (Bernard, 2000). In July 2013, I met with a senior Summerside Electric employee to informally discuss my intention to conduct research on *Heat for Less*. My proposal was received positively, and this individual agreed to act as a gatekeeper, insomuch as he would provide me with a list of persons who might be interested in being interviewed.

My selection criteria were narrow so as to maintain focus; I was interested in interviewing only persons who were (or remain) directly involved, at a decision-making level, in the conceptualization, launch, and/or regular operations of *Heat for Less*. The rationale for these criteria is that they ensure that I will interview only persons with direct, decision-making experience with *Heat for Less*, and therefore able to provide insight into the project's history, conceptualization, operations, and political and economic considerations – the very sort of insight that is required to answer why and how this project transitioned into the mainstream.

In October, 2013, following an email correspondence, my gatekeeper signed an organization consent form, granting me permission to conduct a study of *Heat for Less* and interview his staff. My gatekeeper also provided me with contact information (i.e. telephone numbers and email addresses) for seven individuals who matched my selection criteria. I proceeded to call the individuals on this list, scheduling appointments for in-person interviews throughout the week of November 11-17, 2013. I booked five interviews at this time. I followed-up each successful appointment booking with an email that described my thesis and its objectives, as well as a form which outlined the participant's rights (e.g. able to end the interview at any time, not required to answer questions, etc.; for full email messages and forms, see Appendix).

I was concerned by this somewhat modest pool of interviewees, and resolved to increase participation by employing the snowballing technique following my scheduled interviews; meaning I inquired whether interview participants could refer me to additional candidates who fit my selection criteria.

Ultimately, I conducted five face-to-face interviews during the week of November 11-17, and one phone interview the following week. Participants included Summerside Electric staff persons, City of Summerside staff persons and a City councillor. Interview participants have been anonymized in accordance with Office of Research Ethics guidelines and, when individuals are referred to in Chapters 4 and 5, I refer to the affiliate organization without use of the participant's name or job title.[16]

Figure 8 Summerside City Hall (Image credit: City of Summerside)

Again, I was concerned by this modest sample size. However, when considering this sample it is important to keep scale in mind. Summerside is a city of approximately 15,000 people. City hall and the City's electric utility are proportional in size to the city's population. As an indication of the City's size, most councillors hold full-time jobs outside of City Hall. Similarly, director-level staff persons at Summerside Electric are also responsible for a range of other, non-energy related municipal services (Interview: 1; City of Summerside, 2013).

[16] In-text references to interview data have been anonymized to preserve the confidentiality of the interviewees, making reference only to the number of interviewees who support a given claim.

Consider, too, that in an MLP-based analysis of smart grid development in South Korea, Mah et al. (2012) conducted 11 semi-structured interviews. In a SNM-based analysis of the development of electricity storage in Ontario, Hiscock (2012) conducted 32 semi-structured interviews. As *Heat for Less* operates on a much smaller scale (not national or provincial, but operating at municipal level), it follows that a proportionately smaller number of people could have been directly involved with the conceptualization, launch and ongoing operation of the project. Indeed, it became evident over the course of my interviews that an even smaller unit (which I later refer to as the 'Team') existed within my sample – a group of three individuals whom together led the development of *Heat for Less*, pitched the idea to City Council, and coordinated the launch of the program. Each member of the Team was interviewed. Therefore, despite this small sample, I can confidently assert that I interviewed 100% of the staff persons who fit my selection criteria.

3.4.4 Interview procedures

The five face-to-face interviews were conducted in various locations in Summerside, including a meeting room at City Hall, the business office of a Councillor, the homes of retired staff persons, and an office at Summerside Electric. Each interview followed a routine: I thanked the participant for taking part in my study, briefly reviewed the objectives of my study, discussed the participant's rights and requested their consent, and then began working my way through my interview protocol. Each interview lasted between 1 and 1 ½ hours.

I recorded each interview (including the telephone interview that occurred the week following the in-person interviews) using a digital recording device. I also recorded personal thoughts and observations on a notebook which I brought along to each interview. Following each interview, I elaborated on these notes to ensure that ideas would remain clear to me when reviewed at a later date.

The raw interview data, meaning the digitally recorded audio files and my personal notes, were anonymized and stored in a secure location throughout the research period. I transcribed the raw interview data with the use of Express Scribe, software that allows the transcriber to reduce the speed of playback to ease transcription. I then coded my six interview transcriptions into a themed table (Bernard, 2000), the interview participants listed in the rows and the three internal niche processes occupying the columns. The data coded into this table were cited, so as to enable me to return to the source transcripts should I require elaboration on a point of interest.

Further, as each interview participant drew upon the past to explain the present, I used interview data to create a timeline of events. Timeline entries were also cited, linking each entry to the source transcription data, and later cross-referenced (and supplemented) with document analysis.

3.4.5 Document analysis

I also conducted document analysis to collect data for this study. Document analysis, sometimes referred to as desktop research, refers to the study of text documents as an evidence collection method (Patton, 2005; Bowen, 2009). Document analysis is commonly used in the sustainability transitions studies (e.g. Geels & Schot, 2007; Hurlbert, McNutt & Rayner, 2014b; Ngar-yin Mah et al., 2012; van der Laak et al., 2007;Verbong & Geels, 2007; Geert P.J. Verbong et al., 2013).

As discussed in Chapter 2, the near-contemporaneous MLP studies of energy systems in the Netherlands (Verbong & Geels, 2007) and Ontario (Rosenbloom & Meadowcroft, 2014) rely exclusively on document analysis, while the contemporaneous MLP study of smart grid development in South Korea (Ngar-yin Mah et al., 2012) and the SNM study of energy storage systems in Ontario (Hiscock, 2012) combine interviews with document analysis. As my research is more closely related to this second grouping, in that my research analyzes a contemporary case, I elected to pair my interview data with evidence collected through document analysis.

Over the course of my research I analysed a variety of documents. These included: reports and presentations published by the City of Summerside and Summerside Electric, such as municipal budgets, strategic planning reports, and presentation materials on *Heat for Less*; PEI government reports and legislation related to energy use and policy; news media, including online newspapers articles related to *Heat for Less* specifically, and energy politics (or the *history of* energy politics) on PEI generally; NRCan studies and reports related to energy and electricity use; and academic articles related to smart grids in Canada.

I used evidence from my document analyses to add detail to my understanding of the case, and to verify and cross-reference statements made by interview participants. All cross-referencing was coded into my themed analysis table discussed in the previous section. Here, entries were cited to facilitate the verification of information during the writing process. Further, evidence derived from document analysis was incorporated into my timeline of events to corroborate (or cast doubt upon) interview statements. Again, entries were cited to allow for identification and quick retrieval of source material.

3.5 Analysis

As noted in Figure (see p. 36), I used my coded data to inform my case study narrative, which forms Chapter 4 of this thesis. Given that my research is interested in better understanding a particular smart grid transition (which is to say, understanding how change occurs over time), it was critical to capture the historical roots of *Heat for Less* so as to understand how this smart grid developed over time. This narrative is indeed a research "finding", and was constructed using my timeline, which was informed by interview and document analyses data.

The theoretical analysis portion of this study, though, was reserved for Chapter 5, my Discussion. Here, I made use of the three theoretical frameworks detailed in Chapter 2 to analyse my case narrative, asking how each framework contributes to my understanding of the *Heat for Less* case. My approach to using each framework is described below.

3.5.1 Strategic niche management

As discussed in Chapter 2, SNM is used as an analytical tool in the sustainability transitions literature to explain the success or failure of an innovation trajectory based on the interaction of three internal niche processes: articulating visions, networking, and learning.

Typically, SNM studies highlight the actions and policies that showcase (or hinder the advancement of) each of the internal niche processes (Kemp et al., 1998; Hoogma et al., 2002; Truffer, 2002; Van Mierlo, 2002; Smith, 2003, 2006; Geels & Raven, 2006; van der Laak et al., 2007). I followed this model, describing the actions and policies that fit each internal niche process (creating sub-sections), as documented in my case narrative. Here I relied extensively on my themed table (as data from interviews and document analyses were organized here according to internal niche processes), referencing specific interview data and documents throughout.

Each of my internal niche process sub-sections is anchored to the descriptions of "good" (that is, effective) internal niche processes as supplied by van der Laak et al. (2007). Here I compared and contrasted my findings against the criteria put forth in the literature, gauging how effectively each of the internal niche processes was carried out in the *Heat for Less* case. I close this section by discussing how this framework contributes (if at all) to my understanding of the *Heat for Less* case.

3.5.2 Multi-level perspective

As discussed in Chapter 2, though SNM provides valuable insights into niche-level activity (the primary interest of my study), it tends to do so at the expense of activities and policies occurring outside the niche. Especially in the case of deeply rooted, legacy systems (such as electricity systems), transitions rely as much on 'push' from the niche as they do on the 'pull' from the regime and landscape levels (Geels & Schot, 2007; Schot & Geels, 2008; Verbong & Geels, 2010). For this reason, I complemented my SNM analysis of *Heat for Less* with the MLP framework.

Among the energy-related MLP studies reviewed in Chapter 2, the research of Verbong & Geels (2007) on the history of the Dutch electricity system, Ngar-yin Mah et al. (2012) on the development of smart grids in South Korea, and Rosenbloom & Meadowcroft (2014) on the decarbonization of Ontario's electricity system were particularly instructive methodologically. In these studies, the case is detailed (as I do in my Results chapter), then analyzed using the MLP framework to reflect upon the cross-level interactions that occurred (and in the case of the South Korean study, *continue* to occur).

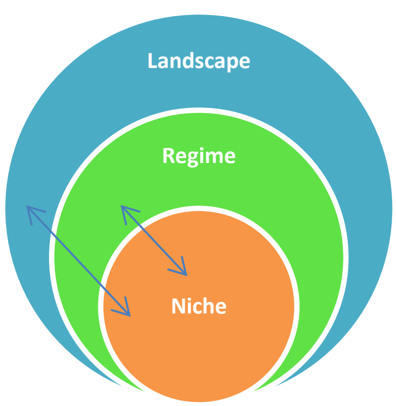

Figure 9 Visualizing cross-level interactions in a nested system (adapted from Mah et al. (2012))

I use the MLP to analyze *Heat for Less* in a similar fashion in Chapter 5, reflecting upon the case narrative documented in Chapter 4 and then categorizing the various factors that affected the development of *Heat for Less* by level. I then discuss how these factors interacted with one another, promoting or inhibiting the development of *Heat for Less*.

My analysis makes use of a diagram (Figure) similar to that used by Ngar-yin Mah et al. (2012, p.137) for visualization purposes. The double-headed arrows in Figure are intended to indicate that, though not adjacent to one another in this visualization, the landscape nevertheless interacts and impacts the development of the niche (and vice versa).

I close this section by discussing these cross-level interactions, noting how this framework contributes (if at all) to my understanding of the *Heat for Less* case.

3.5.3 Transition pathways

Finally, in Chapter 2, I introduced the transition pathways. Put forward by Schot & Geels (2007), the transition pathways expands upon the MLP so as to make the framework sensitive to different types of transitions. The main issue being rectified is that the emergence of a new technology had been depicted in the literature as a bottom-up phenomenon, as illustrated in the MLP diagram (see **Error! Reference source not found.**, p. 22). Research, though, has indicated that innovation is not exclusively the result of 'pushes' from the niche but also the result of 'pulls' from the regime and landscape levels (Geels, 2011). The latter sequence was found to be the case especially in large, infrastructure-based systems, such as the electricity sector (Verbong & Geels, 2007).

Given that my research is interested in understanding the transition experienced by a niche development that occurred in the energy sector, it follows that I should make use of this 'add-on' framework, making my MLP analysis more sensitive to the types of transitions that typically occur in this sector.

To do this, I model my analysis on studies conducted by Hulbert et al. (2010, 2011) which use the four transition pathways as heuristic devices, comparing and contrasting changes that have occurred in Saskatchewan's electricity with the 'ideal-types' documented by Schot & Geels (2007) and Verbong & Geels (2007).

In doing this, it is not my intention to definitively categorise the *Heat for Less* case into a pathway. Rather, by reflecting on the types of innovation journeys documented in the literature in relation to the experience I document in Chapter 4, I may gain new insights into this case study, as well as an indication (albeit speculative) as to what the future might hold. I will close this section by discussing how the transition pathways contribute (if at all) to my understanding of the *Heat for Less* case.

It should be noted that this three-pronged approach to the analysis of a case study is novel. While the frameworks share a common scholarly 'lineage', they have not, to my knowledge, been used in conjunction. However, as I argue above and in Chapter 2, these frameworks suit the aim of my study, and may provide important and valuable insights into how and why *Heat for Less* transitioned into the mainstream.

3.6 Validity and reliability

Four tests are commonly used to establish the quality of empirical social science research: construct validity, internal validity, external validity, and reliability (Babbie, 2010). I take steps to ensure that my research design satisfies each of these tests.

3.6.1 Construct validity

Construct validity, which tests the operational measures used for the concepts being studied (Yin, 2009), will be maintained by following three strategies: the use of different types of evidence; the compilation of a case study database and the maintaining of a chain of evidence; and having my case narrative reviewed by interview participants.

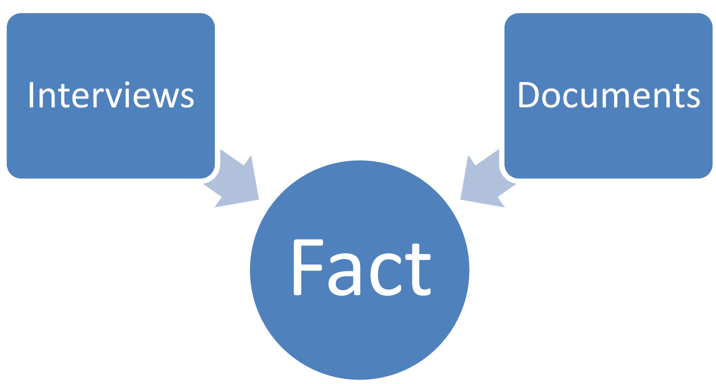

Figure 60 Converging lines of inquiry lead to robust conclusions

My research makes use of different types of evidence so as to show convergences in the data (Figure 7). Further, by cross-referencing different types of evidence against each other, findings are less likely to betray any subconscious personal bias (Yin, 2009).

Another means of maintaining construct validity is by creating a case study database: my themed table and timeline. The value of this database is in its separation from the case and analytical discussion of the case. By filing evidence into a database, I will be less likely to confound the separate phases of data collection, narrative building, and analytical discussion (Yin, 2009).

Further, this division between research stages and evidence organization lends to the creation of a 'chain of evidence'. One test of construct validity is to ask whether a non-affiliated reader would be able to make sense of my findings, having no problem tracing inferences and claims back (or up the chain) to data catalogued in my case study database (Figure 8 p. 47). By maintaining a firm chain of evidence, linking inferences to my case database, I will maintain construct validity.

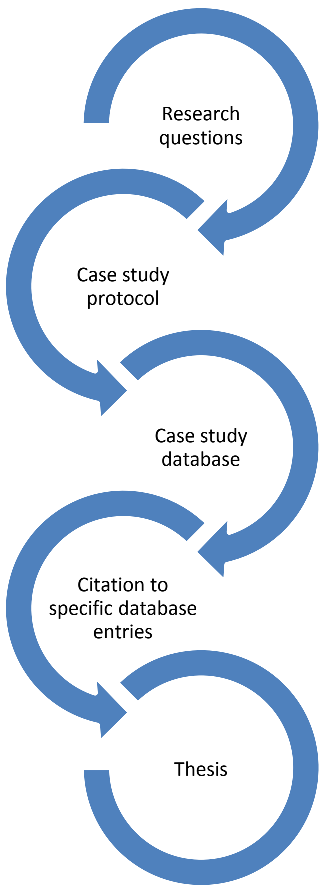

Figure 7 Chain of evidence (adapted from Yin, 2009)

3.6.2 Internal validity

Internal validity relates to the integrity of claims which seek to establish causal relationships between one set of conditions and another (Yin, 2009). As my case study is interested in better understanding how and why *Heat for Less* transitioned into the mainstream, I am interested in relationships of causality. As discussed above, no such inferences will be made in the Results chapter, as this chapter seeks to build a case narrative from my database. My Discussion chapter, on the other hand, will make inferences into causality. These inferences, though, will derive from the three theoretical frameworks discussed above. These frameworks have been revised in light of the great amount of research conducted in the field of sustainability transitions, and therefore stand as a reflection of this collective work.

This said, I do not suggest that these frameworks are infallible. In fact, the frameworks, in my case, serve as heuristic devices, aiding me to consider the case narrative in new ways in light of propositions tested in the sustainability transitions literature. Further, all resulting analysis will be discussed so as to engage with alternate explanations.

3.6.3 External validity

External validity refers to the process of generalizing research findings. Unlike survey research, which requires a significant and representative sample in order to make *statistical* generalizations, case studies instead make *analytical* generalizations: linking particular findings to a broader theory (Yin, 2009). In this regard, my research does not seek to claim that my findings from the *Heat for Less* case can be generalized onto the broader Canadian or global smart grid landscape. Instead, my research will seek to uncover any learnings regarding if or how the propositions advanced in the sustainability transitions literature correspond with my case study findings.

3.6.4 Reliability

Finally, the reliability (typically defined as the 'replicability' of a study (Yin, 2009)) of my study is maintained by virtue of having explicated my research design in this chapter, presenting at length the procedural steps that I have taken to collect case data, construct a case narrative, and analyse this narrative with three frameworks.

3.7 Summary

This chapter accomplished four tasks. First, this chapter introduced the case study as a research method, discussing why this method is appropriate for my study and how my case study is organized. I also engaged with and responded to common critiques levelled against the case study. Second, this chapter explained my research design. Here, I explained my sample selection, data collection, and interview protocol processes in detail. Third, this chapter explained how I will analyze the findings of my case study. Here, I explained how I will operationalize the three sustainability frameworks introduced in Chapter 2. Finally, this chapter discussed the tests of validity and reliability in qualitative research, and how I take steps to ensure that my research maintains rigour.

Chapter 4: Results

4.1 Introduction

The purpose of this chapter is to present a detailed description of the events that precipitated the launch and later sustained the operations of *Heat for Less* in Summerside, Prince Edward Island. This account will serve as a detailed backgrounder for the analysis and discussion that follows in Chapter 5.

Summerside at a glance

Population: 15,414 (approximately 7,000 households; comparatively slow growth rate; aging population)
Geography: Coastal city, surrounded by farmland; situated near narrowest part of the Island; proximity to Confederation bridge
Median household income: $41,988 (in 2005 dollars, ranking below the provincial and national averages) (City of Summerside, 2011)

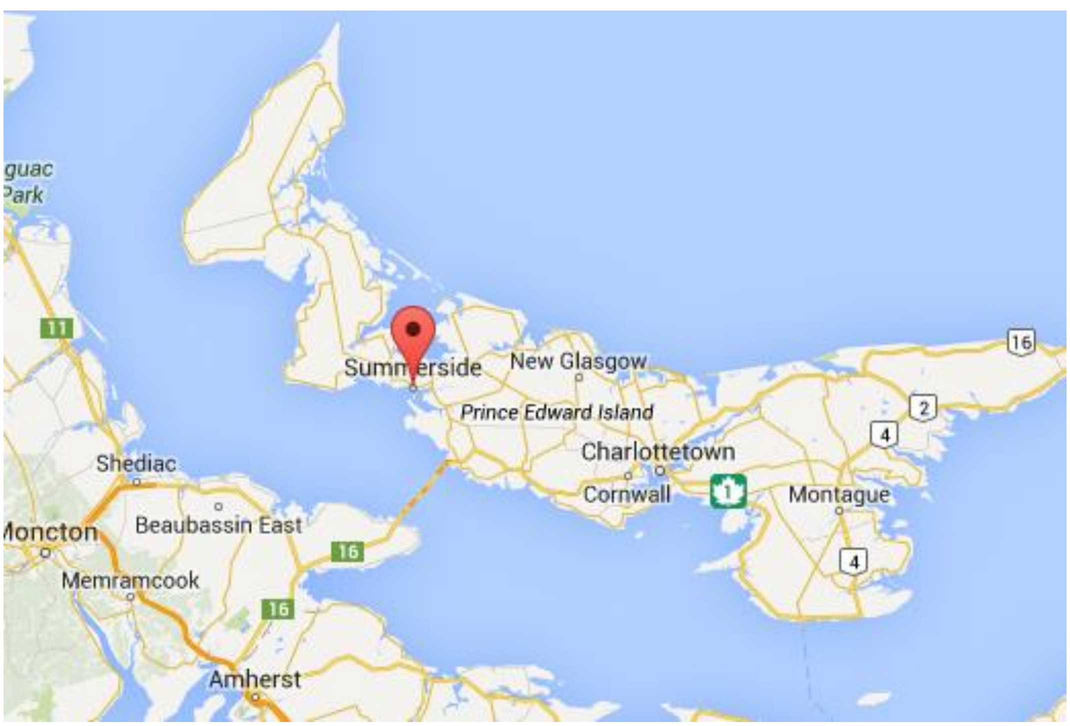

Figure 8 Summerside, PEI (Image credit: Google Maps)

This chapter is informed primarily by a series of elite-level semi-structured interviews I conducted of persons that fit my selection criteria (see section 3.4.3) over a one-week period in Summerside, PEI in November, 2013. Interview data are further supplemented by documents collected during and following this period.

This chapter is organized as follows. First, this chapter presents a detailed timeline of events, highlighting the actions and policies that have affected Summerside's electricity landscape. Second, this chapter will delve into one of these events in particular: the construction of Summerside's wind farm, the piece of infrastructure that underpins the *Heat for Less* program. Finally, the *Heat for Less* program itself will be unpacked, presenting a full description of how the program works, who it serves, and the politics surrounding its launch and upkeep.

4.2 Timeline: Getting here from there

As is often the case, the story of *Heat for Less* begins well before the program's official launch in 2011. For a fuller understanding of how the pieces of this program came together, it is helpful to reach further back in time. This history begins in the 1920s, when Summerside Electric was first established as a municipally-owned electric utility (Interview: 1). While other municipally-owned utilities on PEI, such as Charlottetown Light & Power, were purchased and consolidated into the privately owned Maritime Electric over the first half of the twentieth century, citizens of Summerside resisted this push and Summerside Electric remained a wholly municipally-owned utility, historically controlling electricity generation and distribution (PEI Energy Commission, 2012).

This dynamic changed in 1977 when submarine transmission cables were laid across the Northumberland Strait, linking PEI to New Brunswick and Nova Scotia's electrical grids. At this juncture Summerside Electric shifted its supply mix away from its diesel generators (which had been the primary means of generating electricity on PEI) and toward the cheaper imports brokered by Maritime Electric's new connection to the Maritime market (Interview: 1; PEI Energy Commission, 2012).

In 1994, Catherine Callbeck, then the Premier of PEI, proposed an aggressive take-over of Maritime Electric in a bid to rein in electricity rates which greatly exceeded those charged to customers in neighbouring New Brunswick and Nova Scotia (at the height of this period, Island residents paid nearly 50% more than New Brunswick residents for electricity) (Interview: 1; PEI Energy Accord, 2011). Premier Callbeck's intention was to purchase all of Maritime Electric's stock, and resell it to New Brunswick Power (NB Power), under the condition that Island electricity rates would remain on par with those charged to New Brunswick residents (Interviews: 2). To stave off this hostile takeover, Maritime Electric proposed implementing a price cap on electricity set at New Brunswick rates + 10% (stipulating that rates would be progressively cut until reaching the cap in 1998). The Premier acquiesced to these terms; Summerside Electric, following suit, formalized its existing power purchase agreement with Maritime Electric with a 10-year contract stipulating a price cap on rates not to exceed New Brunswick rates + 10% (Interview: 1).

In 2001, Maritime Electric, unable to profitably maintain the rate of New Brunswick + 10%, attempted to broker a new deal with the then-recently elected Progressive Conservative government of PEI. Rather than a hard price-cap, the new provincial government opted for an energy cost-adjustment regulation, permitting Maritime Electric to adjust rates so as to reflect both market prices and its own operating costs (Interview: 1). Given these new terms, Maritime Electric opted out of its contract with Summerside Electric. This contract, though, included an exit clause which stipulated that should it be terminated by Maritime Electric, Summerside Electric would reserve the right to use Maritime Electric's transmission networks to access and purchase electricity on the open market (Interviews: 2). Taking note of these developments, and weary of future intra-Island rate discrepancies, the province legislated that Summerside Electric's rates were not to exceed Maritime Electric's PEI electricity rates (Interviews: 2). While there were risks inherent in breaking ties with its previous sole supplier, the leadership at Summerside Electric recognized it as an opportunity. As a City director recalls, "If we could go out on the open market, buy [electricity] for cheaper than Maritime Electric, all the profits [margin between rate at which electricity was purchased and Maritime Electric's rate] we made went right back into the community" (Interview: 1).

Summerside Electric, now able to make use of Maritime Electric's transmission infrastructure, signed its first power purchase agreement with Nova Scotia Power in 2002 (Interviews: 2). The first six months of this new 3-year contract proved very profitable for Summerside Electric (and, by extension, the City of Summerside). Disturbed by the low prices Nova Scotia Power was selling its power to Emera (an affiliated energy company which then marketed the electricity widely), Nova Scotia's provincial regulatory body mandated Nova Scotia Power to open its own marketing desk, and to sell its excess capacity at the maximum possible return so as to help deflate electricity rates in Nova Scotia. Seemingly overnight, the rate charged to Summerside Electric for electricity went from $0.045/kWh to $0.075/kWh (Interviews: 2). Unable to sustain this new rate, Summerside Electric terminated its contract with Nova Scotia Power and signed a new power purchase agreement with New Brunswick Power. While not as profitable as its previous short-lived contract, this new arrangement has nevertheless proven very profitable for the City of Summerside. From 2003 to 2012, the annual transfer from Summerside Electric to the City general fund has risen from $0.5 million to $2.1 million, over 10% of the City's annual budget (Interviews: 2; City of Summerside, 2013).

Unlike the provincial and federal transfers, which typically come with conditions as to how these funds are to be used, and revenue collected from property taxes, which, because they are relatively predictable, are earmarked for City operating costs, net revenue generated by Summerside Electric is transferred directly into the City general fund, free from conditions or restrictions; total discretion over these funds rests with City Council.

This new revenue stream has allowed the City to finance a number of capital investment projects over the last decade with a new level of independence, no longer restricted to the various provincial and federal grant programs that municipalities apply for, year after year. One such project was the West End Beach project, a $6 million infilling project designed to eliminate the odour of rotting seaweed that had become a nuisance to residents of Summerside's downtown harbourfront area (Interviews: 2; City of Summerside, 2013). While this project may seem trivial, its significance cannot be overstated as it stands as an important precedent; the City was able to raise its own capital to undertake a City project.

Figure 9: Credit Union Place (Image credit: www.cupevents.ca).

Other large capital investment projects would follow. In 2003, the City of Summerside broke ground in the construction of Credit Union Place (Figure 10), a new wellness and recreation complex slated to replace some of the City's aging arenas. This facility, described on its website as PEI's "largest indoor concert and trade show venue," has an indoor concert seating capacity of 5,400, and also boasts two full-size ice surfaces, a 25-metre pool, a fitness centre, eight bowling lanes, outdoor tennis courts and a skateboard park.[17] As a City director put it, "It's a jewel of a facility. For a city of 15,000 to have a facility like Credit Union Place is probably unheard of. It's a fabulous white elephant in the City. And it comes at a cost" (Interview: 1). Credit Union Place was opened for business in 2006; the project cost the City approximately $40 million.

While the City was able to use its own capital to secure the financing for the project, City officials were also counting on a number of provincial and federal grants to help cover the cost of this large infrastructure project. Unfortunately, these funds were either not available or the project was deemed ineligible for the programs that were on offer during this period

[17] For more information, see Credit Union Place website: http://www.cupevents.ca/ (accessed 16 January 2014).

(Interviews: 4). It was under this climate that the City began investigating alternate means of increasing revenues so as to begin servicing its new debt.

4.3 Building a wind farm

It was during this period (2003-5), while the City was examining its options for financing its new recreation complex, that the City had begun drafting its latest strategic plan. Drafted in 2003 and adopted in 2006, Summerside's strategic plan laid out short term (<5 years) and long term (5-10 years) goals for the City and listed a broad set of economic, environmental and social objectives and indicators to help guide councillors and City staff toward these ambitious goals (City of Summeride, 2011). Two of these goals proved particularly important with regards to the development of the City's wind farm, the parent infrastructure of the *Heat for Less* program. Of these two, one stated that the City should become 100% green, and would work toward this objective by building a wind farm. The second stated that Summerside should become a Smart City[18] (Interviews: 3).

With these objectives in mind, Summerside's director of municipal services entered into discussions with West Cape, a private wind development firm located on the Island's west coast. These discussions led to a power purchase agreement signed in 2006, providing Summerside Electric with 9 MW of wind-generated electricity (or 23% of the Summerside's electricity demand)[19] (Interview: 1; City of Summerside, 2012c).

In parallel to this development Summerside's chief administrative officer, disappointed that federal infrastructure grants for the City's recreation complex were not forthcoming, was made aware of federal funding opportunity reserved for renewable energy projects. Since Summerside Electric began making a profit on the margin at which it purchased and then resold electricity, the utility had become a major contributor to the municipal general fund. It follows, albeit in a roundabout way, that Summerside's chief administrative officer, seeking out ways to better service the City's new debt, was interested in opportunities to increase Summerside

[18] This objective, I later learned, was directly influenced by a then-recently launched IBM grant directed at municipalities interested in using 'big-data' as a policymaking tool. However, the term 'smart city' was interpreted by some staff persons as alluding to the establishment of a city-wide smart grid (Interviews: 2).
[19] Natural Resources Canada profiled Summerside's wind farm in 2009, http://canmetenergy.nrcan.gc.ca/fichier/81075/DE (accessed 21 January 2014).

Electric's generation capacity. In 2007 Summerside officials began filing applications for provincial and federal infrastructure grants to build a city-owned wind farm (Interviews: 3; City of Summerside, 2012b).

Municipal Rural Infrastructure Fund – Federal	$1,904,231	6.3%
Municipal Rural Infrastructure Fund – Provincial	$1,904,321	6.3%
Federal Gas tax rebate	$9,287,307	31%
Municipal Green Fund	$62,500	0.002%
Building Canada Fund –Federal	$4,500,000	15%
Building Canada Fund – Provincial	$4,500,000	15%
City Financing through the federal Municipal Infrastructure Lending Program (low-interest loan)	$7,841,731	26.1%
Total Project Estimate	$30,000,000	100%
Actual Constructed Cost	28,400,000	94.7%

Table 2 Budget of wind farm (City of Summerside, 2012b)

Following a successful Environmental Impact Assessment, Summerside's four-turbine, 12 MW wind farm was commissioned, with construction beginning in 2009. Funding for the project, originally budgeted at $30 million, came in large part from federal and provincial grant programs, which together contributed approximately $13 million[20] (Interviews: 2; City of Summerside, 2012a, 2012b). In addition, the City of Summerside opted to dedicate five years of its federal Gas Tax Fund contributions to the project (funds typically ear-marked for road repair), totalling approximately $9.2 million. The remaining balance was borne by the City of Summerside, financed through a fixed-rate low-interest loan from the federal Municipal Infrastructure Lending Program (Interview: 1; Summerhill, 2011). Taken together, federal and provincial grants, along with federal Gas Tax Fund monies, allowed the City of Summerside to finance a $30 million project while bearing less than $8 million of this total cost (see Table 2).

It is important to note that this wind farm is owned by the City of Summerside, and not by its subsidiary Summerside Electric. Summerside Electric, though, entered into a power purchase agreement with the City of Summerside, agreeing to buy all the energy generated by the wind farm at a rate of $0.08/kWh (Interviews: 3). The revenue generated by the wind farm is

[20] http://www.infrastructure.gc.ca/media/news-nouvelles/2011/20110826summerside-eng.html

substantial. Between 2010 and 2012, the average annual revenue generated from the sale of wind-electricity was $2.4 million; after figuring in the cost of servicing the debt incurred from the wind farm ($0.8 million annually over 20 years), the project produced a $1.6 million annual net contribution to the City general fund (City of Summerside, 2012b).

	MW	MWh (2008)	MWh (2011)
Diesel Plant (used for peaking)	12	49	98
NB Power	7	97,000	62,000
Summerside Wind	12	N/A	33,000
West Cape Wind	9	28,000	30,000
Annual Consumption	-	125,000	126,000
% of Wind Supply	-	~22%	~50%

Table 3 Summerside Electric supply mix (City of Summerside, 2012c)

While this arrangement appeared to benefit all parties on paper, it soon became apparent that Summerside Electric, now beholden to power purchase agreements with West Cape and the City of Summerside (totalling 21 MW, see

Table), was often over-supplied with electricity Between 2010 and 2012 Summerside Electric was annually over-supplied with 7,500,000 kWh on average (City of Summerside, 2012b).

Unable to store this electricity, Summerside Electric entered into an agreement to sell its excess electricity to New Brunswick Power. This electricity, though, is typically generated during off-peak hours and, in that it is wind-generated, is non-dispatchable (insomuch as it is difficult to forecast wind capacity with any degree of certainty), and therefore held a low market-value, which was reflected in the purchase price of $0.04/kWh offered by New Brunswick Power (Interview: 1; Hughes, 2012).

So while the wind farm began generating upward of $2 million in annual revenue for the City of Summerside, Summerside Electric was now suffering annual losses of nearly $300,000,[21] as it was selling excess energy to New Brunswick at half the price it had paid for it (Interview: 1).

4.4 Challenges and "needs"

City officials, for their part, were satisfied with the revenues generated by the wind farm, but Summerside Electric was being adversely impacted by its new business arrangement. Summerside's director of municipal services, who also serves as managing director of Summerside Electric, expressed this dilemma as follows: "Even though [Summerside Electric and the City of Summerside] are the same company, I'm taking [the electricity] from them, and I have to deal with the surplus. So then the need for me was to maximize my value of this surplus" (Interview: 1).

Investigating ways of addressing this "need" became a puzzle which a small team of City of Summerside and Summerside Electric employees began to work on together to solve in late 2009. The core members of this team (Team) included the City of Summerside's chief administrative officer and director of finance and Summerside Electric's managing director. The Team sought out technologies that could improve the utility's business case. The "holy grail," as one Team member put it, was finding a means of storing electricity, allowing the utility to preserve its supply, dispatching it only when demand existed (Interview: 1). The inverse of this question, though, was also asked: if supply cannot be stored, how might the utility increase local demand (creating a 'controllable load' of sorts) for electricity (so as to forgo having to having to export electricity)?

The Team identified residential and commercial heating (fueled almost exclusively by light oil) as an area worth exploring as this sector represented the largest use of energy on PEI, after the transportation sector (which accounts for approximately 46% of the "petroleum product" portion of Figure 11) (PEI Energy Strategy, 2008; NRCan, 2008).

[21] This story was documented in the media. See, for example, the CBC article, "Summerside seeking more wind energy profits," http://www.cbc.ca/news/canada/prince-edward-island/summerside-seeking-more-wind-energy-profits-1.1284049 (accessed 21 January, 2013)

Dr. Larry Hughes, a professor of electrical and computer engineering at Dalhousie University, was consulted to study this question in 2009, affording special attention to the issue of how the utility might maximize the use of its renewable energy assets while providing a benefit to Summerside Electric clients (Interview: 1). In his initial report, Hughes stressed the importance of working toward greater energy security in Summerside – a reasonable observation, particularly in the period immediately following the 2008 recession when the world was

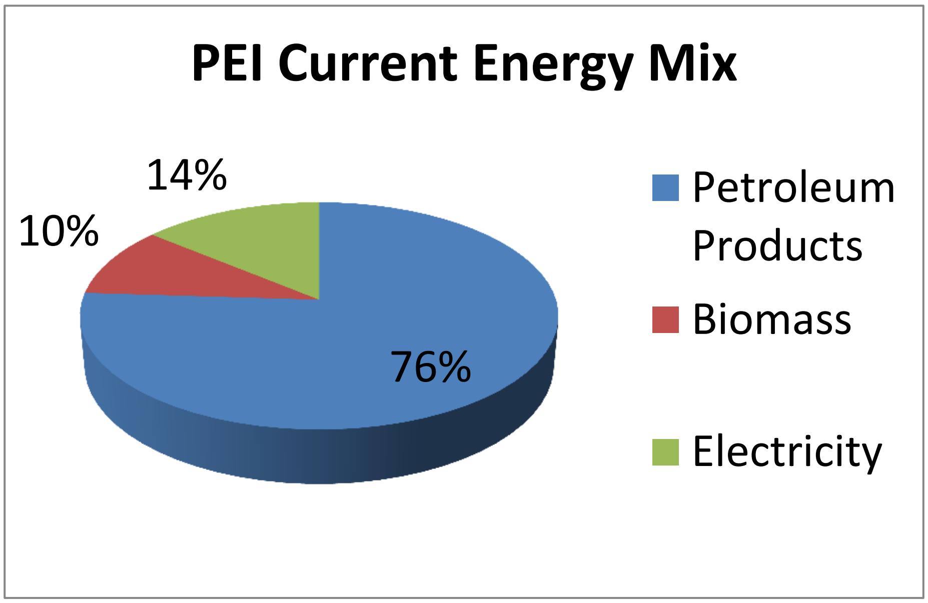

Figure 10 PEI's Energy profile (PEI Energy Strategy, 2008).

witnessing record-high oil prices (Hughes, 2009). This observation (perhaps reminding the utility of its own experience with the vagaries of the open market, having been at a loss when Nova Scotia Power suddenly raised its prices in 2002), in addition to the assertion that the residential and commercial heating sector that was bearing the brunt of the rising cost of oil, represented an opportunity for future electricity demand growth and led Summerside Electric to consider how best to access the heating sector (Hughes, 2009; Interviews: 2).

4.5 *Heat for Less*: from concept to program

In his report, Hughes presented models that charted Summerside's (hourly) wind capacity against the average space- and water-heating consumption patterns of single-detached homes over an average PEI winter in order to calculate whether household heating systems could cope with the intermittency of wind; calculations were conducted for various scenarios, some involving a baseboard heating system and others with an electric thermal storage (ETS) unit. In the ETS scenario, electricity is "used to heat a storage medium (such as ceramic bricks) that subsequently releases the stored heat to the environment for space heating" (Hughes, 2009, p.8). The advantage of in such a scenario is that it not only controls for the intermittency of supply, but also functions as a demand-shifting program, allowing households to shift their demand for electricity to off-peak hours (i.e. the hours when Summerside Electric typically experiences over-supply)[22].

Interestingly, the models for an 'anytime charging' scenario proved significantly more effective than the night-time only charging scenario, as the former optimized charging regardless of time of day; the limitation to the 'anytime scenario' is that it requires a means via which the utility can communicate with the ETS units, whereas the night-time charging scenario can be managed by installing a simple timer device on the ETS unit (Hughes, 2009, 2012). According to Hughes' models, Summerside Electric could potentially heat up to 500 households equipped with ETS units at current wind capacity, and up to 3000 households if the City were to develop a means of communicating with the ETS units (Hughes, 2009, 2012). The idea of deploying a smart grid – smart meters linked via direct fibre connections to the home- had been considered in the past, but in the light of Hughes' findings, and seeing what it would mean for the potential reach of a wind-ETS project, developing such a network took on a fresh appeal.

In 2011, the Team presented a proposal for a wind-ETS smart grid project to City Council. Council, voting 5-3 in favour, approved Phase 1 (deploy into 100 homes and conduct a pilot study) of the project that came to be known as *Heat for Less*, committing the remaining balance of the funds that had been budgeted for the wind farm to this new project, some $1.6 million (see Table 2, p.55). Phase 1, or the pilot phase, involved conducting research & development of hardware and software; laying fibre across one tenth of the city; and piloting ETS units (City of Charlottetown, 2012a).

[22] Work in a similar vein (storing off-peak electricity in the form of heat) has been conducted in the past, see for instance the work of Hartmann (1980).

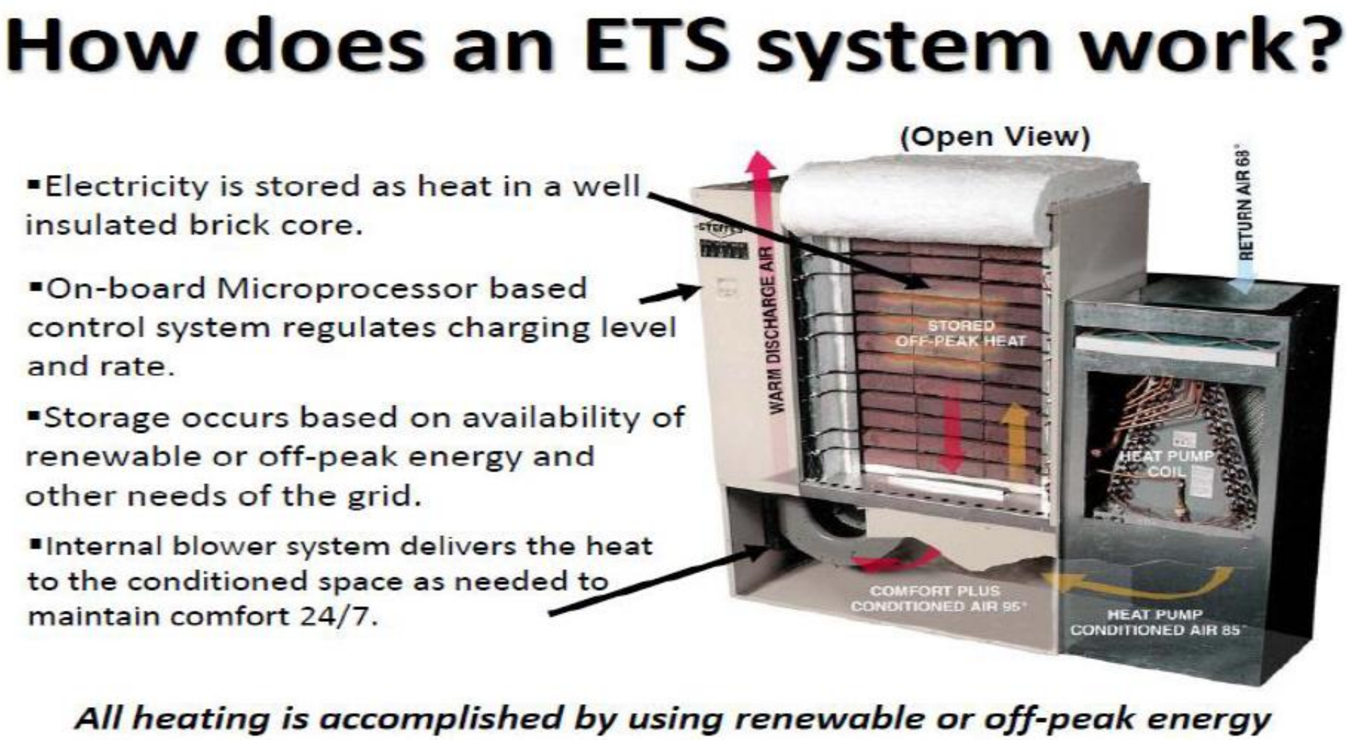

Figure 11 Diagram provided in *Heat for Less* information pamphlet (Summerside Electric, 2012c)

Capital Costs			(Total rounded)
Fiber network (to the curb)			$7,960,000
400 pilot connections	Price	Qty	
Service drops	$1,453.79	400	$580,000
Head end systems	$21,542.51	13	$280,000
Smart meter with collar	$495.00	400	$200,000
			$1,060,000
Total project costs			$9,020,000
Funding			
Pilot funding from completion of wind farm		$1,550,000	
Green Municipal Fund pilot funding		$350,000	
Other (assume none as a worst case scenario)		-	$1,900,000
Summerside Electric – Incremental Share			$7,120,000

Table 4 Financial framework of Heat for Less (City of Summerside, 2012a)

The early stages of Phase 1 were spent conducting research & development, networking with local engineering firms and heating companies to develop an ETS unit that could synch with a future city-owned fibre network. After a lengthy research period, Summerside Electric signed a contract with Steffes, an ETS company based in North Dakota, for exclusive distribution rights to their products on PEI (Interviews: 2). A local engineering firm, in turn, collaborated with Summerside Electric (on the basis that the firm would retain all patents) to develop a device that enabled the Steffes units to receive signals from the utility's 'virtual power plant', the computer system which determines when the ETS units are to charge (Hughes, 2012).

Summerside Electric developed a business model to deploy the ETS units that required homeowners or businesses, following an energy audit that prioritized conservation, to make a capital investment in a space heater or hot water tank. In turn, the purchaser would be 'locked-into' a $0.08/kWh electricity rate for five years, some $0.04 less than Summerside Electric's electricity rate, and $0.045 less than the converted price of a litre of furnace oil (which, at the time, was $1.05/L) (Interviews: 3; City of Summerside, 2012c; Hughes, 2012). If the homeowner reinvested these savings (35% savings when compared against the cost of furnace oil) into the unit, the cost of the appliance could be paid down in three years, leaving two years (of a five year lock-in) of flat electricity rate of $0.08/kWh. While Summerside Electric makes no profit on this electricity, as it is sold it at cost, it does not lose money either, as it had on the open market. Further, the profits accrued on the sales of the ETS units are reinvested into the phased-deployment of the city's fibre network (ETS units deployed outside of the fibre network are programmed to draw (off-peak) electricity on a timer system) and into research & development to further enhance management of the virtual power plant (Interviews: 3; City of Summerside, 2012a).

Despite the momentum the program had built in Phase 1, the project was not without its detractors. Many City councillors, having been lobbied by PEI's two major telecommunications companies, considered building a fibre network beyond the City's purview and expertise. Considering the sizable cost of expanding the fibre network (see Table above)[23], why not strike

[23] The cost of Phase 2 was estimated to be $750,000, to be allocated from the unused funds from Phase 1 and budget approved funds from 2012 Summerside Electric profit (City of Summerside, 2012a).

a deal with the telecommunications companies for access to existing networks, the project's critics argued (Interviews: 5). Further, two key Team members (of the original three-person Team) were scheduled to retire, adding to the uncertainty of whether the project would be approved for further funding.

In 2012, when the *Heat for Less* Team sought funding to pursue Phase 2 of the project (deploy into 400 homes), councillors were divided, splitting the 8-member council in a tie vote of 4-4. In the event of a tie, the vote is to be split by the mayor (who *only* votes in the event of tie). The mayor voted in favour of funding Phase 2 (Interviews: 3). This critical vote, which nearly saw the project discontinued, signalled to the Team that changes were necessary.

Summerside Electric dedicated a portion of its freshly awarded research & development funds toward retaining a consulting firm that was tasked with developing a new communications plan to better market *Heat for Less* to both the public and to councillors. The first change the consultants recommended was to place electricity, and not the communications network, at the centre of the messaging; the fibre network was not the goal, but rather it should be understood as the platform that allows the City to optimize the use of its generation assets (Interviews: 2).

A second change was that Summerside Electric, which, up to that point had been conducting ETS installs with in-house staff, should begin educating, training, and working with local contractors (electricians and plumbers) so as to extend some of the business generated by this program to contractors already working in the community. While this move demanded the development of a new logistics model, it ultimately served to increase familiarity with the program and worked to make local contractors the new "face" of the program by placing them at the forefront of product installs (Interviews: 3).

Third, it was suggested that Summerside Electric explore the auxiliary opportunities attached to the deployment of a city-owned fibre network, such as the possibility of the City serving as a 'living laboratory' for technology entrepreneurs and firms interested in testing, and potentially commercializing technologies, applications and services on this platform (Interviews: 4).

Finally, Summerside Electric was directed to obtain an estimate for running *Heat for Less* on the fibre networks operated by PEI's major telecommunications companies which proved to be far more costly than Summerside Electric's own cost estimates (Interviews: 2).

In October 2013, these new ideas were presented to City council in advance of the vote on whether to fund the roll-out of Phase 3 (deploy into <1000 homes). Following a rigorous question period, the project, now rebranded as *MyPowerNet*, received unanimous support from council (8-0) (Interviews: 2).

The *Heat for Less* program, designed to sink up to 8,500,000 kWh of surplus energy (per year), is approaching the midway point of this target, at approximately 4,000,000 kWh worth of appliances deployed in the community as of November, 2013 (Interview: 1; City of Summerside, 2012a; City of Summerside, 2012b). Summerside Electric is currently reviewing its deployment strategy, refocusing to include institutions and commercial buildings in addition to residential homes. Further, the utility, working in conjunction with the City's economic development officer, has begun targeting developers, so as to install the ETS units en masse in new developments prior to construction (Interview: 2). The managing director of Summerside Electric anticipates the program will reach its 8,500,000 kWh target by 2018 (Interview: 1).

4.6 Summary

As outlined above, the history of the *Heat for Less* program stretches further into the past than its official 2011 launch date betrays. The nuances of this story expose the difficult decisions, technological challenges and political wrangling involved in making *Heat for Less* a reality. The following chapter delves deeper into the thinking and decision making processes of the City of Summerside employees that worked closely on the *Heat for Less* project, using the Strategic Niche Management framework, so as to analyse why and how the Team worked to create the circumstances that fostered the project's transition into the mainstream. This analysis is supplemented with the multilevel perspective and the transition pathways, two frameworks that add context and depth to the SNM analysis.

Chapter 5: Discussion

5.1 Introduction

Having presented a detailed account of the actions and policies that led to the development of *Heat for Less* in the previous chapter, I will now analyse the collected data using a suite of theoretical frameworks introduced in Chapter 2: strategic niche management (SNM); the multilevel perspective (MLP); and transition pathways. The purpose here is to closely examine the historical facts through conceptual frameworks, further unpacking the decision making processes and actor relationships responsible for making *Heat for Less* a reality.

To begin, I will first analyse the project through the SNM frame. Here I will rely primarily on the data collected over the course of my interviews, as these focused explicitly on the three internal niche processes identified in the SNM literature: articulating a vision, developing networks, and engaging in learning over the course of the project. In this section, I will answer my first sub-question: How does SNM contribute to my understanding of this transition?

Second, I will analyse the data through the MLP frame. As discussed in Chapter 2, the bottom-up approach of SNM, though important, is not a sufficient pre-condition for a technology transition. Such a view ignores the importance of cross-level interactions, that is "receptiveness" in the regime, as well as "favorable" pressure from the landscape level (Schot & Geels, 2008, p.542). For this reason, I contextualize my findings in a multi-leveled framework, using interview data and document analysis to demonstrate how actors, policies and events at each level (niche, regime, landscape) influenced the development of *Heat for Less*. I will answer my second sub-question: How does the MLP contribute to my understanding of this transition?

Third, I will discuss whether the *Heat for Less* transition conforms to one (or more) of the four transition pathways put forth by Geels & Schot (2007) and later refined by Verbong & Geels (2010). Each of the four transitions pathways will be briefly revisited, and then related to the collected data. I will answer my third sub-question: How do the transition pathways contribute to my understanding of this transition?

Finally, I will synthesize the findings derived from these three conceptual frameworks, relating them to each other, to the broader technology transitions literature, and to my research question.

5.2 Strategic Niche Management (SNM)

As discussed in Chapter 2, SNM is an analytical framework used to delve into the processes that occur at the niche level that enable or inhibit a technology's journey from a technological niche to a market niche and finally to a regime shift (Figure 13).

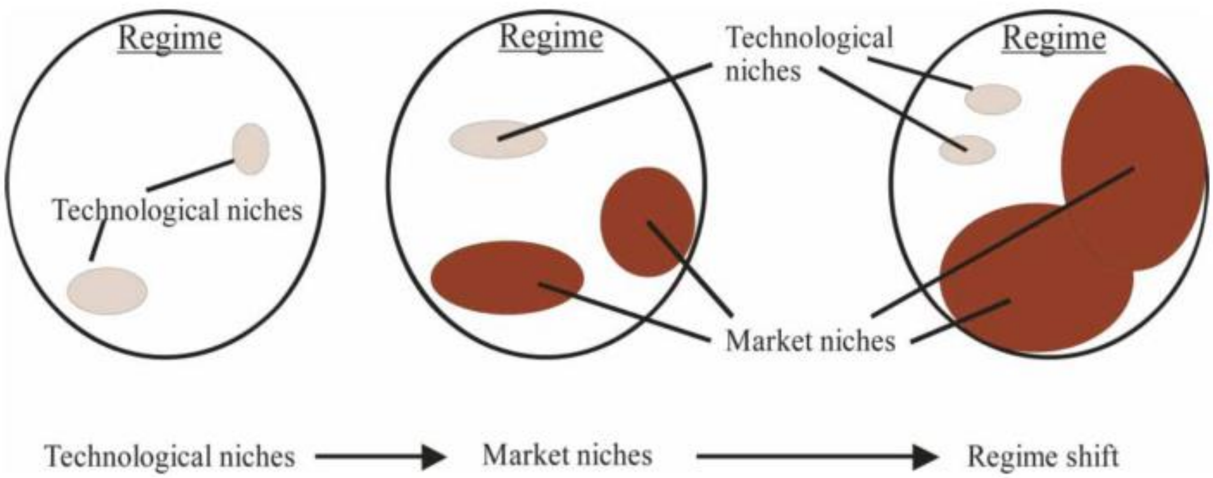

Figure 125 From niche dynamics to regime shift (Schot & Geels, 2008).

Based on a range of insights from evolutionary economics and history of technology, three internal niche processes have been identified for succesful development of a technological niche (Elzen, Hoogma, and Schot, 1996; Kemp, Schot, and Hoogma, 1998; Schot and Geels, 2008): articulation of expectations and visions, building of social networks, and learning processes (for elaboration, see section 2.6 on p.20). In this section I will analyse to what extent each process was advanced by the *Heat for Less* Team, proceeding through these internal processes in the order listed above.

5.2.1 Articulating expectations and visions

In 2009, the City of Summerside's chief administrative officer, director of finance and director of municipal services (Team) proposed a wind-to-heat pilot project to City Council. The project was pitched as a means of alleviating the losses Summerside Electric was incurring from the sale of its excess wind energy to New Brunswick Power (Interviews: 5). Further, the project, it was argued, would generate new revenues for the utility, and by extension the City general fund (Interviews: 4; Hughes, 2012). Lastly, it was proposed that the City would not be required to budget 'new' money to fund this project. As the construction of the wind farm had been completed under budget (see Table 2, p.55), the remaining balance, it was proposed, could be redirected toward the pilot project (Interviews: 3).

In sum, the pilot project was expected to a) address the problem of over-supply of wind energy, b) create new revenue for the City, and c) not require additional City funding. The importance of this final point should be emphasized as the City of Summerside, having recently constructed a wind farm and a recreation complex, was not in a position to take on yet another capital intensive project nor the attendant debt burden (Interviews: 2).

Expressed this way, these expectations offer insight into the ensuing debate that occurred in 2012 when the Team requested funding from Council to expand *Heat for Less*. While the Team had delivered (or demonstrated a capacity to deliver should the project be scaled up) on the first two expectations, the request for funding to deploy a fibre network in Summerside came as a shock to many councillors (Interviews: 2). Not only was the Team requesting funding (see Table , p.60), which clashed with the initial expectation of the project being virtually cost-free, but the Team had seemingly modified the initial parameters, now calling for the deployment of a city-wide communications infrastructure project. The latter request struck many councillors as costly and beyond the purview of Summerside Electric; some councillors argued it represented an encroachment into the domain of the local telecommunications companies (Interviews: 4). As detailed in Chapter 4, the eight-person Council was divided on whether to fund *Heat for Less* further, splitting the initial vote 4-4. The mayor, who exclusively votes in the event of a tie, sided with the project proponents.

This meeting forced the *Heat for Less* team to re-evaluate the project's goals and to consider how best to communicate these goals to the public and to Council. According to one director-level Team member, "we had to hit the reset button and redefine who we were as a project…and I think that rebuilding, rebranding, repurposing the perception has made us somewhat successful this past year [sic]" (Interview: 1).

This process of 'hitting the reset' could be likened to articulating a new set of expectations and a new vision for *Heat for Less.* This new vision involved: rebranding the fibre project as *MyPowerNet* (emphasizing electricity so as not to be confused with a communications project); developing a stronger business plan, highlighting the involvement of local contractors; emphasizing the idea that *MyPowerNet* and *Heat for Less* served the utility *and* the community (some going as far as to suggest that the program was key to fighting youth outmigration), providing residents and businesses with low-cost, environmentally-friendly heating options; and highlighting the potential future business opportunities associated with operating a city-owned fibre network, such as serving as a 'living laboratory' for technology firms (Interviews: 6).

According to van der Laak et al., the process of voicing expectations is considered to be good (i.e. most effective) when "(a) an increasing number of participants share the same expectations (expectations are converging), and (b) the expectations are based on tangible results from experiments" (2007, p.3217). By redefining and then clearly articulating the expectations and vision of *Heat for Less* in a presentation to city council in October, 2013, I would suggest that a convergence of expectations occurred among councillors. As one councillor recalled of the October, 2013 Team presentation, "they got the overwhelming thumbs up, you know, from the council… there were no questions that weren't asked that night that couldn't be answered in a positive way. And that was the big thing" (Interview: 1). The process of redefining the vision of the project, then, should not be underplayed as the four detractors were converted into project supporters following the redefinition of project expectations (4-4 split to 8-0 voting in favour).

5.2.2 Building social networks

As outlined at the outset of this section, building social networks is considered an import internal niche process. These networks facilitate connections between, and build support among, the relevant stakeholders, including project proponents, users, financiers, politicians, contractors, industry leaders and academics, among others (Kemp & Schot, 1998; Schot & Geels, 2008).

Interview data suggest that the *Heat for Less* Team's social networking experience can be thought of as consisting of two periods. In the first period (pilot launch – 2012 council meeting), the primary network consisted of three high-level City employees: the chief administrative officer, the director of finance, and the director of municipal services (a role that involves overseeing Summerside Electric). This group of three formed the core of the Team, meeting several times a week to discuss plans and challenges, set milestones, and provide updates on *Heat for Less*. These three employees, it should be noted, had been working closely together since the initial proposal of the wind farm in 2009.

Each member of this core group networked with 'outsiders' and then reported back to the Team; 'outsiders' included provincial and federal bureaucrats, local banks, local engineering firms, academics, and ETS furnace manufacturers (Interviews: 3). The networking that occurred in the first period set the foundation for *Heat for Less*, providing the Team with the business contacts and technical knowledge necessary to launch the pilot phase of the project (Interviews: 3).

Some actors however were not networked with at all during the first period, namely, City councillors and Summerside's two major telecommunications companies. Given the dramatic shift in councillor votes (from 4-4 in 2012 to 8-0 in favour in 2013), it could be surmised that had the Team dedicated more time and energy to regularly updating councillors on the status of the project, more councillors may have been supportive in 2012. Further, the lack of communication between the Team and councillors created an opening which the telecommunications companies leveraged, lobbying councillors to vote against the development of a city-owned fibre network in 2012 (Interviews: 5).

In the second period (2012 council meeting – present), the Team strategically expanded upon its social networks. The City of Summerside's director of economic development became a champion of *Heat for Less*, promoting it to City developers and to the members of Summerside's chamber of commerce (Interview: 1). Further, this director began discussions with technology firms interested in testing their applications on Summerside's fibre network.

During the second period Summerside Electric hired a business and sales manager, whose role involved: coordinating with and educating the local contractors (plumbers, electricians, HVAC specialists) who would eventually work alongside Summerside Electric staff throughout ETS installs; and marketing and coordinating the sale of ETS units to the public (Interviews: 2). This hire marks a significant development in terms of networking. During the first period, all ETS installs were executed entirely by Summerside Electric staff, the Team being reluctant to allow the project to move beyond its direct control in the early stages. Further, in the first period the extent of the marketing push was limited to a small ETS demonstration space located inside Credit Union Place. In the second period, Summerside Electric's new business and sales

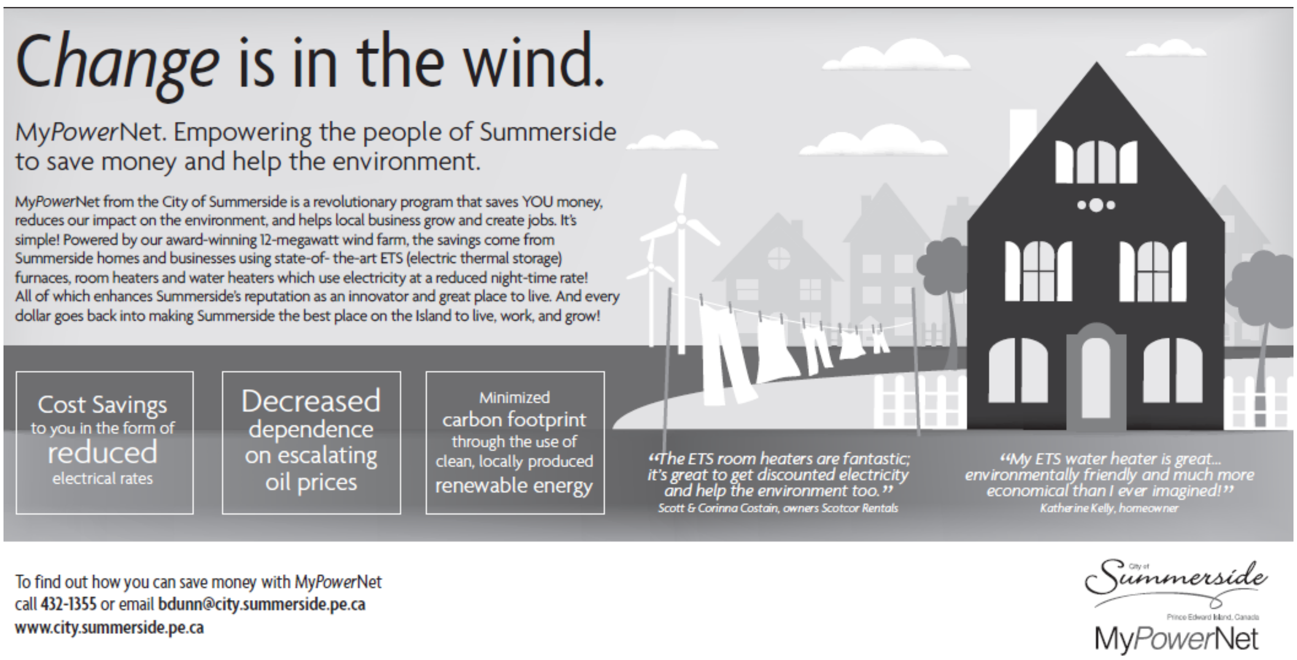

Figure 13 Summerside Electric's 'Change is in the Wind' campaign (City of Summerside, 2013)

manager launched a marketing campaign, running promotional material in the local newspaper and in circulars distributed door-to-door (see Figure 14 p.70) (Interview: 1). Gauging the effectiveness of this campaign is beyond the scope of this research however it remains that, in the second period, the Team took steps to build public awareness, support and participation by promoting *Heat for Less* in new ways.

Finally, once *Heat for Less* began experiencing greater uptake, the director of municipal services was able to step back from the role of project manager and became the program's unofficial public advocate, speaking at numerous academic and industry conferences, both nationally and internationally, over the course of the second period (Interviews: 3).

According to van der Laak et al., the process of building social networks is considered ‘good’ when “(a) the network is broad (including firms, users, policy makers, scientists, and other relevant actors), and (b) when alignment within the network is facilitated through regular interactions between the actors” (2007, p.3217). As set out above, the Team’s network was initially relatively closed during the first period, limited to key City employees, technology firms, and an academic consultant. It was not until the second period that the Team worked to broaden its network, promoting the project to the public and council in new ways, bringing outside contractors on board, and sharing experiences at industry and municipal conferences. This reluctance to expand the network from the outset may be due to the Team’s unwillingness to disclose too much before “getting the bugs out of the system” (Interview: 1). It is difficult to say whether there was wisdom in this close-handedness (would the project have received more support from council had the Team been actively discussing it with councillors, industry and the public on an ongoing basis?). This point notwithstanding, the Team has seemingly recognized the benefits of a broad network as it works to expand and foster (as in van der Laak’s criterion) its social network.

5.2.3 Learning processes

The third internal niche process relates to learning. The literature on SNM notes that regular and deliberate efforts to ‘take stock’ and learn from the project underway enables “adjustment of the technology and/or societal embedding to increase chances of successful diffusion” (van der Laa et al., 2007, p.3217; see also Schot & Geels, 2008). According to Fleck (1994), ‘learning by doing’ is especially crucial in the case of ‘configurational technologies’, such as energy technologies, where the challenge is to get multiple components to work together. A good learning process, according to van der Laak, is “(a) broad – focusing not only on techno-economic optimisation, but also on alignment between the technical (e.g. technical design, infrastructure) and the social (e.g. user preferences, regulation and cultural meaning) – and (b) is reflexive – there is attention for questioning underlying assumptions such as social values, and the willingness to change course if the technology does not match these assumptions" (2007, p.3217).

When asked about learning, each interviewee was quick to respond that learning occurred "every day" (Interviews: 6). This response, in a way, was expected as each Team member is the de facto pioneer in their own area in that the project is new and unlike anything that has come before it in Summerside. Never before have City employees been in a position that required them to develop ETS technologies with local engineering firms and international manufacturers, deploy a city-wide fibre network on which the products operate, coordinate with local contractors to install ETS systems, and market and sell the package to the public and to council.

As would be expected, there was a great deal of 'learning by doing' that occurred throughout the short history of *Heat for Less*. While Team members heeded many technical lessons (e.g. the importance of dedicated fibre, the challenges involved in installing an ETS in a heritage home, etc.) (Interviews: 2), almost all interviewees remarked on the many lessons of a social nature that were learned: relating to politics, public perception, and business and logistics models (Interviews: 5). Speaking to one of these socio-technical lessons, one interviewee said,

> I'm an engineer, so I tend to be very technical – we get this much wind, we put these products in, and we'll get this much revenue to pay for this. And you didn't talk about the consumer at all, because the consumer knows that it's so damn good that he'll want it anyway! Anyway, you just jump some things… I think the biggest thing we've learned through the whole thing is how to pitch a project. It's very important from the start to come up with a very solid plan and one of the things that I already talked about is the consumer linkage. We were always selling the project to council as a community benefit, and not an individual benefit -it was an operational improvement, it was a way to increase revenue to the utility- but we weren't showing the decision makers the benefit to the consumer and the community directly. And when we started repackaging that, that lesson was learned in spades because as soon as you start talking about what it means to individuals, there's a lot less barriers (Interview: 1).

The above statement is indicative of the 'good' learning that occurred across the Team. However, there are aspects of the Team's learning process that seem wanting. For instance, each interviewee noted that lessons learned were shared with the Team on an ad hoc basis, and as such were rarely documented (Interviews: 5). Some interviewees expressed concern about this informal procedure, noting that following the retirement of two core Team members a great deal of 'brain trust' was lost (Interviews: 3).

5.2.4 SNM and Heat for Less

To close this section, I will return to the first sub-question posed at the outset of this Chapter: How does SNM contribute to my understanding of this transition? The value of the SNM approach is that it allowed me to consider this project in a new light, dividing its history into categories. Rather than thinking of the history of *Heat for Less* as a linear story, one event happening after the other, the SNM has allowed me to conceptualize this history in a way that highlights the project's strengths and weaknesses. For instance, my analysis reveals that both the visioning and networking processes moved through two different periods, and that the Team's capacity to learn from the shortcomings of the earlier period informed the direction of this later period. Such a finding may be of considerable value to the *Heat for Less* Team as it examines its own progress in retrospective, and to other utilities, enterprises or governments considering undertaking smart grid pilot projects.

As noted at the outset of this Chapter, SNM and internal niche processes are not sufficient on their own to ferry a niche technology into the regime (Schot & Geels, 2008). In addition to these processes, the regime and landscape levels play a critical role in terms of providing opportunities for and being receptive to new market entrants. To better understand these dynamics, the following section will analyse *Heat for Less* through the multilevel perspective (MLP).

5.3 Multilevel Perspective (MLP)

As set out in Chapter 2, new, disruptive technologies often experience challenges in terms of breaking into the mainstream as incumbent technologies have established strong links between markets, user practices, regulations, infrastructures and cultural meanings (Geels, 2002, 2004; Verbong & Geels, 2010). In spite of these challenges, technology transitions *do* occur. This reality begs the question that underlies much of this research project: How do niche technologies overcome these barriers, transitioning into the regime?

The *Heat for Less* case presents an opportunity to study and analyse one such socio-technical transition. In this section I will analyse this case using the MLP, a framework that conceptualizes technology transitions across three distinct levels: the landscape, regime, and the niche. The landscape consists of a range of contextual factors that influence technological developments (Geels, 2001). Regimes refer to rules and institutions that are built up around an established technology (Geels, 2001). Niches are 'protected' spaces in which innovation takes place (Geels, 2001) (for elaboration, see section 2.7 on p.22).

To begin this analysis, I will first identify the factors that worked to foster or inhibit a socio-technical transition at all three levels. This process of identification will rely on my interview data and document analyses.

Having identified the factors that contributed to the transition of *Heat for Less*, I will discuss the cross-level interactions that occurred, linking these dynamics to similar and contrasting experiences documented in the academic literature.

Lastly, after consideration of the above analysis, I will discuss these findings more broadly. This discussion will summarize my findings and seek to answer the second sub-question posed at the outset of this chapter: How does the MLP contribute to my understanding of this transition?

5.3.1 Landscape

At the landscape level, sector-specific provincial-municipal relations, provincial energy policy, and rising oil costs were key factors. Summerside Electric exists in a special legal space, beyond the regulatory purview of the Island Regulatory and Appeals Commission Act (IRAC), the legislation that grants PEI's Ministry of Energy regulatory authority over Maritime Electric (PEI Energy Commission, 2012). This political history has had the effect of making Summerside Electric accountable (in most respects) solely to its owner: the City of Summerside. This structure effectively strips one level of governance, which has allowed the City of Summerside to freely explore projects (such as *Heat for Less*) without first seeking approval from an outside agency (Interviews: 2). Further, Summerside Electric's capacity to access the open electricity market, via Maritime Electric's transmission system, created a dynamic that contributed to the development of both the wind farm (so as to rely less on electricity imports from the open market) and *Heat for Less* (so as to rely less on electricity exports to the open market) (Interviews: 3; Hughes, 2012).

While Summerside Electric is not legally beholden to provincial regulatory oversight, the utility was party to PEI's Energy Accord, a non-binding agreement negotiated between PEI's Ministry of Energy, Maritime Electric and Summerside Electric that set out PEI's near and long term energy goals (relating primarily to rates and supply mix) (PEI Ministry of Energy, 2008). Among these goals was a commitment by the parties to increase the Island's supply of wind power (Ibid.). It is difficult to say to what extent this commitment figured into the events that unfolded in Summerside regarding the development of its wind farm and *Heat for Less*. It could be surmised that this particular commitment reaffirmed the City of Summerside's goal of greening its supply mix, as stated in its 2006 strategic plan (City of Summerside, 2011).

Lastly, the cost of furnace oil, the fuel used to heat over 75% of residential structures on PEI (NRCan, 2008; Hughes, 2009), has significantly increased in recent times. Between 2000 and 2008, the cost of furnace oil on PEI increased by 172% in real (PEI Energy Strategy, 2008). Although furnace oil prices slumped immediately following the 2008 recession, this trend

AVERAGE RETAIL PRICE FOR HOUSEHOLD HEATING FUEL (CENTS) IN MAJOR URBAN CENTRES, CANADA, 2001-2011

Urban centre:	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
St. John's, NL	54.5	50.1	54.8	62.4	78.6	84.8	87.6	109.4	74.3	88.4	110.4
Charlottetown, PE	**51.3**	**46.5**	**53.5**	**56.8**	**73.8**	**77.6**	**79.3**	**102.3**	**71.8**	**83.2**	**105.0**
Halifax, NS	54.7	53.3	61.4	68.5	83.6	87.9	84.0	106.3	74.4	85.3	106.9
Saint John, NB	58.7	54.9	62.4	66.0	83.2	84.7	89.7	115.1	79.1	92.2	112.0
Quebec City, QC	49.1	48.8	56.3	61.3	77.2	79.1	83.3	112.6	78.3	91.7	115.4
Montreal, QC	49.9	46.3	54.3	58.6	75.0	78.6	82.0	112.2	76.1	87.9	111.6
Ottawa, ON	56.8	49.2	57.2	62.9	77.4	81.6	86.8	113.0	80.0	95.7	121.5
Toronto, ON	55.9	50.8	57.9	64.0	78.0	82.2	87.6	112.7	82.0	96.1	121.8
Winnipeg, MB	60.2	53.0	60.8	64.4	81.7	84.0	91.5	115.8	82.7	94.7	113.8
Regina, SK	55.3	51.8	55.7	62.4	82.0	82.6	91.8	115.3	79.8	90.9	113.6
Saskatoon, SK	56.5	54.6	59.3	65.3	80.0	85.5	91.5	113.4	81.0	92.8	102.3
Vancouver, BC	58.1	54.2	59.2	69.5	88.1	89.0	93.5	115.6	83.2	100.1	119.7
Victoria, BC	58.0	53.6	62.9	72.3	90.8	94.1	99.9	126.3	93.2	108.6	129.7
Whitehorse, YK	63.1	57.5	64.5	72.3	88.4	94.1	102.3	125.6	94.6	106.3	128.3
Yellowknife, NT	51.9	49.0	56.5	62.0	81.3	84.8	96.4	122.6	87.1	97.0	120.4

Table 5 Price for household heating fuel oil (cents/litre) by province (PEI Statistical Review, 2011)

proved short-lived as prices have since exceeded the previous 2008 price peak (Table 5).

While the rising cost of space heating on PEI did not figure into the City of Summerside's decision to pursue the development of a wind farm, these price trends were considered very closely by Dr. Larry Hughes, the consultant hired by Summerside Electric to study the question of how best to address the utility's over-supply problem (Interviews: 2; Hughes, 2009, 2012). In his report to Summerside Electric, Hughes (2012, p.2, emphasis added) noted:

> The energy demand of Summerside's two principal energy services—transportation and heating—are met almost exclusively from refined petroleum products. In fact, more than three-quarters of P.E.I.'s secondary energy demands are met from imported refined petroleum products such as gasoline and light fuel oil. Of the total petroleum available to the province, about 38% is used for space and water heating in the residential, commercial and institutional, and industrial sectors (Natural Resource Canada/Office of Energy Efficiency, 2011). *Events, both local and global, that cause supply disruptions, increase the price of crude oil, or require the reduction in greenhouse gas emissions will all have a detrimental effect on Summerside's energy security in terms of energy availability, affordability, and environmental acceptability.*

In addition to identifying space heating as a potential outlet for Summerside Electric's excess wind-generated electricity, Hughes' proposition also brought the idea of energy security into the forefront, noting that the capacity to become less dependent on energy imports in general over the long term should not be undervalued (Interviews: 3; Hughes, 2012). This idea of shielding Summerside Electric (and its customers) from the vagaries of the world market resonated particularly strongly with the core Team members, all of whom were involved in hurriedly seeking out a new energy purchase agreement following Nova Scotia Power's decision to dramatically raise the rates of its electricity exports in 2002 (Interviews: 3).

5.3.2 Regime

At the regime level, the City of Summerside's municipal structure and assets, a tradition of innovation among City staff, and the character of the Council were key factors.

The City's important stake, as the sole shareholder, in Summerside Electric cannot be over-emphasized. City staff and Councillors fully appreciate the benefits the City derives through this municipal structuring (Interviews: 4). In a 2012 submission to the PEI Energy Commission, the chairman of the Summerside Electric Utility Committee described Summerside Electric as a "not-for-profit, community-owned institution, subject to local oversight and control, providing a service that is *crucial to our community's economic health and quality of life*" (City of Summerside, 2012d, p.2, emphasis added). In an interview, a director-level City employee described the utility as an "economic development enabler" was key to City growth (Interview: 1). A City of Summerside councillor, in turn, emphasized that the City was "very fortunate" to have a close and mutually beneficial relationship with Summerside Electric (Interview: 1).

Had this subsidiary relationship between the City and its utility not existed, the City would not have considered investing in the development of a wind farm as a means of creating a new revenue stream to service the debt incurred following the construction of Credit Union Place (Interviews: 5). By extension, the City's decision to invest in *Heat for Less* could be framed as a means of maximizing the value of a City-owned asset, namely its wind farm. This relationship between the City and its utility, then, was instrumental in the development of both the wind farm and *Heat for Less*.

It is critical to note that the option to invest in a renewable energy project was made possible only because of the availability of federal grants (which offset the bulk of the cost of building the wind farm). Had these grants not been available, and had the City of Summerside not been eligible to apply for this funding, it is likely that this project would not have moved forward.

In addition to this particular municipal corporate structuring, the City's tradition of innovation also propelled *Heat for Less* forward. Many interviewees remarked on how the City's decision to pursue the wind farm and *Heat for Less* were in keeping with some of its previous undertakings, such as the revitalization of the West Beach (see Chapter 4) and the development of *Route 2*, a city-owned wireless internet service provider that caters to rural western PEI (Interviews: 4; City of Summerside, 2013). Some interviewees attributed this "innovative spirit" to one Team member in particular (Interviews: 2), while others (especially those slightly removed from *Heat for Less*) understood it as part of the culture at City Hall (Interviews: 2). A comment made by one director-level City employee captures this attitude succinctly: "we're a blue collar town with white collar ambitions. You're going to fail sometimes, but you'll never know if you don't swing" (Interview: 1).

Lastly, the character of the Council was a key factor at the regime level. Initially, councillors were supportive of the proposal to redirect unused funds from the wind farm budget to a subsidiary program: there was no risk and no cost. The mood in Council became less supportive when it appeared this project had taken on new risks (perceived by some as encroaching into the domain of the private sector) and new costs (as Summerside Electric was now requesting funding to pursue the project further). While Council ultimately voted in favour of funding *Heat for Less* further, it became at one point a very contentious and divisive project, barely escaping being discontinued entirely (Interviews: 2). In this way, the Council's hard-earned support played a key role in the development of *Heat for Less*.

Before moving on to the final level of structuration, it is important to note that regime, in this case, is used to describe the dominant rules and guiding principles of Summerside's electricity system. Understanding this boundary is important as I do not portend to discuss either the broader provincial electricity or energy systems which impact Summerside, but strictly the rules and dominant routines of Summerside's electricity system.

5.3.3 Niche

At the niche level, Summerside Electric's close relationship with the City of Summerside staff, and the willingness of Team members to re-evaluate and rework elements of *Heat for Less* were key factors. From the outset of *Heat for Less*, Summerside Electric employees worked directly with City of Summerside staff. (The core Team was made up of two City staff and one Summerside Electric employee.) Therefore, the separation between these entities was, and continues to be, relatively fluid (Interviews: 2). The overlap between Summerside Electric and the City of Summerside allowed the Team to call upon the expertise present in either organization whenever necessary (Interviews: 2). In spite of the seemingly blurred lines of this partnership, the distinctness of the partnered organizations worked to enforce a system of accountability, as each partner felt beholden to the other to meet agreed upon project milestones (Interviews: 4).

In addition to the close city-utility organizational ties, *Heat for Less* also benefited from the Team's willingness to learn from their experiences. "The research and development doesn't stop," said one director-level Team member, "we're learning everyday" (Interview: 1). This spirit of ongoing experimentation played an important role in the roll-out of *Heat for Less*. For example, the original phased expansion of the fibre network focused on residential areas. When it was observed that commercial and industrial clients were interested in *Heat for Less*, the Team adjusted its deployment strategy, noting that a few large clients could finance the expansion of the project into the residential sector (Interviews: 2). Similarly, when councillors critiqued the Team for not making use of local contractors, the Team responded by revisiting its logistics and business models, educating local contractors, and hiring a business manager to coordinate subcontractors during ETS installs (Interviews: 2).

5.3.4 MLP and Heat for Less

To close this section, I will return to the second sub-question posed at the outset of this chapter: How does the MLP contribute to my understanding of this transition? Similar to SNM, the MLP works to reveal differentiation in the *Heat for Less* story. While SNM focussed on the internal niche processes, the MLP works to enlarge the 'unit of study', so as to take account of the larger systems that contextualized the development of *Heat for Less*. Figure illustrates these nested systems, showing how a range of factors –cultural, social, political, economic, and technological– interacted with each other, supporting and reinforcing the development of *Heat for Less*. Each of these factors played a part in furthering *Heat for Less* along its transition pathway. I will now turn my attention to analysing the dynamics of the transition itself, using Geels & Schot's (2007) typology of transition pathways to characterise the development of *Heat for Less*.

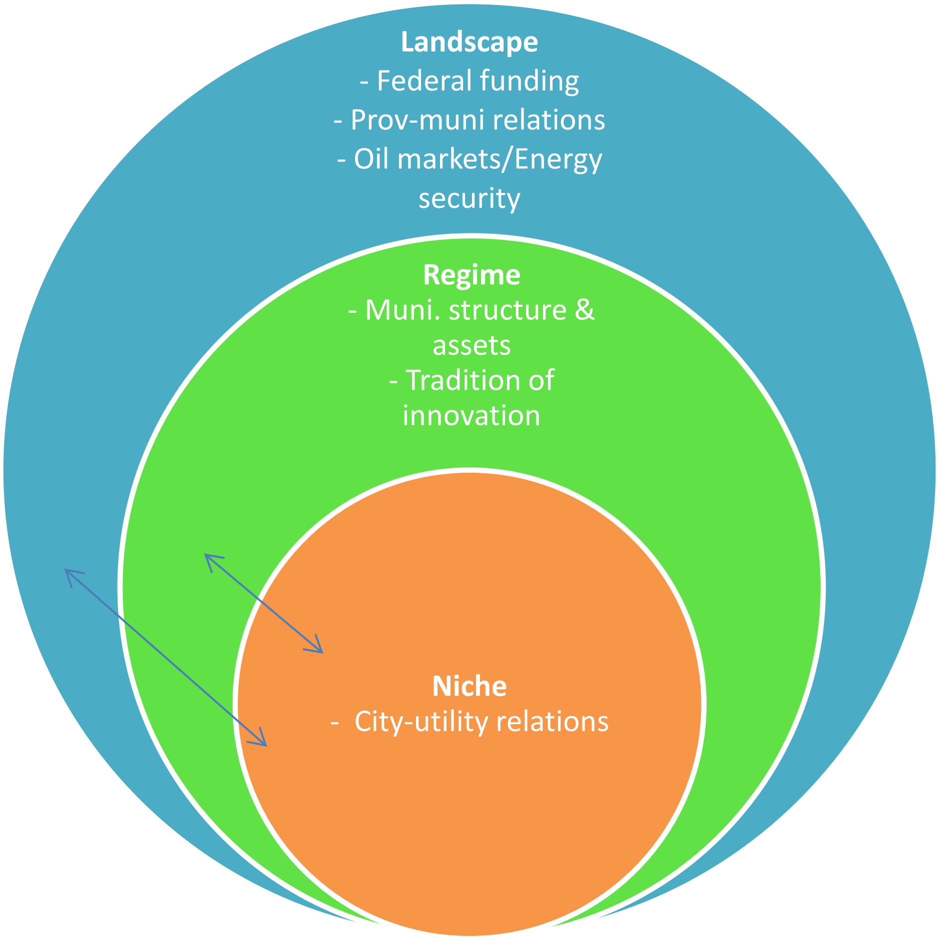

Figure 17 Understanding *Heat for Less* through the MLP. *Source*: author, 2014.

5.4 Transition Pathways

Early MLP studies suggested that radical innovations emerge in niches, gained momentum and support, and proceeded to overthrow the existing regime (see Geels, 2002, 2004; Schot & Geels, 2008). While this pattern has been documented in the literature, it is less likely in large infrastructure-based systems, characterised by sunk investments and high entry barriers (such as electricity systems) (Verbong & Geels, 2010). Transitions that occur in these types of systems are not typically 'niche-driven', however patterns have emerged based on MLP studies of transitions in the electricity sector. Verbong & Geels (2010), building on the typology put forth by Geels & Schot (2007), suggest that transitions in electricity systems follow one (or a sequence) of four pathways: transformation, technology substitution, reconfiguration, and de-alignment and re-alignment. These pathways are discussed at length in in section 2.8 (see p.25), and are summarized here in Table 6.

In this section I will discuss which transition pathways most closely match the experience of *Heat for Less*. To conduct this analysis, I will juxtapose interview data with the transition pathways, as described in Table 6. This section will close by discussing the third sub-question posed at the outset of this chapter: How do the transition pathways contribute to my understanding of this transition?

Based on the descriptors provided in Table 6, two pathways seem out of step with the history of *Heat for Less* conveyed in Chapter 4. First, the experience of *Heat for Less* does not conform to the technology substitution pathway, as the technology developed at the niche level – a network of ETS units, linked via a fibre network, designed to charge when excess electricity is available – was not designed to compete against (with the aim of subverting and replacing) the

Transition pathways	Main actors	Type of (inter)actions	Key words
1. Transformation	Regime actors and outside groups (social movements)	Outsiders voice criticism. Incumbent actors adjust rules (goals, guiding principles, search heuristics)	Outside pressure, institutional power struggles, negotiations, adjustment of regime rules
2. Technological substitution	Incumbent firms versus new firms	Newcomers develop novelties, which compete with regime technologies	Market competition and power struggles between old and new firms
3. Reconfiguration	Regime actors and suppliers	Regime actors adopt component-innovations, developed by new suppliers. Competitions between old and new suppliers	Cumulative component changes, because of economic and functional reasons. Followed by new combinations, changing interpretations and new practices
4. De-alignment and re-alignment	New niche actors	Changes in deep structures create strong pressure on regime. Incumbents lose faith	Erosion and collapse, multiple novelties, prolonged uncertainty

	and legitimacy. Followed by emergence of *multiple* novelties. New entrants compete for resources, attention and legitimacy. Eventually one novelty wins, leading to restabilisation of the regime	and changing interpretations, new winner and restabilisation

Table 6 Main actors and (inter)action in transition pathways (Geels & Schot, 2007).

incumbent electricity system regime. Rather than seek to overthrow the incumbent electricity regime, *Heat for Less* was designed to complement the regime, using new technology to respond to a localized problem (Interview: 1). Second, the experience of *Heat for Less* does not conform to the de-alignment and re-alignment pathway, as *Heat for Less* did not emerge as a 'winner' in the market, rising to challenge the incumbent regime. Instead of emerging as the most effective technology among numerous competing niche technologies, *Heat for Less* was *selected* for development by the City of Summerside (a central regime actor) as the most appropriate means of addressing Summerside Electric's over-supply problem (Interviews: 2; City of Summerside, 2012a, 2012b).

The two remaining pathways (transformation and reconfiguration) bear closer resemblance to the *Heat for Less* experience; I suggest that the *Heat for Less* transition is one in which both of these pathways were followed in sequence (i.e. transformation then reconfiguration), a phenomenon that is not uncommon in the literature (Geels & Schot, 2007; Verbong & Geels, 2010). Elaborating on the description provided in Table 6, the transformation pathway is characterised by,

> external pressure and gradual reorientation of existing regimes. Although external pressures create 'windows of opportunity' for wider change, niche innovations are insufficiently developed to take advantage of them. *Change is therefore primarily enacted by regime actors*, who reorient existing development trajectories (Verbong & Geels, 2010, p.1216, emphasis added).

The proposal to launch a pilot project to resolve Summerside Electric's over-supply problem could be qualified as "external pressure," in that the utility lobbied the City of Summerside to invest in an experimental program designed to minimize its financial losses. The City accepted this argument, financing the initial phase of *Heat for Less*. In this way, activity at the niche level (research & development) was sanctioned and supported by the regime, in keeping with the transformation pathway.

The City's decision to fund *Heat for Less* beyond its pilot phase in 2013 represents a shift toward the reconfiguration pathway. According to Verbong & Geels (2010), the reconfiguration pathway is one in which the regime,

> adopts certain niche-innovations into the system as add-ons or component substitutions, leading to a gradual reconfiguration of the basic architecture and changes in some guiding principles, beliefs and practices… the *cumulative adoption of new components changes the basic architecture of the regime substantially* (p.1216, emphasis added).

Heat for Less is best understood as an "add-on" technology, complementing as opposed to subverting existing electricity regime technologies, fitting with the reconfiguration pathway. Though it could be argued that *Heat for Less* subverts the market share enjoyed by furnace oil providers, as well as that held by telecommunications companies, these regime actors operate outside of the electrical and municipal spaces, and therefore hold limited power in this particular municipal-utility/regime-niche interaction. Raven (2007) and Konrad et al. (2008) have discussed the idea of *multi-regime* interactions, which may be an appropriate way of describing the lobbying effort made by telecommunications companies. Local oil companies, though, have seemingly taken little notice of *Heat for Less*, which is perhaps indicative of the limited impact the program has had on the provincial residential heating marketplace (to date).

While the gradual reconfiguration of "the basic architecture" of the regime may not be evident at this time, I believe that the cumulative adoption of new components (e.g. increased deployment of ETS units, expansion of the fibre network) has changed the guiding principles, beliefs and practices at the regime level. For example, many interviewees described a future scenario in which the city-owned fibre network works to attract technology firms to Summerside (Interviews: 5). That such a novel idea (that it is in the City's interest to pursue partnerships with high-tech start-ups[24] interested in testing their services and products on a fibre network, for instance) has become commonplace speaks to how new principles, beliefs and practices have emerged and gained legitimacy in the wake of the adoption of new technologies. By expanding into renewable electricity generation (wind farm) and subsequently into fibre networking (*Heat for Less*), the regime has inadvertently redefined what it means to be a municipal government and an electricity utility in Summerside. Figure illustrates this gradual pattern of regime reconfiguration.

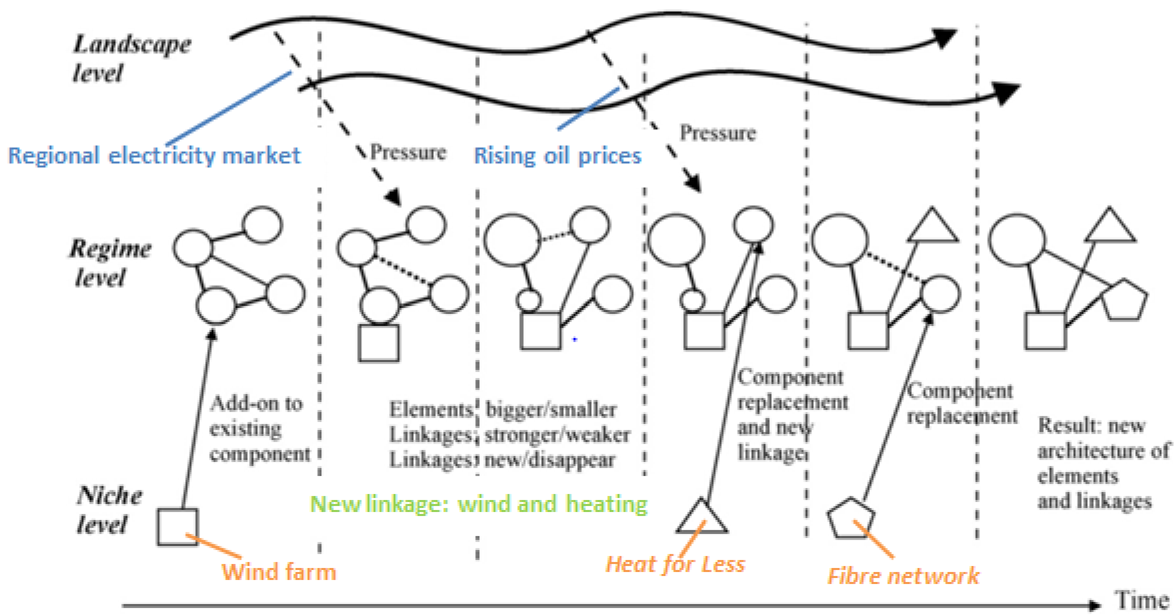

Figure 18 Summerside's electricity 'reconfiguration' (adapted from Geels & Schot, 2007).

5.4.1 Transition pathways and Heat for Less

Returning to the sub-question posed at the outset of this section, the transition pathways provide yet another lens through which transitions can be conceptualized. While SNM importantly draws attention to the internal niche processes, and the MLP highlights the 'big picture', the transition pathways focuses on understanding how and why a transition occurred, and what this means for the regime. Further, the pathways serve as archetypes of sorts, demonstrating the various journeys niche technologies have followed en route to the regime. In this way, the transition pathways framework may provide valuable insights to utilities and

[24] In addition to software firms, the City is also seeking out hardware firms. In March 2014, the City issued a request for information, seeking consultation for the development of a "electric vehicle to grid" program (City of Summerside, 2014).

governments seeking to better understand how an ongoing or future transition might affect regime structures.

5.5 Synthesis

Having put this suite of sustainability transitions frameworks to work, what have I learned? Another way of asking this question is to consider how (or if) the above analysis adds to my understanding of the events presented in Chapter 4. Taken together, these analytical frameworks contribute to my understanding of the *Heat for Less* transition in three ways. First, these frameworks add granularity to the *Heat for Less* story. By drawing attention to particular internal niche processes (processes which have been documented to increase the likelihood of a niche technology's success), the actions of the *Heat for Less* Team are put into focus, showing the importance of agency at the niche level. In this way, the SNM frame in particular worked to focus my attention on the actors that are on the 'front lines' of technology innovation, paying attention not only to the technology itself, but to the social and cultural routines that drive the social and political acceptance of *Heat for Less*.

While the heuristic lens of the SNM provided me with insights, some important data points did not fit neatly in this framework. For example, many interviewees remarked on the importance of third party approval and other forms of public recognition in securing support for *Heat for Less* from Council. Whether it was a budget line read aloud in the House of Commons, a local CBC radio interview, or receiving an award from the Federation of Canadian Municipalities, project proponents felt public recognition was important in terms of swaying hesitant councillors and reassuring proponents (Interviews: 3). This type of recognition, though, fits awkwardly into the internal niche processes as they are not occurring 'within' the niche, per se, but nonetheless work to propel niche activities or support niche actors.

Second, these frameworkss emphasize that technologies do not emerge from a vacuum, but exist in complex socio-technical systems. In particular, the MLP, in that it worked to distinguish between the niche, regime and landscape, placed *Heat for Less* within its broader context, showing how different events, actions, policies, and worldviews coincided, across different levels, to create an opening for this transition. This perspective allowed me to 'see' the history of *Heat for Less* not as a linear series of events, but as a multi-levelled web of actions, policies, technologies and worldviews, each working to reinforce or weaken particular social-technical bonds. This framework, then, complicates this innovation story, in that it revealed the interconnectedness of social-technical systems, as well as the importance of these relationships. Further, the MLP worked to 'spread' the agency, illustrating how decisions and processes at the niche *and* at the regime levels were instrumental in the success of this transition, and that landscape factors worked to create a favourable context for those decisions and processes to play out.

At times, though, I felt the wide-angle view of the MLP, with its emphasis on process and cross-level interactions, obscured the important role played by individual champions of *Heat for Less* operating at the regime level (Genus & Coles (2008) have raised similar concerns). Many interviewees, for example, attributed a great deal of importance to one individual in particular who importantly championed the potential of *Heat for Less*, making a strong case for the program in local, provincial and federal circles (Interviews: 3). The concept of a singular (seemingly homogenous) regime makes it difficult to account for instances that, following the SNM, might be described as "internal *regime* processes".

Third, these frameworks worked to dispel the popular narrative that innovation typically occurs from the bottom-up (e.g. Berkhout et al., 2003). Transitions take many different shapes, and the typology of transition pathways provided me with a kind of classification system, so as to better understand the processes that have taken place or may take place in the future. This typology, in that it offers a set of different paths that technologies have 'travelled' in the past, helped me make sense of the *Heat for Less* case. In terms of understanding the *Heat for Less* experience, the transition pathways proved particularly insightful as the dynamics of this case do not fit with those typically described in MLP studies as the niche technology in question is so closely attached to the regime. This notion, that the city-utility relationship was of great import in terms of the success of *Heat for Less*, which began to show itself in the overlap between the regime and niche levels in the MLP analysis, was cast under new light when considered in terms of the transformation and reconfiguration pathways. This sequence of pathways speaks to the importance of existing regime-niche/city-utility linkages, and how these directly contributed to the ultimate success of *Heat for Less*.

5.6 Limitations

There are limitations to this analysis. As noted in Chapter 3, the purpose of this case study is not to draw *statistical* generalizations from the collected data. Instead, my objective was to use the collected data to make *analytical* generalizations, so as to speak back to the theoretical positions put forth in the literature. I would suggest that the analysis in this chapter succeeds in this regard, juxtaposing theoretical positions with empirical case data gathered through interviews and document analysis. In this way, this work should be read as an attempt to test the propositions put forth in the literature against real-life data from an ongoing technology transition. Conversely, this work should *not* be read as an instruction guide for technology transitions. The findings of this study do not portend to be generalizable in the sense that similar actions in a different setting would likely yield different outcomes. This is not to say that the *Heat for Less* case does not present an interesting model for smart grid development, but merely that the exact landscape, regime and niche factors present in this case (and the outcome of their interactions) are unlikely to be identically reproduced in other settings.

Further, when considering the findings put forth in this chapter, it is important to recall the relatively small scope of this project. As a researcher immersed in this story, there was a temptation to overstate the impact of *Heat for Less*. It remains, though, that *Heat for Less* is a relatively small program undertaken by Summerside Elecric, a utility that serves a City of approximately 15,000 people. Again, this is not to discredit this achievement (indeed, it could be argued that the small and dynamic nature of Summerside Electric contributed to the success of this project), but merely to locate this project in the larger regional, provincial and national contexts of the Canadian smart grid landscape. Geels & Raven (2006), reflecting on a similar point regarding the impact of localized transitions on larger socio-technical systems, put forth the idea that the experiences of and findings derived from local projects should be aggregated so as to inform a larger technical trajectory (Figure). This aggregation only occurs, I would submit, when local experiences are studied, analysed, and shared with others. It is my hope that this study will stand as a small contribution toward this end.

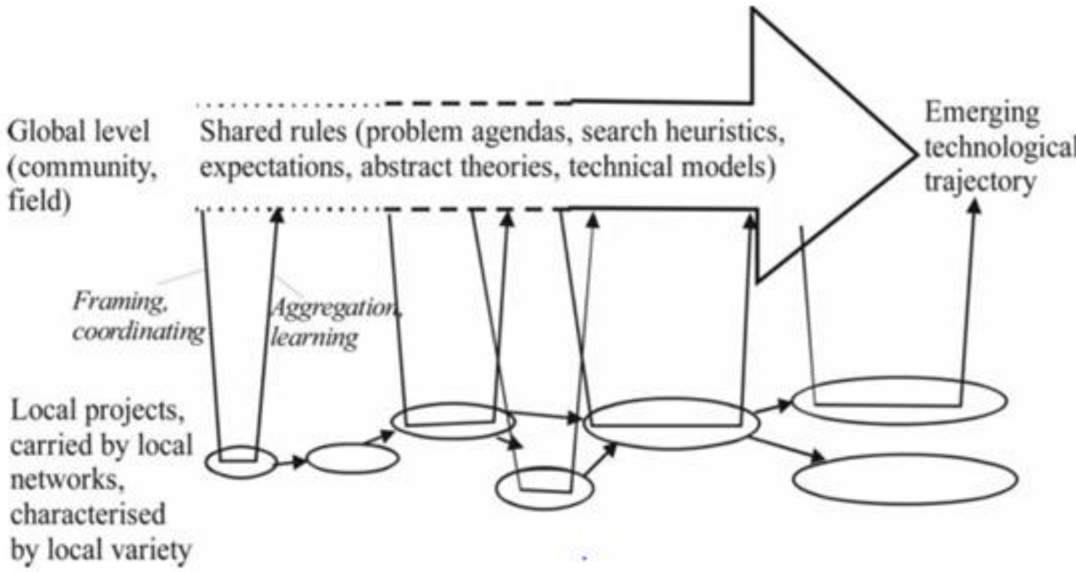

Figure 19 Emerging technical trajectory informed by local projects (Geels & Raven, 2006)

5.7 Summary

This chapter set out to analyse the *Heat for Less* case, as presented in Chapter 4, through the use of a suite of analytical frameworks so as to deepen (and broaden) my understanding of this technology transition. It should be remembered that the three sub-questions posed at the outset of this chapter were borne out of one initial question: How and why did Summerside Electric's *Heat for Less* transition into the mainstream? I would submit that the sub-questions discussed in this chapter have provided me with a more sophisticated understanding of the *Heat for Less* case, allowing me to more fully answer the question at the root of this study. I reflect on this answer further in the following chapter of this study, wherein I discuss my conclusions and present my recommendations for further study.

Chapter 6: Conclusion and recommendations

6.1 Introduction

The objective of this thesis was to develop an understanding of how and why Canadian smart grids transition into the mainstream. As discussed in Chapters 1 and 2, better understanding of how and why smart grids transition is especially important in Canada, as many smart grids have failed to move beyond the pilot stage (CanmetENERGY, 2013).

To study this area, I conducted a case study of *Heat for Less*, a Canadian smart grid that has transitioned into the mainstream. My thesis asked: How and why *Heat for Less* transitioned into the mainstream? After reviewing the literature on sustainability transitions, I expanded my question to include three sub-questions, each based on theoretical frameworks identified as relevant to the study of niche projects undergoing transition in the electricity sector. I expressed my expanded research question as follows:

1. How and why did Summerside Electric's *Heat for Less* transition into the mainstream?
    a. How does SNM contribute (if at all) to our understanding of this transition?
    b. How does the MLP contribute (if at all) to our understanding of this transition?
    c. How do the transition pathways contribute (if at all) to our understanding of this transition?

My primary question was answered in Chapter 4 of this thesis, wherein I used interview data and document analysis to build a case study of *Heat for Less*, discussing how and why the project transitioned into the mainstream. Chapter 5 reviewed this case study, analyzing my case findings by answering the three sub-questions listed above.

Returning to these findings, this chapter will first synthesize my empirical findings. Second, I will discuss the theoretical and policy implications of these findings. Finally, I will make recommendations for future research.

6.2 Empirical findings

The main empirical findings of my case study are discussed at length in Chapter 4 of this thesis. This section will synthesize these findings, answering my study's primary research question.

The transition of *Heat for Less*, from niche project to regime mainstay, did not follow a direct route. Chapter 4 details the unique technological, historical and social context that provided both the impetus and means for the successful development of *Heat for Less*. Technologically, *Heat for Less* can be framed as an outgrowth of Summerside's wind farm. Completed in 2009, the wind farm over-supplied the City with electricity at off-peak hours. Because of the purchase agreement struck between Summerside Electric and the City of Summerside (the owner of the wind farm), the utility was incurring losses by exporting its excess supply of electricity to New Brunswick Power. For this reason, *Heat for Less*, insofar as it represented a means of increasing local demand for electricity at off-peak hours, can be seen as technological fix to the utility's business dilemma.

As Chapter 4 discusses, though, a strictly technological retelling of the *Heat for Less* case obscures the many other factors that affected the development of this project. In particular, the relationship between Summerside Electric and Maritime Electric played an important role in this case. Following the installation of submarine transmission cables in 1977, Summerside Electric shifted its supply portfolio to take advantage of the attractive electricity prices brokered by Maritime Electric (Interview: 1; PEI Energy Commission, 2012). Over the next twenty years, Maritime Electric's rates rose substantially (in relation to rates charged in neighbouring New Brunswick and Nova Scotia), forcing Summerside Electric to reconsider the terms of its purchase agreement. Upon exiting its contract with Maritime Electric, a provisional clause granted Summerside Electric the right to use Maritime Electric's transmission cables to access the open market (Interviews: 3).

This new arrangement was critical for two reasons. First, Summerside Electric initially struggled to secure a feasible purchase agreement on the open market, instilling a weariness of the vagaries of the open market among utility directors (Interviews: 2). My research found that this sentiment motivated Summerside Electric to explore the development of local generation. Second, as Summerside Electric began profiting from the sale of imported power, the City of Summerside began considering its utility as an important source of revenue (Interviews: 2; City of Summerside, 2013). This factor was critical, as it can be seen as antecedent to the decision to build a city-owned wind farm to increase City revenues. Viewed this way, *Heat for Less*, though it was launched in 2011, has roots that extend much further back into the utility's and the City of Summerside's histories.

Related to these last points, that Summerside Electric is a municipally-owned utility played a significant role in the development of *Heat for Less*. As I noted above, the City took great interest in developing the capacity of its utility so as to increase revenues. Establishing new revenue streams became especially important in the wake of new, capital-intensive municipal projects, in particular Credit Union Place. Indeed, some interviewees went as far as to trace a chain of causality from Credit Union Place to the wind farm, and from the wind farm to *Heat for Less* (Interviews: 3). To make possible such a sequence of events requires a close working relationship between the City and its utility. As noted, this relationship enabled the City to take advantage of federal and provincial infrastructure development funds to develop a revenue-generating asset. Likewise, Summerside Electric was able to make use of City resources to pilot *Heat for Less*.

This is not to say that the project did not suffer setbacks. After being lobbied by the major telecommunications companies, many councillors grew skeptical as to whether building a city-owned fibre network, as Summerside Electric proposed, was the best way forward for *Heat for Less*. When put to the vote in 2012, Council was split evenly on whether the project should be continued. While the project was ultimately supported, this vote nearly saw the project discontinued, highlighting the roles played by politics, business, and policy communication in the success of *Heat for Less*.

The points detailed above answer my research question, illuminating the processes (how) and motivations (why) that drove *Heat for Less* to transition into the mainstream. While one might be tempted to frame this case as a technological fix being creatively applied to solve a business dilemma, this reductionist reading obscures the other influencing factors identified above. This observation underscores the value of in depth case studies that highlight not only the present-state of a technology, but also the political, economic and social aspects of the transition process. In this regard, this study contributed an original, in depth analysis of *Heat for Less* to the literature on Canadian smart grids, and in so doing documented the modern history of electricity and electricity policy in one of PEI's largest communities.

These findings were then analyzed using a suite of theoretical frameworks described in Chapters 2 and 3. The outcome of this analysis is discussed in Chapter 5 and is synthesised below.

6.3 Theoretical implications

After answering my primary question in Chapter 4, I delved into my sub-questions in Chapter 5. After reviewing the literature on sustainability transitions in Chapter 2, I was interested in examining how the 'tools' used in this field might respond to the shortcomings of the Canadian smart grid case study literature identified in the same chapter. These frameworks functioned as heuristic devices, pointing me toward particular lines of questioning which produced insights beyond those captured in Chapter 4.

The SNM framework, in that it focuses on internal niche processes, drew attention to the actions and policies that occurred at the niche level. As noted in Chapter 3, the case study has been criticized for producing large, sprawling documents. The SNM framework sifted this information, focusing attention on the actions and policies of the *Heat for Less* Team. While the SNM framework worked to 'zoom in' on niche processes, the MLP framework worked to place these activities into a larger context, casting light on the macro-scale currents, such as rising oil prices, that indirectly contributed to the success of *Heat for Less*. Further, the MLP situates the regime, the incumbent mainstream actors, within the mix. The process of identifying actors and placing them in the MLP's classification helped me think in terms of the relationships and structures that exist in and affect Summerside and its electricity sector, and how these played out in the *Heat for Less* case. As for the transition pathways, this framework helped solidify my hypothesis that the *Heat for Less* transition did not conform with the bottom-up trajectory sometimes (but mistakenly) equated with the MLP (Geels & Schot, 2007). Instead, the regime experienced 'transformation' and 'reconfiguration', as incumbent regime actors deliberately adopted disruptive niche technologies which the City of Summerside had sanctioned through its own research and development efforts.

Using these three frameworks in sequence is a theoretical contribution in itself. This novel application of theoretical frameworks suited my objective of better understanding how and why smart grid projects transition into the mainstream, providing different insights into the actions, processes, and cross-level interactions that spurred this innovation forward. In this way, this study might serve as a methodological model for future smart grid research.

6.4 Policy implications

In terms of policy, the primary contribution of my thesis is in its enlarging the scope of what it means to undertake a smart grid case study. As discussed in Chapter 2, much of the existing research on Canadian smart grids focuses on technological configuration and performance. And while I agree that these features are central to any smart grid project, my research shows that technology alone is not sufficient to spur a project into the mainstream. Rather, social, political and economic systems must be in place to support such a transition. Given this reality, utility managers and provincial governments would do well to consider smart grid research and development from this holistic and interdisciplinary perspective, considering a full range of factors so as not to isolate (and strand) a developing technology at the niche level.

Second, the *Heat for Less* case is instructive for policymakers with regards to its many value propositions (the so-called "co-benefits"). As discussed in Chapter 5, the project went through phases, learning from its missteps and making adjustments. One of these adjustments relates to how the Team began framing the project. "We initially pitched the project to Council as an operational improvement," said a Summerside Electric senior staff person, "not as a community benefit" (Interview: 1). As research on the roll-out of smart meters across Canada shows, the way in which ideas are framed and communicated affects popular opinion and public support.[25] Understanding this, perhaps intuitively, the Team began placing the community benefit at the centre of the project, and Council reacted by becoming more amenable to the project. In prioritizing the community benefits, a larger emphasis shifted to realizing these benefits, such as reining in GHG emissions, creating savings for program participants, creating jobs for local contractors, providing program participants with free (or low cost) internet services via their

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[25] See the studies conducted by Derek Peters; Xavier Descesnes-Philion; and Alexandra Mallett, https://uwaterloo.ca/sustainable-energy-policy/projects/unlocking-potential-smart-grids-partnership-explore-policy (accessed 3 March 2013).

fibre connection, and envisioning a future in which entrepreneurs make use of a City-owned fibre network to develop new products and services (Interviews: 4; City of Summerside, 2011).

Third, the *Heat for Less* case is remarkable because of the mutually beneficial city-utility relationship. As discussed in Chapter 4, the City invested in a wind farm to generate revenues for the general fund, and the utility, in turn, hedged the risk of this investment by guaranteeing that it would purchase all the electricity produced by the City's wind farm (Interviews: 2). This arrangement made the City's foray into wind generation (a unique case among Canadian municipalities) virtually risk-free. The lack of such (safe) opportunities act a barrier to investment in innovation (Geels et al., 2008). Policy-makers interested in promoting smart grids might consider how best to create a climate that takes steps to minimize risk so as not to preclude a break from the status quo.

Finally, the *Heat for Less* case is interesting from a policy standpoint because it challenges the conventional wisdom that views innovation and risk-taking as the hallmarks of the private sector, and not typically associated with municipal governments (let alone particularly small municipal governments). However, as this case study illustrates, the City of Summerside, in cooperation with Summerside Electric, was uniquely well-positioned to take on a project that a) increased utility revenue (and by extension, City revenue), b) lowered the cost of heating for participating Summerside residents, and c) decreased greenhouse gas emissions. Given that technological innovation is not de facto in the public interest, perhaps municipalities would do well to follow the example set by City of Summerside, and seek to drive innovation so as to achieve ends that benefit the local economy and environment.

6.5 Recommendations for future research

Looking toward the future, there are opportunities to conduct additional research on *Heat for Less*. While interviewing program participants was beyond the scope of this study, the exclusion of these voices expose a gap worthy of future investigation. Here, Rogers' diffusion of innovations theory (2003), for example, could serve to identify the factors which foster (or impede) participation in *Heat for Less*. The results of such a study could prove immensely beneficial to electricity systems managers undertaking any type of project that hinges on voluntary uptake of new technologies.

Further, there are opportunities to build on this study by conducting comparative analyses. Having established a novel methodological and analytical approach, this format could be transposed onto other case studies for comparative purposes. For instance, conducting a multi-case study of *Heat for Less* and Powershift Atlantic,[26] a Maritime-based consortium of smart grid projects (one of which involves shifting demand through the deployment of electric hot water tanks in Halifax), may produce interesting insights. While in the same region, these projects differ in terms of scale, financing, and organizational structure. Has one proven to be more effective at achieving the desired outcomes, and if so, why? A comparative case study based on the methodological approach detailed in Chapter 3 could answer such a question.

Lastly, there is an opportunity for this research to serve an applied purpose. In keeping with the competence kit for practitioners developed by Raven et al. (2010), insights from this study could be used to develop a workshop for practitioners, introducing those on the front lines to the frameworks used in this research so as to stimulate reflection on internal niche processes and possibly inform future policy making, bridging the gap between theory and practice.

6.6 Conclusion

This chapter accomplished four tasks. First, it reviewed the empirical findings of this study, noting how my research has contributed to the Canadian smart grid literature. Second, this chapter reviewed the theoretical implications that flowed from my analysis of these findings. Here, I discussed the insights that emerged from my use of a suite of theoretical sustainability transitions frameworks. Third, this chapter discussed what these findings mean to policymakers. Finally, I closed this chapter by making recommendations for future research.

[26] As noted in Chapter 2, NRCan has conducted a case study of Powershift Atlantic, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/2013-057_en.pdf (accessed 3 May 2013).

Bibliography

Babbie, E. (2010). The practice of social research, 13th edition.

Barriball, K., While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing 19*(2), 328-335.

Berkhout, F., Smith, A., & Stirling, A. (2003). Socio-technological regimes and transition contexts Socio-technological regimes and transition contexts, *44*(106).

Bernard, H. (2000). Data management and analysis methods.

Bowen, G. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal 9*(2), 2-40.

CanmetENERGY. (2013). Smart Grid in Canada 2012-2013 CanmetENERGY – Smart Grid Knowledge Sharing.

City of Summerside. (2011). Economic Development Action Plan: Full Report.

City of Summerside. (2012a). Smart Grid Project: A Presentation to Council.

City of Summerside. (2012b). Community Wind Success: Summerside Wind Plant.

City of Summerside. (2012c). *Heat for Less*: Electric Thermal Storage.

City of Summerside. (2012d). Submission to PEI Energy Commission.

City of Summerside. (2013). Summerside Electric: Operations Overview.

City of Summerside. (2013). Summerside Budget: 2013.

Chopra, A. et al. (2011). A Policy Framework for the 21st Century Grid: Enabling our Secure Energy Future. *US National Science and Technology Council*.

Clastres, C. (2011). Smart grids: Another step towards competition, energy security and climate change objectives. *Energy Policy*, *39*(9), 5399–5408. doi:10.1016/j.enpol.2011.05.024

Constitution Act of Canada. (1982).

Faruqui, B. A., Harris, D., & Hledik, R. (2009). October 2009 Unlocking the € 53 Billion Savings from Smart Meters in the EU How increasing the adoption of dynamic tariffs could make or break the EU's smart grid investment, (October).

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, *12*(2), 219–245. doi:10.1177/1077800405284363

Foxon, T. J., Hammond, G. P., & Pearson, P. J. G. (2010). Developing transition pathways for a low carbon electricity system in the UK. *Technological Forecasting and Social Change*, *77*(8), 1203–1213. doi:10.1016/j.techfore.2010.04.002

Geels, F.W. (2005). Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850–1930)—a case study in multi-level perspective. *Technology in Society*, *27*(3), 363–397. doi:10.1016/j.techsoc.2005.04.008

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, *31*(8-9), 1257–1274. doi:10.1016/S0048-7333(02)00062-8

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems. *Research Policy*, *33*(6-7), 897–920. doi:10.1016/j.respol.2004.01.015

Geels, F. W. (2005). Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technological Forecasting and Social Change*, *72*(6), 681–696. doi:10.1016/j.techfore.2004.08.014

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. doi:10.1016/j.eist.2011.02.002

Geels, F. W., Hekkert, M. P., & Jacobsson, S. (2008). The dynamics of sustainable innovation journeys. *Technology Analysis & Strategic Management*, *20*(5), 521–536. doi:10.1080/09537320802292982

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. doi:10.1016/j.respol.2007.01.003

Genus, A., & Coles, A.-M. (2008). Rethinking the multi-level perspective of technological transitions. *Research Policy*, *37*(9), 1436–1445. doi:10.1016/j.respol.2008.05.006

Giles, S. et al. (2010). ACCELERATING SUCCESSFUL SMART. *Forum, World Economic*.

Giordano, V., Gangale, F., Jrc-ie, G. F., Sánchez, M., Dg, J., Onyeji, I., Maschio, I. (2011). *Smart Grid projects in Europe : lessons learned and current developments*. doi:10.2790/32946

Hartmann, T. 1980. "Dynamic control of heat called key to saving energy" Air Conditioning Heating and Refrigeration News, Vol.151, No. 1, pp. 14-16.

Hiscock, J. (2012). Understanding the influence of complementary innovations on niche formation in large energy technology systems: The case of distributed electricity storage in Ontario's electricity system. *Ryerson University - Unpublished Thesis*.

Hughes, L. (2009). Meeting residential space heating demand with wind-generated electricity. *Renewable Energy*, *35*(8), 1765–1772. doi:10.1016/j.renene.2009.11.014

Hughes, L. (2012). The Summerside Smart-Grid Pilot Program : An innovative approach to improved energy security and reduced greenhouse gas emissions.

Hurlbert, M., Mcnutt, K., & Rayner, J. (2010). Policy Pathways : Transitioning to Sustainable Power Generation in Saskatchewan. *Renewable Energy Law and Policy Review, 1*, 87-100.

International Energy Agency. (2011). Technology Roadmap: Smart Grids.

International Energy Agency. (2012). *Energy Technology Perspectives 2012*.

Independent Electricity System Operator. (2011). Smart Grids in the North American Context: A US-Canada Clean Energy Dialogue Event.

International Panel on Climate Change. (2007). Fourth Assessment Report: Climate Change.

International Panel on Climate Change. (2014). Summary for Policymakers.

Johnson, A. P. (2010). The history of the Smart Grid evolution at Southern California Edison. *2010 Innovative Smart Grid Technologies (ISGT)*, 1–3. doi:10.1109/ISGT.2010.5434757

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technology Analysis & Strategic Management*, *10*(2), 175–198. doi:10.1080/09537329808524310

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, *41*(6), 955–967. doi:10.1016/j.respol.2012.02.013

Moffet, M. & Beauvais, D. (2012). Etude de cas: Equilibrage de la production eolienne a l'aide d'accumulateurs thermiques et de chauffe-eaux electriques.

Ngar-yin Mah, D., van der Vleuten, J. M., Chi-man Ip, J., & Ronald Hills, P. (2012). Governing the transition of socio-technical systems: A case study of the development of smart grids in Korea. *Energy Policy*, *45*, 133–141. doi:10.1016/j.enpol.2012.02.005

Natural Resources Canada. (2012). Smart Grid in Canada 2011-2012. *Natural Resources Canada*.

Patton, M. (2005). Qualitative Research and Evaluation Methods. Sage Publications: Thousand Oaks, California.

Patwardhan, A., I. Azevedo, T. Foran, M. Patankar, A. Rao, R. Raven, C. Samaras, A. Smith, G. V. and R. W. (2012). *Transitions in Energy Systems*. *Global Energy Assessment - Toward a Sustainable Future* (pp. 1173–1201).

Paull, L. (2010). A novel domestic electric water heater model for a multi-objective demand side management program. *Electric Power Systems Research 80*(12), 1446-1451.

Peattie, K. (2001). Towards sustainability: the third age of green marketing. *The Marketing Review 2*(2), 129-146.

Prince Edward Island Energy Commission. (2012). Charting Our Electricity Future, *137*(2), NP. doi:10.1093/toxsci/kft286

Prince Edward Island Ministry of Energy. (2008). Securing our Future: Energy Efficiency and Conservation. Charlottetown: Ministry of Energy.

Prince Edward Island Ministry of Energy. (2011). PEI Energy Accord Backgrounder. Charlottetown: Ministry of Energy.

Raven, R., Bosch, S. Van Den, & Weterings, R. (2010). Transitions and strategic niche management: towards a competence kit for practitioners. *International Journal of Technology Management*, *51*(1), 57. doi:10.1504/IJTM.2010.033128

Robson, C. (1993) Real world research: A resource for social scientists and practitioners-researchers. Wiley: United Kingdom.

Rosenbloom, D., & Meadowcroft, J. (2014). The journey towards decarbonization: Exploring socio-technical transitions in the electricity sector in the province of Ontario (1885–2013) and potential low-carbon pathways. *Energy Policy*, *65*, 670–679. doi:10.1016/j.enpol.2013.09.039

Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management*, *20*(5), 537–554. doi:10.1080/09537320802292651

Stephens, J. C. et al. (2013). A Smarter Grid for Climate Change? or Getting Smart: Climate Change and the Electric Grid, 1–14.

Summerhill. (2012). Project Profile: Summerside Electric's Wind Farm and Smart Heating Initiative.

United Nations Environment Programme. (2012). Emerging Issues in our Global Environment.

Unruh, G. (2000). Understanding carbon lock-in. *Energy Policy, 28*(12), 817-830.

Van der Laak, W. W. M., Raven, R. P. J. M., & Verbong, G. P. J. (2007). Strategic niche management for biofuels: Analysing past experiments for developing new biofuel policies. *Energy Policy*, *35*(6), 3213–3225. doi:10.1016/j.enpol.2006.11.009

Verbong, G., & Geels, F. (2007). The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy*, *35*(2), 1025–1037. doi:10.1016/j.enpol.2006.02.010

Verbong, G., Beemsterboer, S., & Sengers, F. (2013). Smart grids or smart users? Involving users in developing a low carbon electricity economy. *Energy Policy*, *52*, 117–125. doi:10.1016/j.enpol.2012.05.003

Verbong, G., & Geels, F. W. (2010). Exploring sustainability transitions in the electricity sector with socio-technical pathways. *Technological Forecasting and Social Change*, *77*(8), 1214–1221. doi:10.1016/j.techfore.2010.04.008

Yin, R. (2009). The Case Study: Design and Methods.

Appendix

A.1 Organization recruitment

Dear [Redacted]:

This letter is a request for Summerside Electric's assistance with a project I am conducting as part of my Master's degree in the Department of Environment and Resource Studies at the University of Waterloo, Ontario, under the supervision of Dr. Ian Rowlands**.** The title of my research project is "A Smart Grid Pilot Project in Transition: A Strategic Niche Management Analysis of Heat for Less". I would like to provide you with more information about this project that explores the role organizations play in creating the circumstances that allow smart grid pilot projects to succeed.

The purpose of this study is to test propositions put forth by scholars of innovations studies so as to better understand how organizations affect the success of new technologies**.** Knowledge and information generated from this study may help other electricity utilities interested in developing smart grids pilot projects.

It is my hope to connect with persons who are, or were formerly, engaged in Summerside Electric's *Heat for Less Now* project to invite them to participate in this research project. I believe that the individuals involved in launching and running this project (hereafter "*Heat for Less Now* team") have unique understandings and experiences relating to how it got off the ground and how it achieved the impact it has. During the course of this study, I will be conducting interviews with the *Heat for Less Now* team. At the end of this study the publication of this thesis will share the knowledge from this study with other technology transitions researchers, energy specialists, and community members.

To recruit participants for this study, I would appreciate if you provided me with a list of contacts, and their work emails, whom fit the profile of participants described above and are interested in participating in this study. I will then send an Information and Consent email to potential participants, describing the study and providing them with contact information for me and my advisor should the recipient be interested in following-up and arranging a meeting time for an interview. Participation is completely voluntary. Each participant will make their own independent decision as to whether or not they would like to be involved. All participants will be informed and reminded of their rights to participate or withdraw before any interview, or at any time in the study. Participants will receive detailed information about this study, as well as informed consent forms.

To support the findings of this study, quotations and excerpts from the stories will be used labelled with pseudonyms to protect the identity of the participants. Names of participants will not appear in the thesis or reports resulting from this study. Participants will not be identifiable, and only described by role vis-à-vis *Heat for Less Now*.

If Summerside Electric wishes the identity of the organization to remain confidential, a pseudonym will be given to the organization. All paper field notes collected will be retained locked in my office and in a secure cabinet in the Department of Environment and Resource Studies at the University of Waterloo. All paper notes will be confidentially destroyed after three years. Further, all electronic data will be stored indefinitely on a CD with no personal identifiers. Finally, only myself and my advisor, Ian Rowlands in the Environment and Resource Studies at the University of Waterloo will have access to these materials. There are no known or anticipated risks to participants in this study.

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation belongs to Summerside Electric, and *Heat for Less* team members. If you have any comments or concerns with this study, please feel free to contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

If you have any questions regarding this study or would like additional information to assist you in reaching a decision about participation, please contact me at (226) 808-6690 or by n2belang@uwaterloo.ca. You may also contact my supervisor, Ian Rowlands at 519-888-4567 x32574 or by email irowlands@uwaterloo.ca.

I hope that the results of my study will be beneficial to Summerside Electric, and to electricity utilities involved in smart grid pilot projects across Canada, as well as the broader energy research community. I very much look forward to speaking with you and thank you in advance for your assistance with this project.

Yours sincerely,

Nicholas Belanger
Master's Candidate
Department of Environment and Resource Studies
University of Waterloo

Dr Ian Rowlands
Professor
Department of Environment and Resource Studies
Associate Director (Global Initiatives), Waterloo Institute for Sustainable Energy
University of Waterloo

A.2 Organization permission form

We have read the information presented in the information letter about a study being conducted by Nicholas Belanger of the Environment and Resource Studies at the University of Waterloo, Ontario, under the supervision of Ian Rowlands at the University of Waterloo. We have had the opportunity to ask any questions related to this study, to receive satisfactory answers to our questions, and any additional details we wanted.

We are aware that the name of our organization will only be used in the thesis or any publications that comes from the research with our permission.

We were informed that this organization may withdraw from assistance with the project at any time. We were informed that study participants may withdraw from participation at any time without penalty by advising the researcher.

We have been informed this project has been reviewed by, and received ethics clearance through a University of Waterloo Ethics Committee and that questions we have about the study may be directed to Nicholas Belanger at 226 808-6690 or by email n2belang@uwaterloo.ca and Ian Rowlands at 519-888-4567 x32574 or by email irowlands@uwaterloo.ca.

We were informed that if we have any comments or concerns with in this study, we may also contact the Director, Office of Research Ethics at (519) 888-4567 ext. 36005.

Nicholas Belanger
Master's Candidate
Department of Environment and Resource Studies
University of Waterloo

Dr Ian Rowlands
Professor
Department of Environment and Resource Studies
Associate Director (Global Initiatives), Waterloo Institute for Sustainable Energy
University of Waterloo

We agree to help the researchers recruit persons that are or have formerly been directly involved in *Heat for Less Now* to be participants for this study***.***

□ YES □ NO

We agree to the use of the name of the Summerside Electric in any thesis or publication that comes of this research.

□ YES □ NO

If NO, a pseudonym will be used to protect the identity of the organization.

Director Name: ___________________________________ (Please print)

Director Signature: ________________________________

Board of Directors Representative Name: ___________________________________ (Please print)

Board of Directors Representative Signature: _______________________________

Witness Name: _____________________________________ (Please print)

Witness Signature: _________________________________

Date: ___________________________________

A.3 Information letter and consent form for interviews

University of Waterloo

Date

Dear ***participant's name:***

This letter is an invitation to consider participating in a study I am conducting as part of my Master's degree in the Department of Environment and Resource Studies at the University of Waterloo under the supervision of Professor Ian Rowlands. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

Innovation, despite having become a buzzword of our time, remains poorly understood by scholars. Policymakers and scholars alike, though, recognize that innovation is needed if we, as a society, are to change direction and opt for more sustainable ways of living and doing business.

Energy plays a major part in this equation, and smart grids in particular have demonstrated their capacity to make the generation, distribution and use of energy more sustainable. Given this, how best can electricity utilities make use of and incorporate these innovative technologies into their everyday processes? My study works to shed light on this question by conducting a case study of a successful smart grid pilot project. The purpose of this study, therefore, is to better understand which actions and policies create the circumstances which allow smart grid pilot projects to transition into the mainstream, becoming staple programs or technologies of an energy utility.

By conducting a case study of Heat for Less, a successful Canadian smart grid pilot project, my research will shed light on the drivers of smart grid development – insight that will be of interest to governments and utilities engaged in smart grid pilot projects as well as academics in the field of innovation studies.I believe that because you are or were formerly actively involved in the management and operation of the *Heat for Less Now* project, you are suited to speak to the various issues, such as how and why circumstances favourable to the success of this project were fostered.

Participation in this study is voluntary. It will involve an interview of approximately 45 minutes to one hour in length to take place in a mutually agreed upon location. Should it be inconvenient to meet while I am on Prince Edward Island, the interview may be conducted by phone or by Skype on a mutually agreed upon date. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Data collected during this study will be retained for 3 years in a locked office in my supervisor's office. Only researchers associated with this project will have access. There are no known or anticipated risks associated with participation in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at (226) 808-6690 or by email at n2belang@uwaterloo.ca. You can also contact my supervisor, Professor Ian Rowlands at 519-888-4567 ext. 32574 or email irowlands@uwaterloo.ca.

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin in the Office of Research Ethics at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

I hope that the results of my study will be of benefit to those organizations directly involved in the study, other electricity utilities engaged in smart grid pilot project deployment not directly involved in the study, as well as to the broader research community.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Nicholas Belanger

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

____

I have read the information presented in the information letter about a study being conducted by Nicholas Belanger of the Department of Environment and Resource Studies at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at 519-888-4567 ext. 36005.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

☐YES ☐NO

I agree to have my interview audio recorded.

☐YES ☐NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.

☐YES ☐NO

Participant Name: ____________________________ (Please print)

Participant Signature: ____________________________

Witness Name: _________________________________ (Please print)

Witness Signature: _______________________________

Date: _____________________________