Interpreting Barriers to Energy Efficiency within Southern Ontario Municipal Buildings: A Case Study

by

Amanda San Filippo

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Author's Declaration

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

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

Amanda San Filippo

Abstract

Recent concerns regarding climate change, environmental degradation, human health and energy security associated with the consumption of energy have raised questions about the sustainability of current energy systems. Increasing energy efficiency is considered a core strategy for ultimately achieving a sustainable energy system by offering a cost-effective method for reducing energy use for organisations. However, the slow execution of energy efficiency solutions is said to be reflective of a much wider debate within energy economics, and lead to what is commonly referred to as the "efficiency gap". Historically, the debate involves theoretical differences between engineering-economic, or "bottom-up", models which suggest there is ample room for profitable energy efficiency measures; and, orthodox economic, or "top-down", models which argue that there are significant costs associated with reducing energy consumption. The result has been a diversity of opinions on the potential for, and costs of, energy efficiency, the nature and significance of associated barriers and the appropriateness of various policies in overcoming these barriers.

In reality, there is no one-size-fits-all solution to resolving the debate. Rather, the differences across energy service markets require that the existence of an efficiency gap be assessed within the context of these parameters. This requires understanding the nature and significance of barriers to energy efficiency and their economic and organisational impacts within various contexts. This paper explores a taxonomy of barriers to energy efficiency within one potentially influential sub-sector within the country's most densely populated and highest energy consuming region – Southern Ontario municipalities.

The information was collected in three phases. First, a review of the literature was conducted which helped identify and understand potential barriers to energy efficiency and the instances in which they would merit policy intervention. Secondly, 26 questionnaires from individuals responsible for various aspects of energy management and municipal decision-making were completed to gain further insight into municipal structures, policies, decision-making procedures and perception of barriers. These questionnaires were supplemented with 6 detailed interviews conducted with municipal energy managers, or the equivalent.

The results presented in this study confirm the presence of an energy efficiency gap within the participating municipalities and that barriers to cost-effective energy efficiency measures do in fact exist. These barriers are most often associated with a lack of information on obtaining appropriate measures and difficulties accessing available capital required for initial investments. The findings support the claims of "bottom-up" models which indicate that policy intervention may rationally overcome many of these barriers. For example, organisational policy measures

such as the implementation of energy reserve funds for individual departments may be implemented at low costs. Other barriers that do not justify policy intervention, such as risk, were considered to be less relevant to the participating municipalities.

The case studies suggest that with adequate public and organisational policy intervention, the energy efficiency gap may be reduced within these municipalities, thus increasing overall energy efficiency.

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1. Introduction

1.1. Introduction and Background

1.1.1. Energy: A brief history

Throughout the last century, applied sciences have revolutionised the way we live. Through the expedition of communication and transportation systems, and the mechanisation of daily activities, their contributions have created a level of convenience and economic prosperity unknown to previous generations (Costanza et al., 2007; Merchant, 1992; WECD, 1987). While these are marked advantages, more recent concerns regarding the externalisation of environmental and social costs that are incurred from the production, distribution, use and disposal of many technologies have raised questions about the sustainability of current economic systems (Daly and Farley, 2004). Being pushed to the forefront are the costs associated with the consumption of energy required to fuel these processes. From the exploitation of certain resources to create new products through to the required use of unsustainable energy sources to run them, climate change, environmental degradation, human health concerns and energy security are but some of the issues being considered. Through the comprehensive scientific assessment of climate change research, experiments, and models, it is now broadly accepted within the scientific community that burning fossil fuels increases the levels of air pollutants released into the atmosphere, directly contributing to climate change (IPCC, 2001a). This phenomenon has been linked to, among other threats, food scarcity, water shortages, natural disasters and the extinction of many land-based species (IPCC, 2007; Diammond, 2005). Other direct ecological impacts, such as radioactive emissions, oil spills and the acidification of land and water surrounding mines and energy plants, have well documented impacts on human and ecosystem health (UNICEF, 2007). In addition to these concerns, security issues related to the availability of energy supply are becoming apparent. Increased oil prices and scarcity are fuelling political instability in some exporting nations. Finally, blackouts, such as those experienced throughout parts of the Northeastern and Midwestern United States and Ontario in August of 2003, and chronic electricity shortages experienced throughout emergent nations are shaking consumer confidence about the reliability of these supply systems (Yergin, 2006; WEC, 2004). As the demand for energy is predicted to increase, so too are the associated costs of this unsustainable system (Daly and Farley, 2004).

Mitigating these impacts and ultimately achieving a sustainable energy future will require reformation of current energy practices and systems. Many studies and publications that address the issue of sustainable energy often indicate that achieving a sustainable energy future requires: a) the replacement of non-renewable energy sources with locally produced renewable and low

emission energy systems; and, b) that growing energy demands be reduced by improving energy efficiency (WEC, 2010; UNGA, 2009; Coley, 2008; IPCC, 2007; Elliot 2003; Boyle et al., 2003). It is the latter that will be the focus of this thesis.

Given the close economic relations among countries through trade agreements and multinational corporations, and the global impacts of climate change and other issues associated with energy consumption, achieving a sustainable energy future demands global participation and coordination (UN-Energy, 2010; UNGA, 2009). However, the strategies used to accomplish this reduction will depend on an individual country's resources and circumstances. While certain countries may feel they are at a disadvantage as to their ability to follow international protocols, the Intergovernmental Panel on Climate Change (IPCC) has recognised the potential for relatively simple, well-proven and cost-effective opportunities in energy efficiency. Unlike complex decision-making processes required at national and international levels, these opportunities are often rooted in local efforts and include the implementation of low-risk and well-proven technologies across individual sectors (Sorrell et al., 2004).

Among Canadians, there continues to be a growing recognition of the importance of adopting energy efficient practices and technologies (OEE, 2011a). However, the country's slow execution of these solutions continues to draw international criticism (Maurino, 2008; De Souza, 2008; Hoppa, 2008). Ontario, as Canada's most populous province, and the highest energy consumer in the country, plays an important role in the mitigation of climate change and other health, social and environmental risks associated with energy consumption. Though Ontario does utilise forms of renewable and non-greenhouse gas emitting energies, a history of government subsidies and legislative support have rendered modern energy-supply mixes dependent on fossil fuels and nuclear energy (Adachi, 2009; OCAAR, 2008). In addition, the Eastern-North American Blackout in 2003, the province's mandate to remove coal-powered generators from the supply mix by the end of 2014 and the need to replace aging nuclear generation facilities are creating additional pressure to improve overall efficiency within the province (Bill 150, 2009; Beauregard-Tellier, 2005; ECFTS, 2004).

Given these pressures, organisations and governments are beginning to promote more stringent efficiency targets for themselves, and across various sectors. After being given a legislated mandate in 2005 to ensure a sustainable and efficient energy system for the province, the Ontario Power Authority (OPA) released a living document, the *Integrated Power System Plan* (IPSP), detailing the province's energy landscape over the next 20 years and put forth initiatives to ensure provincial targets are met (OMEI, 2010). Under the assumption of a medium electricity demand growth scenario between the residential, industrial and commercial sectors (electricity representing approximately one third of residential energy consumption, one eighth of industrial

consumption and almost half of commercial consumption (OEE, 2011a)), and a population increase of approximately 28%, Ontario's electricity demand is expected to grow 15% by 2030. Maintaining flexibility, in case of higher electricity demand growth through technological progress, the OPA plans to achieve a peak demand reduction target of 7 100 megawatts (MW) and an energy savings target of 28 terawatt-hours (TWh) by the end of 2030, with interim targets serving as milestones to measure progress (OMEI, 2011).

Five major sectors contribute to Ontario's energy landscape. These are:

- the residential sector;
- the industrial sector;
- the commercial and institutional sector;
- the transportation sector; and,
- the agricultural sector. (OEE, 2011a)

Each of these sectors is comprised of a multitude of sub-sectors. There exist significant differences in energy use and trends in energy efficiency across these sub-sectors, as well as in their physical and organisational characteristics (OEE, 2011b). Therefore, it would be reasonable to assume that opportunities to increase energy efficiency be assessed within the context of these parameters.

This thesis responds to the call for a greater understanding of the sub-sectors of Ontario's energy landscape by focusing on one sub-sector within the commercial and institutional sector - Southern Ontario municipalities. The reasons for this focus are discussed in the following section.

1.1.2. Energy consumption and Southern Ontario municipalities

1.1.2.1. Sector overview

As of 2010, Ontario's population is estimated at approximately 13 .2 million (StatCan, 2010a), the majority of which is located within one of the province's 444 municipalities. The province's overall population is 5 times greater than it was a century ago (StatCan, 2006). However, population growth and changes are not uniform across municipalities. Many communities have maintained slower growth rates, while others have had to accommodate rapid increases. The majority of this growth has occurred within the borders of Southern Ontario (StatCan, 2006).

Southern Ontario is described as the physical boundary situated south of the French River and Algonquin Park. Although Southern Ontario represents only approximately 15% of the province's

geographical area, it houses 92% of its population of over 13 million and the area is distinguished from its Northern counterpart in climate and culture (StatCan, 2006).

There are 290 municipalities situated within the borders of Southern Ontario. Each municipality is governed by an elected council that provides a number of services to ensure the well-being of its community members. The number of buildings operated by each municipality can range from a few to hundreds. Depending on the year the municipality was established and its population, building age, size, and other construction characteristics can also vary immensely. For example, Elgin County, located in Southwestern Ontario, consists mostly of small towns and counties. Once part of Suffolk County, it was organised in 1851 and the majority of its communities were established in the early 1800's. Three-quarters of Elgin's private dwellings were built prior to 1986. In contrast, the Regional Municipality of Halton, situated in the Greater Toronto Area (GTA), was only established as a municipality in 1973. Between 2001 and 2006, the region experienced a growth rate of 17.1%, one of the county's highest. Approximately half of the region's private dwellings have been built in the last 25 years. This is similar to the neighbouring Region of Peel, where two-thirds of its dwellings have sprung up since 1986 (Census, 2006). The types of buildings owned and operated within municipalities range from office buildings to sewage treatment centres, each with individual energy requirements. These are some of the physical characteristics that will inevitably contribute to the various energy profiles found within this geographical area.

The importance of energy efficiency within the context of municipalities is twofold. First,like all public-sector organisations, municipalities face a mandate to use any public funding responsibly. Any financial surplus resulting from municipal activities is reinvested in some form or another for the purpose of the continued function and possible improvement of either that organisation (for example the purchase of medical equipment in a hospital) or society as a whole (maintenance of infrastructure, adequate salaries for public sector employees, tax rebates, etc.) (Energy Charter Secretariat, 2008); and second, municipalities, in general, may have a better understanding of local needs in their proximity and availability to their populations (Van Wie McGrory et al., 2002). Like most public sector organisations, municipalities often play the role of purchaser, investor, and regulator and are responsible for the management of their own energy (Energy Charter Secretariat, 2008).

Because of Southern Ontario’s dense population and significant energy consumption, these municipalities are in the unique position of influencing a large number of individuals with regards to energy efficiency through their own purchasing decisions. It can, therefore, be argued that if opportunities for low-risk and well-proven technologies do exist, energy efficiency in this sector could become a critical tool for responsible fiscal management that could lead to an overall

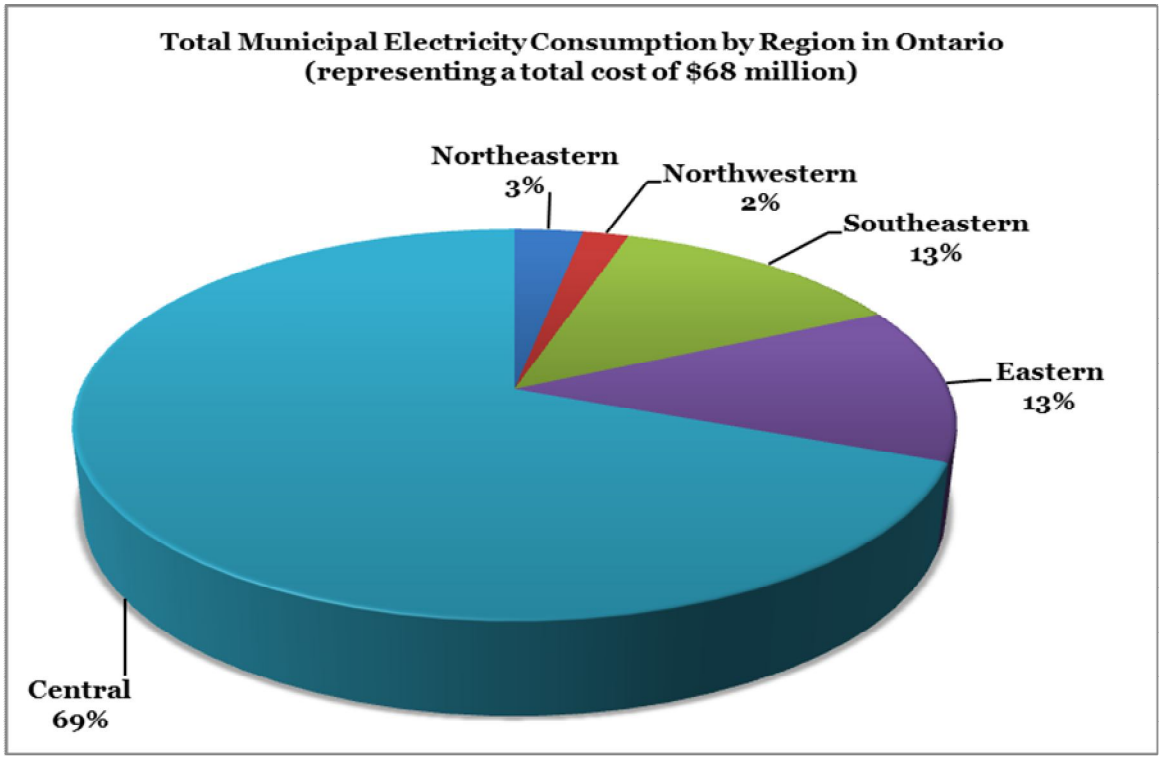
market shift towards energy efficiency (Van Wie McGrory et al., 2002). These opportunities will be discussed in greater detail in section 1.1.2.3.

1.1.2.2. Energy use

In 2006, an OPA study on energy conservation within Ontario municipalities found average energy costs to be $3.15 per square foot of building space. This is only slightly higher than Ontario's commercial and institutional sector as a whole, which is calculated at approximately $3.12 per square foot of building space. However, the cost appears to be significantly higher than the Canadian average, which is approximately $2.43 per square foot. This does not necessarily mean that Ontario's municipal sector is significantly less energy efficient. There could be a number of complex reasons for the differences. Among them may be the region's climate, the form of energy used and the price set per unit of energy (CICES 2005). These differences should be taken into consideration when attempting to understand energy consumption trends in the region. Electricity expenditures were significantly higher in comparison to natural gas expenditures for municipalities. Of the 15 municipalities surveyed in the OPA study, on average, electricity expenditures accounted for 78% of their total energy expenditures (OPA, 2006).

In 2008, the Independent Electricity System Operator (IESO) contracted Power Application Group Inc. to develop an electricity profile of Ontario municipalities. It was concluded that the 444 municipalities (445 municipalities at the time the study was conducted) consumed 6.6 billion kilowatt hours of electricity, or $680 million were spent annually on electricity consumption. This represented 4.3% of Ontario's total electricity consumption in 2008.

Most municipalities have a city/town hall, recreation buildings, libraries, fire halls and some sort of treatment plant, such as a water and waste or recycling plant. Energy consumption is distributed across the range of building types, and is affected by age and size. Although a breakdown of energy consumption per building type could not be found, the IESO's (2008) study provided a breakdown of electricity usage per building type. The percentages are represented in Figure 1.1.



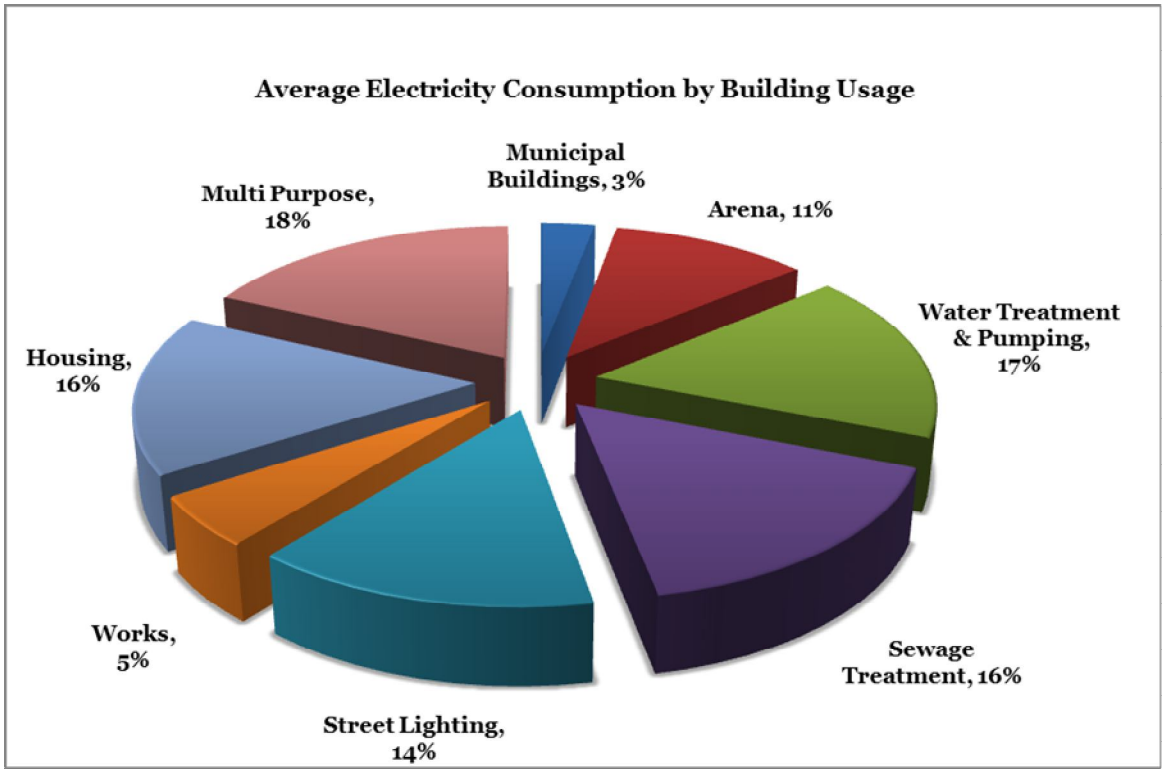


Figure 1.1: Energy consumption within Southern Ontario municipalities

Source: From IESO (2008), pp. 1-2

1.1.2.3. Energy saving potential

Although Ontario municipalities only represent 4.3% of provincial electricity consumption, as demonstrated in section 1.1.2.1, the close proximity of municipal government to their respective populations can permit a more direct influence on their decision-making than other levels of government. In addition, like most public sector organisations, municipalities often play the role of purchaser, investor, and regulator and are responsible for the management of their own energy consumption. Consequently, investment in energy efficiency measures for these public sector buildings has the potential to "create a strong, sustained, buyer led shift in the market" (Van Wie McGrory et al., 2002).

Many energy efficiency measures are considered to be "low-hanging fruit"; that is, they are easily achievable while offering rapid returns on investments for organisations (WEC, 2010). In terms of the reformations required to achieve a sustainable energy future, a number of energy efficiency measures can help address several energy issues presented at a low, or even negative, cost (WEC, 2010).

Although there have been studies conducted by organisations presenting conservation and demand management potential and energy efficiency strategies for the province (Peters et al., 2007; Winfield et al., 2006; ECSTF, 2004), there are limited detailed data available on energy savings potential within Southern Ontario municipalities. As will be discussed later in this chapter, the ultimate potential of energy efficiency will depend upon the nature, role and importance of individual barriers across the sector. Any estimates would be based on best available information. Having said this, the IESO's (2008) study reported the potential for municipalities to reduce *electricity* consumption by 12%. Achieving these savings would require a total capital investment of $560 million with a payback period of 6.5 years. An additional 314.3MWh was noted as the self-generation potential for municipalities and a potential savings off 221.4 MWh through demand response initiatives (IESO, 2008).

1.1.2.4. Current initiatives

As of 2011, several initiatives, which include plans, legislation, incentives, guidelines, and policy processes by the government to address issues of electricity production, distribution, and consumption have been established, or are underway, throughout the province of Ontario. Some significant examples include Ontario's Feed-in Tarrif Programme, the Integrated Power System Plan (IPSP), and plans for a complete phase-out of coal-fired electricity generators by 2014. Most noteworthy may be the introduction, on February 23, 2009, of Bill 150; the Green Energy and Green Economy Act by Ontario's Minister of Energy and Infrastructure which also amends or

incorporates many previous initiatives. Its purpose is to facilitate the development of a green energy economy while protecting communities and the natural environment. Obligatory investment and priority granting, consumer protection and direct participation from Aboriginal communities are some of the plans designed to propel the province into one of the North American leaders in renewable energy and energy efficiency (GEAA, 2009).

Bill 150 amends and repeals several previous acts and attempts to satisfy all levels of society by drawing on core policy components to ensure its goals are met with limited effect on economic development and social equality. If implemented properly, the Act may support the initial conditions required to shift various aspects of Ontario's energy market, such as the increase of affordable energy efficient products and services and renewable and non-greenhouse gas emitting energy sources (Bill 150, 2009).

The Act acknowledges the significance of municipal roles in shifting Ontario's energy market. For example, the Act provides the province with permission to direct the OPA to develop programmes that are designed to reimburse costs incurred by municipalities in order to facilitate the development, transmission and distribution of renewable energies. The Act also includes an amendment to the Environmental Bill of Rights stating that annual reports on energy conservation by the Environmental Commissioner must identify any by-laws or policies of municipal councils that result in barriers to the development or implementation of measures to reduce the use or make more efficient use of energy. Reducing these barriers is then prioritised by different stakeholder groups ((Bill 150, Schedule A, Part II, (6)).

The enactment of Bill 150 remains however, in its early stages of implementation. While it encourages prescribed energy and environmental standards, including standards for energy conservation and demand management, questions still exist as to how they may be prescribed.

1.1.3. An introduction to the “efficiency gap”

Despite the enactment of Bill 150, overall energy consumption in the province of Ontario continues to rise (OEE, 2009; Ménard, 2005), appearing as though many simple, well-proven and cost-effective opportunities in energy efficiency are continuing to be neglected. This “efficiency gap”, a term commonly used to describe the difference between levels of investment in energy efficiency that appear to be cost effective and the (lower) levels actually occurring (Golove and Eto, 1996), isn’t unique to Ontario and has been the focus of a number of studies (e.g. Schleich, 2009; Schleich and Gruber, 2006; OPA, 2006; Borg et al., 2006; Sorrell et al., 2004; DeGroot et al., 2001; DeCanio, 1998; Jaffe and Stavins, 1993; Howarth and Andersson, 1993). While these studies have highlighted a number of energy efficiency measures that may be implemented at a

low, or even negative cost, the fact energy consumption continues to rise within Ontario, may be indicative of neglected opportunities. And, if this were the case, the factors contributing to this neglect would need to be understood if the implementation of measures aimed at increasing energy efficiency were to be effective.

This argument is well supported and has been the subject of a number of studies (Schleich, 2009; Schleich and Gruber, 2006; Borg et al., 2006; Sorrell et al., 2004; DeGroot et al., 2001; Harris et al., 2000; DeCanio, 1998; Jaffe and Stavins, 1993; Howarth and Andersson, 1993; Gruber and Brand, 1991). Among these studies, there also appears to be consensus among experts on the primary factors, or "barriers", which are preventing individuals and organisations from investing in energy efficiency (these barriers are introduced in section 1.3 and will be described in detail throughout chapter 2). This raises two questions:

- If simple, well-proven and cost-effective opportunities in energy efficiency exist, why are they not being adopted on a larger scale?
- What are the studies on barriers to energy efficiency failing to explain, given that various tools aimed at increasing the adoption of energy efficiency measures, such as marketing techniques, or policy interventions, have had only minimal success?

It has been argued that the slow uptake of energy efficiency measures is reflective of much more complex disagreements among experts over the methodologies and models upon which studies on energy efficiency are based (Sorrell et al., 2004). In other words, while most experts agree on the presence of specific barriers to energy efficiency (Schleich, 2009; Schleich and Gruber, 2006; Borg et al., 2006; Sorrell et al., 2004; DeGroot et al., 2001; Harris et al., 2000; DeCanio, 1998; Jaffe and Stavins, 1993; Howarth and Andersson, 1993; Gruber and Brand, 1991), inconsistent frameworks used to study them have created opposing opinions on the nature and significance of certain barriers, and on the cost and likely success of different mitigation tools (Helm, 2008; Sorrell et al., 2004).

Historically, the studies on barriers have relied on either "bottom-up" or "top-down" economic models, which can manipulate results into appearing more or less cost-effective than they actually are (Helm, 2008; Canes, 2002; IPCCb, 2001; EIA, 1998; DeCanio, 1998; Jaffe and Stavins, 1993; Howarth and Andersson, 1993; Gruber and Brand, 1991). Proponents of top-down models argue that bottom-up models overestimate energy efficiency potential by neglecting fundamental orthodox concepts used to study economic efficiency. On the other hand, proponents of bottom-up models argue that top-down models tend to underestimate energy efficiency potential by applying often unrealistic mathematical modelling techniques to the evaluation of energy efficiency potential, while neglecting human aspects of decision-making.

Sorrell et al. (2004) have argued that resolving these differences requires a much more comprehensive approach to studying these barriers; one which incorporates various aspects of the economic, organisational and behavioural theories relevant to decision-making:

> The further development of modelling techniques can only go so far in resolving these disputes. Ultimately what is required are detailed empirical studies of the nature, origin and operation of the supposed barriers to energy efficiency in a wide range of energy service markets, together with evaluation studies on the costs and benefits of different types of policy intervention (p.4).

They go on to suggest that:

> ... a realistic objective would be to assess the relative importance of different barriers in different contexts and their aggregate impact on energy and economic efficiency (p.4).

The importance of studying energy consumption and efficiency within the context of Southern Ontario municipalities is highlighted by both the OPA (2006) and IESO (2008) studies. While they do briefly introduce some potential barriers to energy (or electricity) efficiency within Ontario municipalities, which will be detailed extensively in the following chapter, the primary focus of both studies was not to study barriers to energy efficiency. The purpose of the IESO study was to present an electricity profile for Southern Ontario municipalities. The OPA's study, on the other hand, produced findings on municipal energy expenditures and described more general decision-making processes which relate to energy efficiency. Both studies supplemented much of the information sought within this study. However, neither study provides the detailed empirical data pertaining to the nature, origin and operation of these barriers to energy efficiency that are needed to resolve the efficiency gap. As a result, the factors that inhibit the adoption of energy efficiency measures within municipalities are, aside from the hypotheses presented by the literature, largely unknown. This will be discussed in greater detail in the following chapter.

1.2. Objectives

Thus far, three gaps in our current knowledge on barriers to energy efficiency have been identified. These gaps in knowledge are represented below as the thesis questions which need to be answered if the efficiency gap is to be resolved:

- To what extent are Southern Ontario municipalities neglecting simple, well-proven and cost-effective energy efficiency measures?

- Why are Southern Ontario municipalities neglecting these measures (What barriers, as hypothesised by previous research, are preventing municipalities from adopting these measures)?
- How do these barriers affect decision-making in energy efficiency within the contexts of the Southern Ontario municipalities being studied?

Therefore, the purpose of this thesis is to understand energy efficiency performance as perceived by Southern Ontario municipalities, and to determine the reasons for this performance by answering the questions outlined above. An important component to understanding this performance is to establish the extent to which Southern Ontario municipalities have or have not adopted a number of effective and available measures to improving energy efficiency. However, the overall aim of this study is to elaborate on current knowledge of barriers to energy efficiency, by describing, understanding and explaining the particular factors which prevent Southern Ontario municipalities from adopting simple, well-proven and cost-effective energy efficiency measures. In Sorrell et al.'s (2004) studies on barriers to energy efficiency within various European sectors, they responded to this challenge by undertaking the following:

> ... instead of asking why a single type of energy efficient technology had or had not been adopted, the study sought to determine why a broad range of decisions had or had not been taken... instead of focusing solely upon the adoption of specific energy efficiency technologies, the project explored the full range of reasons why organisations performed better or worse in energy efficiency (p.7).

The argument presented above provided the criteria for studying organisational performance in energy efficiency. Decision-making procedures within individual organisations, particularly those influencing energy efficiency, were used as the primary unit of analysis for establishing this performance. Again, this was guided by Sorrell et al.'s (2004) studies, where the data were sought by combining the results from interviews, surveys and a literature review on barriers to energy efficiency to:

- Identify the number of existing simple, well-proven, and cost-effective technologies and practices that had been adopted by Southern Ontario municipalities for their buildings;
- Examine Southern Ontario municipal decision-making structures, and their influence on performance in energy efficiency; and,
- Identify the nature, operation and determinants of barriers to energy efficiency from the perspective of Southern Ontario municipalities.

1.3. Hypotheses and Research Methods

1.3.1. Establishing barriers to implementation

The next step in the research was to conceive a plausible list of hypotheses that could potentially explain the neglect of energy efficiency within organisational decision-making. As previously identified, several studies have been conducted on the topic of improving energy efficiency. From these studies, several barriers to the adoption of energy efficiency measures have been proposed. The categories of barriers are most often represented, in some form or another, by a lack of information, communication, priority, and capital.

As previously indicated, two studies pertaining to energy or electricity consumption and efficiency within Ontario municipalities have been conducted. While the focus of these studies was not to present barriers, both provided some insight into possible barriers to implementation of energy efficiency measures. The information appears to support the categorisation of barriers discussed above. The study conducted by Ontario's Independent Electricity System operator (IESO) identified a lack of capital for investment, a lack of resources (specifically related to knowledgeable personnel), municipal organisation and practices (generally related to lack of communication across departments) and a lack of priority regarding education and awareness on issues related to energy efficiency as potentially significant obstacles to implementation (IESO 2008). Materials prepared a few years earlier by Bridgepoint Group Ltd. for the Ontario Power Authority's (OPA) Conservation Bureau stated similar "municipal challenges", specifically related to a lack of financial and informational resources, low priority both within and outside of the municipalities and too much competition and a lack of coherence among departments (OPA 2006).

Combining the commonly used categories of barriers found within various studies, a taxonomy of barriers was established for this thesis. Each barrier is considered a hypothesis that explains the reasons a municipality has potentially neglected a measure that appears to be both economically and energy efficient. These barriers were evaluated in tandem with the other factors that determine organisational performance in energy efficiency to establish and understand the role these barriers play with Southern Ontario municipalities.

As previously explained, the aim of this study was not simply to establish *what* barriers were relevant to municipalities within the study region. It can be argued that establishing barriers has already been done and repeating these studies would not bring to light any new or useful information. What can be said is that the continued contradictions between the literature and the actual adoption rates demonstrate that specific information on these barriers has yet to be

presented. Therefore, and rather than repeating previous studies, this study aimed to: 1. elaborate on current knowledge of barriers to energy efficiency to determine the various components that had formed the basis for the barrier; and, 2. explain if, and how, that barrier could potentially explain the "gap" within the context of the Southern Ontario municipalities being studied. In other words, this study went one step further by assessing the significance of the hypothesised barriers within this specific context, and the impact these barriers may have on overall energy and economic efficiency.

While each category represents a hypothesis as to the reasons for neglecting energy efficiency, when comparing studies on energy efficiency, the barriers stated are a categorical representation of specific factors that affect organisations individually. Sorrell et al. explain that "...each of these barriers may have a number of contributory mechanisms, and several of these mechanisms may co-exist in different situations." (2004, p.9) and describe the following example:

> ... imperfect information on energy efficiency opportunities may result from both the nature of information as a public good and the overhead costs of establishing and maintaining an organisation energy information system.

This study will attempt to draw upon much more formal ideas rooted in economic, organisational, and behavioural models to understand these barriers and their effect on organisational decision-making in energy efficiency within the context of the municipalities studied. These formal ideas will be described in detail in Chapter 2.

1.3.2. Conduct of the research

The research methods described in the previous section helped identify measures that would allow the hypotheses, which will be established and described in chapter 2, to be tested within the context of the case study. Testing them required assembling a large quantity of evidence from various sources, such as previous studies conducted in the region, detailed online questionnaires completed by several municipal employees and semi-structured interviews with energy/environmental managers, and seeking emergent correlations between the barriers and the municipal contexts in which they exist. Sorrell et al. (2004) once again guided the type of questions being asked. However, additional sources were used to render them more relevant to this particular context. These methods will be discussed in detail in Chapter 3.

1.4. Chapter Outline

This chapter has presented background information pertinent to this thesis and provided the rationale for answering the thesis question. In the following chapter, a comprehensive review of the literature pertaining to barriers to the adoption of energy efficiency measures will be presented. This will better describe the adoption processes related to energy efficiency and will help provide a framework that will guide the methodological processes throughout the study. Chapter 3 will outline and justify the methods used to collect and analyse the research data. The majority of the data are collected through in-depth interviews with individuals responsible for decisions related to investments in energy efficiency. This sampling process will also be highlighted in this chapter. The results of the interviews and questionnaires are presented in chapter 4. Chapter 5 will discuss emergent correlations between the barriers and the municipal contexts in which they exist, in addition to discussing the findings related to potential organisational, promotional and policy measures. Chapter 6 concludes by summarising the findings, exploring their implications for policy design and promotion of energy efficiency measures and technologies and finally offering timely recommendations to the relevant sections of the Ontario Green Energy and Green Economy Act.

This study aims to contribute to the development of a sustainable society by further examining the existing market barriers to efficiency and to use this information to find ways of increasing the demand for, and adoption of, efficiency measures. Findings will be of particular interest to promoters, adopters and policy makers by helping to uncover the most effective ways of encouraging the adoption of such measures within this sector.

2. Interpreting Barriers to Energy Efficiency

2.1. Introduction

The purpose of this thesis is to understand energy efficiency performance as perceived by Southern Ontario municipalities, and to determine the reasons for this performance. This is accomplished in part by illuminating the factors that inhibit Southern Ontario municipalities from investing in simple and cost-effective measures that could improve overall organisational performance in energy efficiency. However, while these factors are the principal focus of this particular case study, they are not the only focus. There appears to be consensus among experts on the primary factors, or "barriers", which prevent individuals and organisations from investing in energy efficiency (Schleich, 2009; Schleich and Gruber, 2006; Borg et al., 2006; Sorrell et al., 2004; DeGroot et al., 2001; Harris et al., 2000; DeCanio, 1998; Jaffe and Stavins, 1993; Howarth and Andersson, 1993; Gruber and Brand, 1991). However, investment decisions and consequential performance in energy efficiency by an organisation are influenced by numerous internal and external factors. It has been argued that the slow uptake of energy efficiency measures is reflective of much more complex disagreements among experts over the methodologies and models upon which studies on energy efficiency, in a variety of energy service markets, are based (Sorrell et al., 2004). Therefore, it can be argued that additional research pertaining to the nature and significance of these barriers within the specific contexts in which they are found is needed. This is in part because the frameworks used to study barriers and energy efficiency potential are inconsistent and lead to conflicting opinions on the existence and size of the efficiency gap. In light of this, instead of asking why certain energy efficiency measures had or had not been adopted, the aim is to explore the broad reasons as to why municipalities performed better or worse in energy efficiency.

This literature review focuses on exploring the various economic, organisational and behavioural theories that have been used to guide previous studies pertaining to the "efficiency gap", including the nature of barriers to energy efficiency and their strengths and weaknesses in shaping the tools needed to reduce energy consumption.

This chapter is structured as follows: Section 2 introduces the various studies on barriers to energy efficiency, examines their underlying economic theories and draws upon these theories to understand the implications they have on the wider "barriers debate". Section 3 summarises the taxonomy of barriers to energy efficiency and how they will relate to the remainder of this thesis. Section 4 concludes by summarising the key points of this chapter and leads the reader into the next chapter.

2.2. The Economics of Energy Efficiency

In 2007, the newly elected Canadian conservative government's decisions to not attempt to reach the targets previously set by the Kyoto Protocol, and to reduce funding for Canada's climate change plan and programmes, were met with both criticism and praise from various stakeholder groups (Sierra Club, 2008; Baird, 2007).

On February 8th, 2007, then Environment Minister John Baird announced that Canada would not attempt to meet the targets set by the Kyoto Protocol. Believing that attempting to reach them would create irreparable damage to the Canadian economy, the plan was to introduce legislation that would regulate industrial pollutants as part of the proposed Clean Air Act. The Act shifted baseline targets from 1990 to 2006, and introduced intensity based reductions, whereby companies reduced their emissions based on their unit of production. Many insisted that the government made a well-calculated decision to follow in the footsteps of the Americans, who had decided to withdraw from the Kyoto Protocol claiming that the costs associated with reducing energy use far-outweighed the environmental benefits (Baird, 2007).

Others, such as former World Bank Chief Economist Nicholas Stern, argued that overall costs associated with inaction on climate change would cost the global GDP at least 5% each year (Stern, 2006). Prominent Canadian organisations and politicians, such as the Sierra Club and Elizabeth May, compiled several other studies arguing that, even considering the most pessimistic assumptions, Canada would still experience continued economic growth if the Protocol's targets were met and the new plan did not take into account the immediate threats associated with climate change. Many opportunities to reduce consumption and associated emissions at a low, no or even negative cost were widely available, and would render the Protocol's targets achievable (Sierra Club, 2008).

This continued lack of consensus is representative of a much larger debate within the economics of energy efficiency. While both sides of this debate are supported by several well-documented empirical studies (e.g. UNGA, 2009; Helm, 2008; IPCC, 2007; Stern 2006; Laitner, 2004; IWG 2000; EIA, 1998), disagreements over the methodologies and modelling techniques used to study energy efficiency have created opposing views on the effectiveness and feasibility of various energy efficiency tools. Sorrell et al. (2004) explain the issue as follows:

> ...the debate is between one group of researchers using 'top-down', or macroeconomic modelling tools who find there are significant costs associated with reducing energy use and carbon dioxide emissions, and a second group using 'bottom-up' or engineering-economic modelling tools who argue that there are substantial

> opportunities to mitigate climate change that will allow emission targets to be achieved at negative cost (p.2).

While these disagreements demonstrate a need to continue research in this area, their results have had, and continue to have, a significant influence in shaping the politics of countries around the globe (Sorrell et al., 2004; Sanstad and Howarth, 1994).

In Canada, this lack of a consensus may be a contributing factor to the 28% increase in energy use between 1990 and 2007 (OEE, 2009). And, while Canadian Prime Minister Stephen Harper has claimed that "climate change (is), perhaps the biggest threat to confront the future of humanity today" (PM, 2007), the stark contrasts between provincial economies and climates have many decision-makers referencing the side of the debate that best supports their political agendas.

The highly publicised and politicised nature of energy efficiency means that understanding the theoretical concepts from which different groups draw their ideas and conclusions is more relevant than ever before, especially if Canada and other countries are to agree on, and implement, real and immediate solutions needed to mitigate the negative effects of energy consumption. Understanding these theories and ultimately resolving this debate begins with an examination of the history of this debate.

2.2.1. The "efficiency gap"

In academic literature, the efficiency gap is most often defined as the difference between the optimal level of investment in energy efficiency as demonstrated by the literature, and that which is actually being adopted among various organisations (Harris et al., 2000; Golove and Eto, 1996; Howarth and Andersson, 1993). In other words, this gap refers to currently unadopted but seemingly cost-effective technologies and practices aimed at improving energy efficiency.

The concept of barriers to energy efficiency was first introduced by researchers who observed a gap while studying the economic and technical potential in energy efficiency. Studies often demonstrated that investment in energy efficiency offered high return rates and yet, adoption levels for these proposed technologies and practices remained relatively low (Sorrell et al., 2004; DeGroot et al., 2001; Harris et al., 2000; DeCanio, 1998; Sutherland, 1996). As it was assumed that firms functioned at economically efficient levels, and made decisions aimed at maximising profits, researchers were led to believe that investment in energy efficiency was being inhibited by a different set of factors that rational economic decision-making theories were not explaining.

Some of the barriers postulated by researchers included split incentives (where the person benefiting from the financial savings created through energy efficiency differed from the individual investing in the measures) and the inability to access funds required for initial investment (Sorrell et al., 2004). And, it was argued that these barriers could be eliminated with the appropriate policy tools. While these hypotheses had their merit, these studies were most often conducted by "energy efficiency practitioners" (Sutherland, 1996; Sanstad and Howarth, 1994). Academics, whose roots were more firmly planted within economics, argued that the term "barrier", as described by these practitioners, lacked coherence and that the engineering-economic models used to study them were too limited (or selective) in their use of economic theory (Helm, 2008; Sorrell et al., 2004; Parfomak, 1997; Sanstad and Howarth, 1994). Orthodox economists claimed this ambiguity "obscured key methodological issues concerning the measurements of the costs and benefits of policies" needed to promote the adoption of energy-efficiency (Sanstad and Howarth, 1994, p.811).

2.2.2. Orthodox theory

Clarifying the aforementioned ambiguities provided an important step in the development of a framework in which energy efficiency potential could be assessed. The original argument presented by engineering-economic models, simply put, was that with adequate public intervention, the efficiency gap could be eliminated – a statement which was strongly opposed by many orthodox economists (Helm, 2008; EIA, 1998). A starting point in disproving this theory was that these early engineering-economic models failed to distinguish between barriers that were representative of market failures (Box 2.1), which, *if* implementation of a certain measure was proven to be economically efficient, merited public intervention, and those that were not. In fact, many organisations that chose not to adopt energy efficiency practices or technologies may very well have been responding to real, but "hidden" costs within a well-functioning market (Helm, 2008; Sorrell et al., 2004).

Box 2.1 Market failures

In economic terms, a perfect market requires a good to be equally rivalrous (whereby the consumption of a good reduces the quantity available to others) and excludable (which allows the owner of a good or service to exclude others from using it) (Daly and Farley, 2004). When a good or service shares these characteristics, it contributes to an efficient market. Because a market based economy is dedicated to generating profits, if a good is non-excludable, people are able to use it "free of charge", thereby reducing its profitability. Daly and Farley (2004) explain as follows:

"If people are unwilling to pay for a good, there will be no profit in its production, and in a market economy, no one will invest in producing it, or at least not to the extent that the marginal benefit to society of producing another unit is equal to the marginal cost of production (p. 166)."

Additionally, market efficiency requires that the marginal cost to society of producing or using a good or service be precisely equal to the marginal benefit (Daly and Farley, 2004, p.159). Markets cannot efficiently allocate goods if their use does not equal a monetary value above zero. Theoretically, an individual will pay for a good or service, as long as its cost is perceived as equal to the cost of its use. A good or service that is rival diminishes in value as it is used, thereby encouraging individuals to reinvest when its cost exceeds the benefit being drawn. There are two types of non-rival goods and services: those that are strictly not affected by the number of people using them, streetlights for example; and those that do diminish in quantity or quality when *too* many people use them, such as traffic jams caused by too many people driving down the same road at the same time. The latter are referred to as "congestible resources".

An example of a good that is generally efficiently produced and allocated by a market would be that of a vehicle. If an individual has paid for a vehicle, and they own the vehicle, the owner of this vehicle may prohibit others from using it. If an individual is able to use this vehicle, whether or not it has been paid for by someone else, it is considered less likely that this individual will pay for it. Without investment, this good ceases to be profitable. At some point, it can be assumed that parts of the vehicle will wear out and that various costs, financial, spatial, or other, required to maintain the vehicle will surpass the initial cost. When the cost/benefit ratio no longer represents a value above zero, the owner may choose to sell the vehicle, and the asking price would reflect this depreciation. He may then choose to invest in a new vehicle where the price set by the market's demand and supply curve is equal to the benefit retained by the individual.

A market failure arises when a good is non-rivalrous, non-excludable, or both. Simply put, when a good or service demonstrates any of these characteristics, market forces may not provide them and will not efficiently allocate them.

In the example of the vehicle, a market failure may equate to the costs imposed on individuals who breathe in polluted air created by the burning of fossil fuels required to run it. The pollution imposed by the vehicle's exhaust falls under the rival but non-excludable category of market failures. If this external cost is not taken into account, the additional costs imposed on society, such as an individual who is unable to work due to severe respiratory ailments, create a gap in overall economic efficiency. In this case, the internalisation of the external costs, such as a gas tax, has the purpose of reinstating economic efficiency.

Market failures are a fundamental concept to economic analysis. Orthodox economists admit to the existence of imperfect markets and accept the need for public intervention in scenarios where market failures are present (Daly and Farley, 2004). Table 2.1 demonstrates the six combinations of possible market failures, and will be discussed in greater detail in the following sections.

Table 2.1 Market relevance of excludability, rivalness, and congestibility

	Excludable	**Nonexcludable**
Rival	Market goods such as the vehicle	Open access regimes ("tragedy of the commons" such as with ocean fisheries)
Nonrival	Potential market good, but if so, people consume less than they should (i.e., marginal benefits remain greater than marginal costs) such as information	Pure public goods such as streetlights
Nonrival but congestible	Market goods, but greatest efficiency would occur if price fluctuates according to usage, such as a toll road	Nonmarket goods, but charging prices during high-use periods could increase efficiency, such as public beaches

Source: Adapted from Daly and Farley (2004), p. 160

However, while a barrier that is a market failure creates the condition needed for intervention, a barrier itself may not necessarily reflect a market failure. Where a barrier has been proven to be the result of a market failure, from the perspective of the orthodox economist, any public intervention is only justified if it encourages economic efficiency. Sorrel et al. (2004) state:

> The starting point is that public policy should aim to encourage economic efficiency... The basic theorems of orthodox economics demonstrate how, under a particular set of assumptions, competitive markets can maximise social welfare. But in some circumstances the requirements for efficient allocation of resources through well-functioning markets can be violated.... While the term barrier may refer to any factor which explains why technologies which appear cost-effective are not taken up, only a subset of these may correspond to recognised market failures. Hence from the perspective of orthodox economics, only a subset of the identified barriers may justify policy intervention to improve economic efficiency (pp. 28-29).

It is important to note that markets only function efficiently with a narrow class of goods. The mere existence of a market failure does not necessarily justify public intervention. If the barrier *does* result from a market failure, policies must be tailored to the specific combination of

excludability and rivalness in order to be economically efficient. Because market failures result from a wide range of factors, as demonstrated by table 2.1, estimating whether the benefits arising from public intervention exceed the cost of implementation is difficult, and will ultimately vary from case to case.

From a “bottom-up” standpoint, the potential for increasing energy efficiency is greater than that of the orthodox economist. However, the argument for implementing public mechanisms to promote that increase is not feasible if it does not contribute to overall economic efficiency. From “top-down” standpoint, public intervention may potentially increase energy efficiency by removing market failures that explain the efficiency gap. However, only a fraction of the barriers that are present may justify the implementation of such policies. Intervention must contribute to economic efficiency and this potential is an empirical question that is expected to vary with context.

This thesis, however, has no interest in taking the reader through an exploration of the effectiveness of public policy on reducing barriers to energy efficiency. Rather, the purpose of this section was to gather early studies on energy efficiency and understand the initial arguments used to establish a rationale for neglecting energy efficiency. The theories presented within these studies helped demonstrate the differences between the economist’s potential, and the technologist's potential for energy efficiency, and the extent to which public intervention could assist in resolving the efficiency gap. Later in this chapter, the limitations of the market failure approach will be discussed and alternative theories will attempt to build on the orthodox model. Prior to presenting these limitations, the orthodox model will be extended by describing market failures and their relevance in explaining the efficiency gap.

2.2.3. The orthodox model and the economics of information

A market failure arises when the allocation of a good and/or service within a market is not efficient. Their existence is the primary justification for government intervention within a particular market. They are most often associated with:

- asymmetric information;
- non-competitive markets or imperfect competition;
- externalities; and,
- incomplete property rights or public goods (Daly and Farley, 2004).

The following sections present orthodox market failures and their relevance to explaining the efficiency gap. Table 2.2 summarises these market failures. The aim of this thesis is to explore the

relative importance of barriers to energy efficiency. Consequently, externalities and imperfect competition will not be discussed further here as they are not directly relevant to the debate.

Examples of the problem of asymmetric information, which are relevant to the barriers debate, relate to adverse selection, moral hazard and possibly most commonly split incentives. Consequently, these will also be discussed.

Table 2.2 Barriers to energy efficiency and orthodox market failures

	Explains the efficiency gap	**Does not explain the efficiency gap**
Barriers that ARE market failures	• Public good attributes of information • Positive externalities of technology adoption • Asymmetric information in energy service markets – leading to problems of adverse selection, moral hazard and split incentives	• Distortions in energy pricing **(**such as cross subsidies**)** • Environmental externalities **(**such as air quality**)**
Barriers that ARE NOT market failures	• Hidden costs (such as production disruptions or information gathering) • Reduced product performance • Option value of delaying investment	

Source: Adapted from Sorrell et al. (2004). p. 30

2.2.3.1. Information as a public good

Efficient markets require goods to be equally rivalrous and excludable and a market failure arises when one or both of these conditions are not met. A pure public good is said to be a resource that is "non-rival, non-excludable, and (is) desired by the public" (Daly and Farley, 2004, p. 438). Orthodox theory predicts that without full property rights in place, "inefficiencies", either in their supply or use, may be present. Information is considered to have aspects of a pure public good (Sorrell et al., 2004; Sanstad and Howarth, 1994; Fisher and Rothkopf, 1989). Its quantity is not reduced by additional users, and it is near impossible to exclude people from its benefits. Three issues arise within the energy efficiency debate:

- The incentive to provide information about certain goods or services is reduced, as an increase in the demand of the information will not necessarily benefit the individual or organisation who implemented the good or service.

- The availability of this information may reduce the need for agencies whose role is to provide alternative (and possibly unbiased) sources of information.
- A disincentive to adopt new technologies may arise as the information created through its adoption becomes available to competitors. The value gained through diminished risk associated with the adoption of associated technologies will not directly benefit the supplier.

In some cases, a consumer may lack information due to a firm's decision to retain information because they do not receive the full benefit. In other cases, such as those of copyrighted materials, a consumer may lack information because of costs associated with its use. If a consumer does not have access to all of the information related to practices and technologies related to energy efficiency, a loss of productivity or increased cost may occur, if they were, for example, to purchase the wrong quantity of a product, or one that is less efficient than another. Of course, the mere existence of imperfect information does not merit public intervention unless, as discussed in previous sections, the limitation to this information inhibits other transactions that increase social welfare at a relative scale.

2.2.3.2. Asymmetric information

The study of asymmetric information relates to decision-making processes when one party has more information, or better information than another party. When one information holder has more power, imbalances in these processes can occur (Sanstad and Howarth, 1994). At the basic level, risk of a market failure is reduced when information on the good or service is available prior to its purchase. (This, of course, is assuming that the quality of the information is appropriate, which will be discussed in greater detail below.) When a consumer is able to verify certain characteristics of a good prior to purchase, generally, a market failure will only arise when the costs associated with the research are significant, the price of the good or service varies, or frequency of the purchase is low, thereby limiting the quantity of information (Sorrell et al., 2004).

More prone to market failures are goods or services whose quality can only be determined post-purchase. Unlike the previous category, the risks associated with only being able to test a product after purchase is that the consumer may end up regretting, for any reason, the purchase decision. Such as with the potential long term health effects of pharmaceuticals, a consumer may never fully recognise the true quality of a good or service. This could be detrimental to an organisation, if the purchase is considered irreversible, or if it is bound to certain contract agreements.

In some of these circumstances, market mechanisms, such as advertising and branding of products, the development of certification schemes or other types of public regulation may reduce these inefficiencies (Schleich and Gruber, 2006; Sorrell et al., 2004; Reddy, 1991). However, as discussed in the next section, other circumstances may arise, limiting the effectiveness of such interventions.

2.2.3.3. Adverse selection, moral hazard and split incentives

A few broader themes related to asymmetric information should be considered within the barriers debate. As stated, asymmetric information models assume that one party to a transaction has more, or better, information than the other.

Adverse selection, a term originally used in insurance for describing a situation where an insurer is unable to price the cost of insurance in correlation to the risk of the insured (Polborn et al., 2006), is relevant to the barriers debate in two scenarios: the supplier of a good or service is unable to fully communicate information to the potential consumer; or if the incentive to share product quality does not exist, it may cause a supplier to act opportunistically (Sanstad and Howarth, 1994). In other words, the supplier of a product or service may be motivated to distort or limit information by lying, stealing or cheating, to perhaps supply a poorer product or service at a greater price.

Moral hazard on the other hand, refers to post-contractual opportunism, such as when the terms of a contract reduce risk associated with one party's actions. One party may be inclined to act opportunistically, or undertake “riskier” behaviour, knowing that full responsibility is mitigated under the terms of the contract. This leads to inefficient contracts, as it is often difficult to monitor and enforce (Howarth and Andersson, 1993).

There are various means available to reduce and control market failures within these scenarios. Screening and signalling are methods that permit the credibility of information to be verified. Monitoring and verification schemes or introducing incentives to meeting contractual obligations can also be useful in reducing post-contractual opportunism (Schleich and Gruber, 2006; Sorrell et al., 2004; Gruber and Brand, 1991). In some cases, additional public intervention may be necessary.

Finally, within this category of literature, split incentives, also referred to as principal-agent problems or the investor/user dilemma, are most often cited as potential barriers to energy efficiency (Schleich and Gruber, 2006; Borg et al., 2006; Howarth and Andersson, 1993). This is essentially the creation of a disincentive to invest in energy efficiency because the investor is not

able to benefit from the investment return. The most common example used is that of the rental-housing market. In this scenario, an imbalance between the interests of the owner and tenant is present, as demonstrated by a building owner investing in energy efficiency when energy costs are absorbed by the tenant. These market failures may be reduced if mandatory energy audits are combined with labelling schemes. This allows energy efficiency to be reflected within rental prices, thereby reinstating economic efficiency.

2.2.4. Transaction cost and behavioural approaches to economic theory

Thus far, the technologist's perspective on the use of public intervention to resolve the "efficiency gap" and its contribution to the energy efficiency debate has been introduced. It is true that the promotion of public intervention, within the context of energy efficiency, may help reduce the efficiency gap. However, public intervention is only justified when an account as to why economic efficiency is not achieved through normal market processes is presented. In researching the market failure approach to public intervention, some important limitations have been revealed, while highlighting a broader category of "real but hidden" costs to energy efficiency.

Orthodox economic frameworks tend to treat market failures as absolute, neglecting the possibility of the removal of additional "hidden" costs through non-price regulatory policies (Sorrell et al., 2004). In addition, studies utilising orthodox economic frameworks assume the use of mathematical models is adequate to solve complex optimisation problems. This "lack of realism" has attracted criticism (DeCanio, 1998; Sanstad and Howarth, 1994) and has led to the development of additional approaches to studying energy efficiency potential (Marechal and Lazaric, 2010; Sorrell et al., 2004; DeGroot, 2001; DeCanio, 1998; Sanstad and Howarth, 1994)

From the technologist's standpoint, maximising energy efficiency requires the removal of an additional set of barriers that do not correspond to market failures and therefore do not necessarily justify public intervention. Proponents of the "technologist's" potential, such as those mentioned in section 2.2, must detail why conventional economic reasoning is inadequate in deciding the need for policy intervention. This requires the exploration of alternate economic theorems, notably through the introduction of more "progressive" ideologies such as Transaction Cost Economics and Behavioural Economics. Both of these theories attempt to overcome the weaknesses revealed by the often unchallenged ideas of orthodox economics, by integrating "practical" models related to human and organisational decision-making. These may include, but are not limited to, altruism, bounded-rationality, organisational structures and hidden costs, and will be discussed in greater detail in the following sections.

2.2.4.1. Transaction cost economics (TCE)

Self-contained neoclassical reasoning may be sufficient in studying certain situations. However, within the realm of energy efficiency, researchers should be alert to the possibility that many circumstances arising from complex decision-making within organisations are non-economic in nature. While historically, theories hold more weight when supported by strong empirical evidence (Friedman 1997), the application of precise mathematical models, which is a core component of neoclassical reasoning, to the study of decision-making can, and does, lead to "contrived, convoluted, and mistaken interpretations" (Williamson, 2007, p.13) .

Economist and Nobel Prize recipient, Robert Solow's description of "what one economist thinks he is doing" in the words of Williamson, is to "keep it simple; get it right; make it plausible" (Williamson, 2007, p. 6). In other words, the sheer complexity of real life creates a need to "de-clutter" theories by: prioritising, refining and ridding it of the inessentials; working out the logic, through words, diagrams or mathematical models; while maintaining its contact with the original phenomena (Williamson, 2007). Williamson (2007) goes on to argue that:

> Plausible simple models of complex phenomena ought "to make sense for 'reasonable' or 'plausible' values of the important parameters". Also, because "not everything that is logically consistent is credulous", fanciful constructions that lose contact with the phenomena are suspect – especially if alternative and more veridical models yield refutable implications that are congruent with the data (p.7).

In line with this argument, TCE joins economics with organisational theory. The purpose of the introduction of TCE into the barriers debate is to elaborate the concepts introduced by orthodox economics by integrating three additional concepts, notably, the behavioural assumptions of bounded rationality; the nature of transactions and their associated costs and risks; and, their association with governance structure.

Orthodox economics assumes that individuals make decisions based on complex mathematical models, and that their decisions are consistent with these models. The concept of bounded rationality opposes this view in the sense that, when only limited resources, such as time, information, ability, etc., exist, "inherently rational" individuals will tend to base decisions on routines and "rules of thumb" (Williamson, 2007; Simon, 1957). This raises two important consequences: since it is impossible to foresee every circumstance arising from a decision, any contract created from a transaction between individuals is inevitably incomplete; and, the transaction costs associated with any decision making, such as gathering information, legal counsel, administrative costs, monitoring, information transfer, etc., are unavoidable, if an individual is boundedly rational (Sorrell et al., 2004).

Transaction costs tend to be rather difficult to measure. Determining their absolute value in any given circumstance is near impossible. Instead of reasoning through the application of absolute values into mathematical models, TCE focuses on the "determinants of the transaction costs, their relative size in different circumstances and how they can be minimised by the choice of an appropriate governance structure" (Sorrell et al., 2004, p.45).

While TCE provides interesting insight into the barriers debate by recognising the presence of transaction costs and their incidence within different market, contractual, and organisational agreements, it has yet to allow the researcher to explore the full effect that human behaviour has on decision-making. Since one of the purposes of this study is to explain the reasons for neglecting energy efficiency opportunities, additional perspectives should be taken into consideration.

2.2.4.2. Behavioural economics

In the past century, two trends have led to the divide between economics and psychology: one attempting to make the discipline of economics more scientific through the development of mathematical models; and, the other attempting to accomplish the same with psychology by developing theories based on experimental regularity (Camerer, 1999). Consequently, economists routinely use models that are inconsistent with psychological findings. However, it is important to note that economics is the science of how resources are distributed by individuals and institutions (Daly and Farley, 2004). Because of these human components, psychological processes of human behaviour should inform the economic assumptions related to decision-making.

The final stage of reviewing current frameworks used in guiding the debate is to discuss the notion that transaction cost economics is a more realistic, but still inadequate model in its ability to describe the full extent of bounded rationality on human decision-making.

TCE raises, in part, the idea that more knowledge is embodied within "organisational capabilities" than are revealed within contracts between independent parties. However, no attempt to address these limitations is made within the context of bounded rationality. Foss (2003) raises a few important questions regarding these limitations:

> What exactly is it that cannot be written in contracts? Even if the costs of writing contract are prohibitive, why cannot relational contracting, involving highly incomplete contracts between independent parties, handle the transfer of knowledge?

> Why is it only vertical integration that economizes with what are presumably writing and communication costs (p.92)?

The argument is that within TCE (and other theories, such as contract theory), bounded rationality is treated more as a background argument, rather than a framework that provides a basis for explaining economic organisation; and one that pays too little attention to "boundedly rational individual decision-making" (Foss 2003, p. 259). He goes on to explain that:

> ... The bounded rationality research effort may be understood as an attempt to elaborate and examine the insights that (1) the human capacity to process information is quite limited, (2) humans try to economize on cognitive effort by relying on short-cuts, and (3) because of (1) and (2), as well as other factors, such as the influence of emotions on cognition, human cognition and judgement is subject to a wide range of biases and errors.

Since the purpose of this study is to explore the perceived performance of various municipalities within Southern Ontario in relation to energy efficiency, and to determine the reasons for this performance, the incorporation of concrete psychology-based notions of bias and human error into this study's framework should be considered. While its application to energy efficiency is still being developed (Lissowska, 2011; Marechal and Lazaric, 2010; DellaVigna, 2009), behavioural economics increases this realism by incorporating the "psychological underpinnings of economic analysis" (Camerer and Loewenstein, 2004, p. 3). In the study of barriers to energy efficiency within an organisational context, behavioural economics acknowledges the significance of individual decision-making on the organisation. Its teachings do not outwardly reject neoclassical economics, but rather they seek to modify a few of their assumptions to incorporate a more realistic model of human decision-making. As an example, Camerer and Loewenstein (2004) states that there is nowhere within the neoclassical teachings that state that people needn't care about fairness, that risky decisions should be measured linearly or even that human limits to "computational power, willpower, and self-interest" exist (p.4). In fact, they go on to argue that these assumptions "can be considered 'procedurally rational' because they posit functional heuristics for solving problems that are often so complex that they cannot be solved exactly by even modern computer algorithms"(p.4).

To demonstrate the universal existence and predictability of these notions, Nobel Prize recipient, Daniel Kahneman has tested human decision-making within a variety of conditions. The results have led to the development of "prospect theory", which provides "descriptively accurate" alternatives to the assumptions of orthodox economics (Kahneman and Tversky, 1979). To date, this theory has received little attention outside of behavioural and experimental economics in relation to energy efficiency (see Zundel, 2011; Swim et al., 2011; Sorrell et al., 2004). However,

the implications on the barriers debate have been highlighted: losses are weighted more heavily in decision making than gains. Therefore the cost of investing in energy savings may be perceived as being more significant than the gains achieved by those savings. Sorrell et al. (2004, pp.49-50) define two characteristics of this theory as the certainty effect and loss aversion. They explain their relevancy to energy efficiency as follows:

- ...outcomes received with certainty are weighted more heavily than uncertain outcomes... most people would prefer $500 with certainty to a 50 per cent chance of winning $1000. But the orthodox model maintains that these two options are equivalent... individuals have been shown to under-weigh outcomes with a low probability and over-weigh those with a high probability, leading to risk aversion with respect to gains and risk seeking with respect to losses.
- ...individuals generally require more money in compensation to give up something than they would pay to obtain it... Many decisions take the form of a choice between retaining the status quo and accepting an alternative which is advantageous in some respects and disadvantageous in others... Since individuals place greater weight on losses than on gains, the decision is biased in favour of retaining the status quo.

These predictions are relevant since they imply that often business decisions will deviate from the predictions presented by orthodox models, in that individual and organisations decisions will strongly depend on how the options are framed (Lockwood, 2011; DellaVigna, 2009; Karsten and Reisch, 2008).

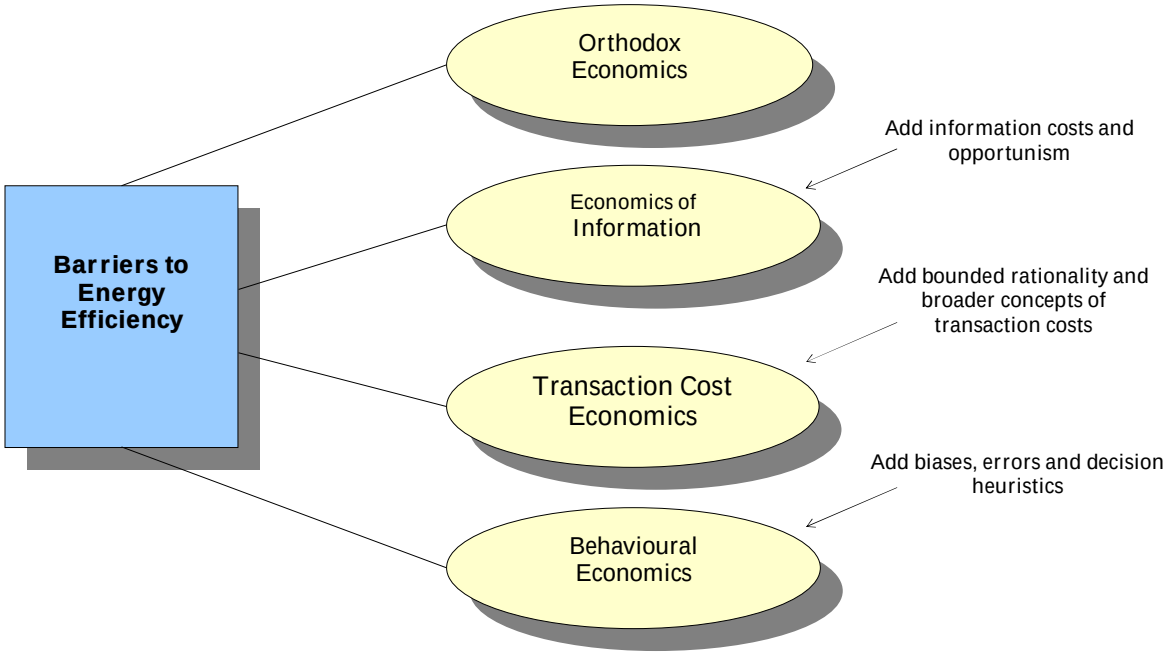


Figure 2.1: The economics of energy efficiency

Source: From Sorrell et al., (2004), p. 51

2.3. Towards a Taxonomy of Barriers to Energy Efficiency

Thus far, using Sorrell et al's (2004) studies as a baseline in determining the different economic frameworks used to understand barriers in energy efficiency (see figure 2.1), the orthodox model has been extended. This has been accomplished by examining key assumptions in orthodox, TCE and behavioural frameworks and their relation to several studies on energy efficiency. Within these studies different research methods have been used to highlight and explain various barriers and to offer recommendations to reduce the efficiency gap.

The orthodox model to energy efficiency provides a theoretical starting point to reducing the efficiency gap by promoting public intervention when market failures are present. However, through the study of these orthodox frameworks, it has been revealed that many orthodox studies tend to treat market failures as absolute, neglecting the possibility of the removal of additional "hidden" costs through non-price regulatory policies (Sorrell et al., 2004). Therefore alternate economic theorems, notably through the introduction of more "progressive" ideologies such as Transaction Cost Economics and Behavioural Economics have been used more recently, to overcome these weaknesses.

This section will develop a taxonomy of barriers to energy efficiency. The classification itself is created by summarising categories of barriers widely used throughout previous studies on energy efficiency. There appears to be little disagreement in the literature as to what these primary barriers are. However, as previously described, the frameworks used to understand these barriers, lead to conflicting opinions on their relevancy to organisational and individual decision-making and the effectiveness and feasibility of various tools used to reduce them. Therefore, by gathering several studies on barriers to energy efficiency, and relating them to one or more of the theoretical ideas discussed above, sub-themes of barriers, referred to as "contributory mechanisms", have been compiled. A summary can be viewed in Table 2.3. These are to be considered a list of hypotheses that could potentially explain the neglect of energy efficiency in organisational decision-making within Southern Ontario municipalities. Sorrell et al. (2004) propose that each barrier attempts to answer the following three questions:

1. Why do organisations impose very stringent investment criteria for projects to improve energy efficiency?
2. Why do organisations neglect projects that appear to meet these criteria?
3. Why do organisations neglect energy efficiency and apparently cost-effective alternatives when making broader investment, operational, and maintenance and purchasing decisions?

Table 2.3. Barriers to energy efficiency

Primary Barrier	Contributory Mechanism	Example
Imperfect Information	Non-existent information	Lack of information on funding opportunities
		Lack of expertise and implementation experience
		Lack of consistent and easily analysable benchmarking data
		Lack of information on specifying the right opportunities/ equipment
	Inaccessible information	Difficulty in obtaining information for specifying the right opportunities/ equipment
		Difficulty in obtaining information on consistent and easily analysable benchmarking data
	Asymmetric Information	Lack of information provided by contracts
		Doubt regarding the trustworthiness of certain information sources
Hidden Costs	General overhead costs of energy management	Cost of employing specialists
		Costs of energy information systems/ gathering information
		Costs of audits
	Costs associated with individual technology decisions	Costs of full investigation on technology
		Costs of seeking municipal council approval for spending
		Additional staff costs for maintenance
		Costs for replacement, retirement or retraining of staff
		Costs of contract negotiations
		Costs of disruptions/ inconvenience
	Loss of utility with energy efficiency choices	Costs of reduced capacity
		Costs of lower reliability
Capital Constraints	Limited accessibility to funds	Lack of personnel/ specific department for researching funding opportunities
		Low rate of return
		Lengthy pay-back periods
	Non-existent funds	Insufficient external funding
		Scarce or unavailable internal funds
Risk or Uncertainty	Changes in technologies	Future development of new technical solutions
	Price fluctuations	Future energy costs are uncertain
		Price fluctuations of energy efficiency technologies in relation to changing demand
	Legal/ Political uncertainty	Increasing standards rendering current solutions obsolete
		Uncertainty regarding procurement policies
Split Incentives	Investor/ User dilemma	Lack of accountability/ awareness between energy user and investment/ energy/ finance departments
	Conflicting objectives	Different priorities/ mandates throughout departments/ individuals
Bounded Rationality	Bounded rationality	Constraints on time
		Constraints on attention
		Constraints on the ability to process information

Note: Table compiled from various sources including Schleich, 2009; IESO, 2008, EPA, 2008; Schleich and Gruber, 2006; OPA, 2006; Borg et al., 2006; Sorrell et al., 2004; DeGroot et al., 2001; Harris et al., 2000; DeCanio, 1998; Sutherland, 1996; Sanstad and Howarth, 1994; Jaffe and Stavins, 1993; Howarth and Andersson, 1993; Gruber and Brand, 1991

2.3.1. Imperfect information

Before proper investment decisions can be made, adequate knowledge on efficiency opportunities is required. The primary argument is, for some reason, individuals lack the information to make proper investment decisions related to energy efficiency. This is most often a result of non-existent or inaccessible information or asymmetric information (IESO, 2008; Schleich and Gruber, 2006; Borg et al., 2006; Sorrell et al., 2004; de Groot et al., 2001; Howarth and Andersson, 1993; Gruber and Brand, 1991).

The existence of imperfect information may explain the efficiency gap. However, the imperfect information itself is described differently throughout the literature. It most often includes: a lack of expertise and implementation experience within an organisation (EPA, 2008; Howarth and Andersson, 1993); difficulty obtaining consistent and easily analysable benchmarking data, funding opportunities and negotiating contracts (EPA, 2008; Schleich and Gruber, 2006; de Groot et al., 2001); unavailable or inaccessible information for specifying the right equipment (Schleich and Gruber, 2006; Borg et al., 2006; De Groot et al., 2001; Gruber and Brand, 1991); and, doubt over the effectiveness of certain information sources (Sorrell et al., 2004). In some situations, firms may believe that their level of energy efficiency is already at a desirable level (EPA, 2008).

Since imperfect information is central to orthodox perspectives on market failures, its existence may justify intervention. There have been suggestions for both labelling schemes and the application of minimum efficiency standards (Karsten and Reisch, 2008; Borg et al., 2006; Sorrell et al., 2004; Sutherland, 1996; Howarth and Andersson, 1993). From an orthodox point of view, labelling schemes address the market failure by informing potential buyers about certain characteristics of their products or may identify information relevant to seeking efficiency opportunities (de Boer, 2003). However, minimum standards may be met with more scepticism. As with pharmaceuticals, unknown long term risks associated with energy consumption may in fact prove a case. Justifying such policies would require consideration of the costs incurred by producers to “shift towards more efficient goods” as well as the benefits of lower energy costs to the consumer (Sorrell et al., 2004, p. 63).

However, choosing the appropriate form of intervention is far more complex then suggested above, as the methods used to defend certain public policy measures may be debated. When in need of information, most firms turn to specialist publications, such as trade literature and reviews and contacts with suppliers or equipment producers and colleagues (Gruber and Brand, 1991). Transaction cost and behavioural perspectives are less interested in the availability of information itself, but rather seek to confirm its credibility. And, the source, or context in which

information is presented will greatly affect its perceived credibility (Sorrell et al., 2004). An example is highlighted in de Groot et al.'s (2001) study on decision-making barriers and policies:

> The public-goods nature of information provides good arguments for such a governmental role in providing and disseminating information. At the same time, firms' perceptions on the role of a government agency ... in stimulating the diffusion of information cast some doubt on the potential effectiveness of the government as a driving force behind information dissemination (p. 724).

These types of observations are not uncommon throughout the literature (Zundel, 2011; Lissowska, 2011; Schleich and Gruber, 2006; Sorrell et al., 2004; Gruber and Brand, 1991; Reddy, 1991). It is suggested that greater success can be achieved when information provided by existing intermediaries are used, and that interpersonal contacts and recommendations are perceived more positively than non-interpersonal means of communication, such as labels.

It is also important to note that many organisations argue that the existence of clear and concise information on opportunities is limited (Borg et al., 2006). The more difficult it is to access or understand information, the less likely it is to be used. Information should be simple, clear and relevant. Sorrell et al. (2004) suggest:

> ...personalised information such as that provided by energy audits, should be more effective than general information on cost saving opportunities, while a demonstration of tangible success with a technology is likely to have more persuasive power than a sales pitch (p.64).

Finally, it is important to note that there is considerable overlap between the existence of imperfect information and hidden costs (Schleich and Gruber, 2006; Sorrell et al. 2004). This is because the transaction costs associated with the need to find, analyse, and apply information on efficiency opportunities may result from imperfect information. Hidden costs will be defined in the next section.

2.3.2. Hidden Costs

Hidden costs may be the most relevant of barriers to energy efficiency due to the various contexts in which they exist. Orthodox economists argue that public intervention is only merited when barriers equate to market failures. Therefore, under orthodox economic reasoning, “engineering-economic” models' claims that barriers can be resolved through public intervention, inherently assume hidden costs are negligible. Consequently, engineering-economic models tend to overestimate efficiency potential.

The orthodox argument arises from the ideas that “normal” markets tend to be efficient (Sanstad and Howarth, 1994), and hidden costs are characteristics of normal market processes. This demonstrates that many organisations are likely neglecting energy efficiency for perfectly rational reasons.

The reality is likely situated somewhere in the middle and that, while economic reasoning is important to understanding the barriers debate, the idea that markets are always efficient is simply untrue. The orthodox rationale that hidden costs are a rational reason for neglecting efficiency is an exaggeration that contradicts theories pertaining to the economics of information and transaction cost economics.

Sorrell et al. (2004) argue that there are three possible empirical categories of hidden costs. These include: general overhead costs of energy management; costs associated with specific technological or energy efficient choices; and, costs associated with a reduction in utility with those choices. Examples are provided in table 2.3.

These examples of hidden costs may relate to four of the theoretical ideas discussed under section 2.2: production costs; loss of utility; market transaction costs; and organisational transaction costs. The first two categories are possibilities when adopting any product or service. Once adopted, the existence of these production costs, or loss of utility costs, are unavoidable and any form of policy intervention will not reduce them. The latter two on the other hand are contingent on internal and external structures surrounding an organisation or technology. For example, costs of a product or service will fluctuate, based on demand and supply, and the cost of having to pay an employee to research energy efficiency opportunities may depend on the ease of access of that information. In some circumstances, these costs may be lowered through public or organisational interventions such as subsidies.

Identifying these hidden costs can be rather complex. The heterogeneity of energy users may imply that the relative importance of the aforementioned costs, and consequently their policy implications will vary between organisations and technologies. The significance of these hidden costs on organisational decision-making should therefore be studied on an individual case basis (Howarth and Andersson, 1993).

2.3.3. Capital constraints

An often cited barrier to energy efficiency investment is that of limited access to capital (Schleich and Gruber, 2006; Borg et al., 2006; Sorrell et al., 2004; Harris et al., 2000). Generally, limited access to funding is a straightforward barrier that takes on two dimensions:

- Limited accessibility, or nonexistent internal funds
- Lack of access to external funds

Both internal and external accessibility may be dependent on various factors, such as organisation size (small and medium organisations versus large corporations) or the type of organisation (for profit, non-profit or public). For example, investment in energy efficiency often requires various initial borrowing costs. If an organisation has restricted access to capital and is able to borrow, even if the investment yields a return, interest rates related to borrowing will affect the rate of return and payback period. This is especially significant for organisations that have to pay higher interest rates due to the lender's risk or organisations whose thin profit margins lead to strict thresholds for their payback periods (EPA, 2008; Schleich and Gruber, 2006).

Subsidies for energy-saving measures are another option for acquiring investment funds. However, studies have demonstrated that the availability of subsidies is rarely a decisive factor, notably for small and medium-sized companies, which state the programmes are often ill-adapted to their specific needs. Overlapping with informational barriers, are the inability for smaller organisations to dedicate limited resources to gain information and fill in application forms (Gruber and Brand, 1991).

In addition, politics and budgeting laws may prevent an organisation from accessing outside capital. The politics, policies and strict mandates related to budgets and funding often exert a strong influence on decision-making and are subject to consensus (Schleich and Gruber, 2006), notably within cases across the public sector. Municipalities, specifically, are often subjected to additional barriers to financing such as a lack of budgetary autonomy and restrictions on the amount of debt they can assume or how to write off investments in energy efficiency (EPA, 2008). In many commercial organisations, energy consumption is rarely seen as being significant enough to merit being addressed strategically in relation to other costs (Sorrell et al., 2004). Although many organisations are now integrating what is known as a triple bottom-line, which incorporates social and environmental initiatives into the core mandates of an organisation (Laszlo, 2003), many organisations still maintain functional approaches to environmental management and consider the environment simply as something to be incorporated into costs (Winsemius and Guntram, 2002). Even if organisations have access to capital at relatively low prices, issues of

bounded rationality (Sorrell et al., 2004) and uncertainty associated with returns may be prohibitive (Schleich and Gruber, 2006).

The reasons for imposing strict investment criteria may be significant. However, Sorrell et al. (2004) note that the rationale for the behaviour, the extent to which this behaviour is reproduced within other organisations, and, whether this behaviour is the cause of strict organisational mandates, need to be considered when evaluating organisation specific energy efficiency potential.

2.3.4. Risk or uncertainty

The perception of risk may take on a variety of forms. But most relevant to this debate are the potential impacts that these perceptions have on the adoption of energy efficiency, as opposed to other forms of investment. In other words, are investments in energy efficiency riskier than other investments, and are therefore rationally overlooked?

Risk and barriers related to uncertainty may take on a variety of forms. Unknown changes or improvements in unfamiliar technologies, rendering them either obsolete or unreliable constitute real concerns (Schleich and Gruber, 2006; de Groot, 2001). Investments in certain technologies may prove to be inadequate in light of shifts in policies (de Groot, 2001). Legal uncertainty has been highlighted in studies pertaining to public procurement (Borg et al., 2006) (and is therefore noteworthy within this context of municipalities). Generally, legislation does not prohibit investment in energy efficiency within public institutions. However, interpreting procurement policies can be difficult and often lead to questions of what is and is not allowed. For example, would the most “economically advantageous technology” be one that yields the quickest rate of return? Changes in pricing of new technologies, due to increased demand may be an issue. Finally, changes in future energy prices are often cited as they may potentially affect rates of return on investment (Schleich and Gruber, 2006; Sorrell et al., 2004; Sanstad and Howarth, 1994).

While regulatory and technical risk, and rates of return may be a rational response to risk within individual organisations (Sanstad and Howarth, 1994), criticism has been brought to this argument on the grounds that they are too often rooted in usual orthodox modelling issues (Schleich and Gruber, 2006; Sorrell et al., 2004). Studies often only account for risks associated with investment and fail to consider the costs associated with delaying investment in energy efficiency. Schleich and Gruber (2006) explain that:

> ...if risk-averse investors consider the effects of stochastic energy prices on the returns of the investment project only, they are expected to invest less. But if they take into account the effects on company costs and profits, they may actually invest more because overall company costs and profits become less volatile (p.454).

Either way, investment in energy efficiency is considered to be permanent and irreversible (Sorrell et al., 2004). Consequently, and regardless of the results, it generally carries a greater risk. Coupled with the aforementioned risks, an organisation's perspective on the optimal rate of return tends to be higher in energy efficiency investments than similarly important, conventional ones.

2.3.5. Split incentives

As previously mentioned, the most commonly cited example of split incentives in the energy efficiency literature are situations that arise between owners of properties and their tenants (Schleich and Gruber, 2006; Sorrell et al., 2004; Howarth and Andersson, 1993; Gruber and Brand, 1991; Reddy, 1991). Leasing and tenant issues in large, multi-tenanted retail and office buildings will often alter energy use and conservation engagement issues. Tenants may be unmotivated to invest in energy efficiency improvements if they do not own the buildings, particularly when payback is longer and leasing situations are shorter (Sorrell et al., 2004). This may be less applicable in municipal buildings, where the buildings tend to be owned by the municipalities. However, issues of split incentives also arise when managers remain in their posts for shorter periods of time, and are therefore biased towards investments with short term payback periods.

In larger organisations, different responsibilities are often split amongst several players, and investments often require initiation and approval by someone at a higher level (ECS, 2008; Van Wie McGrory et al., 2002). Understanding the requirements of energy efficiency requires coordination between those paying the utility bills, those operating equipment and those in charge of investment decisions. Consequently, initial acceptance of energy efficiency technologies may be more significant in organisations with simple organisational and ownership structures and whose representatives tend to be early adopters of newer technologies or environmental initiatives. Of course, these organisations may be subject to more financial restrictions.

If individual departments become accountable for their own costs, this could increase incentives to prioritise energy efficiency projects. This would of course require the incorporation of individual billing practices, with the help of sub-metering technologies (Sorrell et al., 2004). In 2005, the Ontario Power Authority Conservation Bureau conducted a limited number of

interviews with owners and managers of large office and retail buildings for the Large Office and Retail Market Opportunity Assessment. According to the interview findings, there appeared to be a high level of interest in "sub-metering technologies" and "tenant control technologies" as a method of electricity and demand savings amongst building owners. Known as net-net-net leasing options, the adoption of this type of lease is most common for industrial properties in Ontario (OPA, 2005). The issue of split incentives may therefore remain a common barrier for Southern Ontario municipalities.

2.3.6. Bounded rationality

Many researchers treat bounded rationality as a method of guiding the study of energy efficiency. Others will argue that it is put to better use as a reason for neglecting energy efficiency. As discussed in previous sections, this study treats it as the latter. Just as the existence of certain barriers, such as asymmetric information, may lead a decision-maker to fall back on bounded rationality, the barrier itself may be the reason for the existence of other barriers, such as hidden costs. However, as stated by Sorrell et al. (2004, p. 78), "bounded rationality may also be classified as a barrier itself, since it contributes to decisions which depart from those predicted by orthodox models".

When systematic analysis is an unrealistic option or a lack of information about energy efficiency options is nonexistent, or not easily accessible, decision-makers will often apply routines and rules of thumb to decision-making processes or will favour the status quo. Within larger organisations, issues related to split incentives, such as conflicting policy objectives, or extensive regulations leading to difficulty in accessing funds, are additional difficulties that tend to favour reliance on past practices (Williamson, 2007; Schleich and Gruber, 2006; Foss, 2003; Sanstad and Howarth, 1994). The purpose in these scenarios is often to facilitate information handling, and minimise transaction costs, but the lack of flexibility often stifles innovation.

2.4. Summary

The existence of an "efficiency gap" has been established and was defined as being the difference between the optimal level of investment in energy efficiency as demonstrated by the literature, and the actual level of adoption among various organisations. It has been argued that various barriers commonly cited in the literature, and as presented in table 2.3, are responsible for this gap. However, inconsistent or inadequate frameworks used to study these barriers have resulted in a lack of consensus among experts regarding their significance within different organisational contexts, and, more indirectly, regarding which tools may resolve the gap. These conflicts continue to stifle the adoption of energy efficiency efforts.

This chapter has presented some of the theoretical models which have been used to frame the barriers debate and discussed the implications they may have when attempting to resolve the efficiency gap. These models include ideas derived from orthodox, transaction cost and behavioural economics – each of which integrates new economic, behavioural and organisational concepts that provide additional insight into the barriers debate.

The results of the literature review presented throughout this chapter have revealed a taxonomy of barriers to energy efficiency which are commonly listed in a variety of Canadian and international studies within the commercial and institutional sectors, and helped establish a comprehensive framework which will be used in studying the factors which affect municipal energy performance. These included issues of imperfect information, hidden costs, capital constraints, risk or uncertainty, split incentives and bounded rationality. However, as demonstrated by the theoretical models presented throughout this chapter, the mere presence of a barrier does not necessarily justify policy intervention.

The remainder of this thesis will explore the results collected from questionnaires and interviews to decipher which of these barriers are relevant to Southern Ontario municipalities and whether they may be rationally addressed through policy intervention.

3. Methodology

3.1. Introduction

Chapter 2 used literature sources to outline a number of hypotheses which would answer the questions presented in section 1.2:

- To what extent are Southern Ontario municipalities neglecting simple, well-proven and cost-effective energy efficiency measures?
- Why are Southern Ontario municipalities neglecting these measures (What barriers, as hypothesised by previous research, are preventing municipalities from adopting these measures)?
- How do these barriers affect decision-making in energy efficiency within the contexts of the Southern Ontario municipalities being studied?

The purpose of this chapter is to describe the methods used to answer these questions. Before introducing the methods used in this study, it is important to note that maximising the adoption of energy efficiency measures equally requires an understanding of the factors that drive adoption. This research, however, focuses solely on barriers. It is believed that excluding research pertaining to drivers permits a more thorough examination of these barriers. Therefore, this study only supports part of the research needed to fully understand municipal performance in energy efficiency. However, it is considered an essential step. The results of this study will help reveal tools that will help drive the adoption of energy efficiency and the contexts in which these drivers are most beneficial. Consequently, more thorough studies pertaining to the nature of drivers to energy efficiency may be completed.

Primary units of analysis in this research were provided by decision-makers and managers of municipal buildings within small and medium sized Southern Ontario municipalities. These buildings included: Town/city halls, community and recreation centres, fire halls, arenas, libraries, water and waste facilities, waste or recycling facilities, public transportation buildings, and any other municipal buildings indicated by questionnaire or interview respondents. The physical boundary of the research consisted of municipalities in Southern Ontario situated south of the French River and Algonquin Park (Chapman and Putnam, 1984). Municipalities with populations of 400,000 or less by the end of the 2010 calendar year were selected. The term medium sized municipality (often referred to as second-tier or third-tier municipalities) is used in this thesis to describe municipalities with populations between 100,000 and 400,000. This population criterion was established based on a study by the Canadian Policy Research Networks (CPRN) on Housing for Immigrants in Ontario's Medium-Sized Cities (2008).

> The terms "second-tier city" and "third-tier city" are frequently used to describe urbanized areas that are smaller than the large metropolises that dominate regional or national economies, but they have no single accepted definition… In Ontario, there is little question that Toronto is the only first-tier city… The lower population bound of a second-tier city in the province is somewhat harder to determine, but figures in the range of 300,000 to 350,000 are sometimes used for the United States (Sweeney, 2004). In Ontario, there are a number of Census Metropolitan Areas (CMAs) with populations between 300,000 and 400,000, but none between 200,000 and 300,000… A further category of "third-tier city" can be used to refer to the remaining CMA's that have populations of more than 100,000 (the minimum for a CMA) but fewer than 300,000 (pp. 1-2).

Small municipalities are, therefore, considered to be municipalities with populations with less than 100,000. The reasons for not including municipalities with populations over 400,000 relate to the complexity of municipal structures. Generally these municipalities contained a significantly greater number of staff and departments. Making meaningful connections between decision-making processes and energy efficiency would have required a large number of interviews with a variety of experts from across departments. The scope was considered too big for the purposes of this study.

Data were collected from September 2010 to August 2011, although secondary data were collected as early as fall of 2008. The research methods are summarised as follows, and will be described in greater detail further in this chapter:

- Questionnaire: In September 2010, an initial email was sent to various municipal employees, inviting them to respond to a questionnaire via kwiksurveys.com. The purpose of this questionnaire was to obtain information on energy consumption, energy management practices and the adoption of specific technologies related to energy efficiency. The questionnaire was open to respondents from September 2010 to December 2010 and reopened from June 2011 to August 2011.
- Interviews: Follow-up interviews were then conducted by telephone with a select group of municipal employees to obtain additional information. Interviews were conducted from December 2010 to January 2011 and June 2011 to August 2011.

This chapter is structured as follows: section 3.2 explains the research methods and the rationale for selecting them; section 3.3 discusses the methods used to select participants; sections 3.4 and 3.5 describe the questionnaire and the interview as research methods and the reasons for selecting them within this study; section 3.6 presents the strategies taken for data analysis; section 3.7 discusses potential limitations of the study; and, finally, section 3.8 summarises the points discussed and prepares the reader for the following chapter.

3.2. Research Strategies

The objective of this case study was to explore the perceived performance of energy efficiency among municipal buildings of Southern Ontario municipalities and to understand the reasons for their performance. For this case study, Sorrell et al.'s (2004) study on barriers to energy efficiency provided a clear introduction of the efficiency gap and the economics of energy efficiency. It was therefore useful in guiding the research framework and method.

Organisational performance in energy efficiency is inherently complex given the broad range of economic, organisational and behavioural factors that influence it. Given the broad range of factors to be studied, a multidimensional case study approach was chosen.

Case study research is ideal for investigating complex social phenomena by allowing multiple sources of quantitative and qualitative evidence to be employed (Yin, 2009; Sorrell et al., 2004). A common criticism of case studies is that they do not allow results to be applied to a general population (Yin, 2009; Bitektine, 2008; Schleich and Gruber, 2008; Sorrell et al., 2004). Yin, in particular, has refuted this criticism by stating that "in analytic generalisation, previously developed theory is used as a template against which to compare the empirical results of the case study" (1984, p.32). Though multiple case studies do not represent samples of a population, they needn't be treated as such. The purpose is to *explain* specific phenomena from the perspective of the participants by comparing and contrasting results from multiple sources. Many relevant variables within this type of study may be difficult to identify within a quantitative model, creating a risk that "important factors" are misrepresented or ignored (Sorrell et al., 2004). Sourcing Yin's (2009) *Case Study Research: Design and Methods,* Table 3.1 summarises the reasons for selecting this method. The number of cases and the implications on the results will be discussed later in this chapter.

The objective of this case study was achieved by seeking corroboratory and converging evidence among the collected data. These included both quantitative and qualitative data, as quantitative data on energy consumption were not always available, or were difficult to normalise in terms of weather patterns, building characteristics and equipment operation. While it is true that case-studies are not statistically justified and may render hypothesis testing more difficult, it is considered appropriate for this study in that it permits a richer depiction of issues and influences related to organisational decision-making in energy efficiency.

Table 3.1. When to use the case study

When to use the case study method	Why to use the case study method in this research
When understanding complex social phenomena	Organisational decision-making within Southern Ontario municipalities rests on complex social structures and any contributory mechanism, or barrier to energy efficiency may be offset by a number of other organisational mechanisms.
When asking a "how" or "why" question	Why do organisations neglect energy efficiency projects that appear to be cost-effective? Why do organisations neglect energy efficiency and apparently cost-effective alternatives when making broader investment, operational, maintenance and purchasing decisions?
When examining contemporary events	Energy efficiency is a contemporary issue introduced by growing concerns associated with climate change and other related issues.
When relevant behaviours cannot be manipulated	The purpose is to address the energy efficiency gap through a comprehensive examination of already established energy management practices within municipalities.
When the contextual conditions need to be clarified to understand the phenomenon being studied	Despite previous studies pertaining to barriers to energy efficiency in a range of contexts, an "efficiency gap" still appears to be present within Southern Ontario municipalities, indicating the relative importance of barriers to energy efficiency have yet to be fully understood within this context.
When there are many variables of interest	Potential barriers result from and may result in changes in relevant decisions or behaviours related to policies, incentives, hierarchy, contracts, routines, and relevant actors, such as suppliers, local distribution companies, designers, engineers, managers, politicians, etc.
When triangulating multiple sources of data	Literature reviews, questionnaires and interviews were used because performance in energy efficiency is difficult to measure and the factors responsible for this performance are difficult to isolate.
When using prior theoretical development to guide question development, data collection and analysis	Studying barriers to energy efficiency is not a new field of study, but the ongoing presence of an efficiency gap indicated the need for detailed empirical studies in different contexts.

Source: Adapted from Yin (2009), pp. 3-19

The first stage of the research consisted of gathering information on energy markets within Southern Ontario and current policies used to promote energy efficiency. Combined with an analysis of the municipalities' and buildings' organisational characteristics and energy use patterns, this helped establish the current energy climate within Southern Ontario and the region's associated municipalities.

The next stage, as detailed in chapter 2, consisted of outlining factors contributing to municipal performance in energy efficiency and identifying potential barriers affecting that performance. Each barrier is considered a hypothesis to explain whySouthern Ontario municipalities may be neglecting energy efficiency within organisational decision-making. The primary question is: "why do organisations neglect energy efficiency?" To answer this question, it is important to examine the role of individuals and departments in decision-making within an organisation. This includes understanding the relative policies, incentives, hierarchy, contracts, and routines.

Having determined the data needed to test the hypotheses, the next stage consisted of selecting appropriate methods for collecting the data. The methods employed were required to establish the nature and significance of each proposed barrier. The primary sources used to collect data consisted of semi-structured telephone interviews with energy managers. These were supplemented by questionnaires completed by a wide range of municipal employees and additional documentary evidence. The questionnaires and interview questions were largely based upon Sorrell et al's (2004) case studies on barriers to energy efficiency. The similarities stem from the influence these studies have had on the framework and subsequent taxonomy of barriers developed for this case study. The case studies identified by Sorrell et al. (2004) stretch across several countries and various sectors. The questionnaires and interviews used were designed to synchronise approaches between research teams, without generalising results. They consisted of a standardised set of questions that utilised both the quantitative and qualitative measures that would allow the existence of each barrier to be identified across case studies. Given this, the line of questioning was considered appropriate for this study. Adaptations were made where necessary and they will be discussed in detail in the following sections.

Once the data had been collected, the final stage was to bring together the results from the questionnaires and interviews to characterise the Southern Ontario municipal sector, to describe energy management practices within the sector, to discuss the evidence for, and relevance of, different types of barriers, and to discuss the policy implications and relevant tools that may overcome such barriers. Table 3.2 summarises the research approach.

The research protocol used, and any subsequent changes to the research methods, received approval from the Office of Research Ethics at the University of Waterloo and can be found in Appendix A.

Table 3.2 Overview of research approach

	Research Method	**Data Collection**	**Data analysis**
Objective	To explore performance in energy efficiency within Southern Ontario municipalities and to understand the reasons for this performance	To collect appropriate information for testing the research hypotheses	To answer the research questions
Approach	Multidimensional case study	A literature review; Semi-structured telephone interviews w/ energy managers; and, Pre-interview questionnaires completed by a wide range of municipal employees	Bring together the results by categorising/ coding data to retrieve meaningful connections which explain the existence, and cause of, an efficiency gap

3.3. Participant Selection

The next stage was to identify and contact a number of municipalities across Southern Ontario. When seeking data that can be replicated across a general population, researchers prefer probabilistic, or random, sampling methods, where the probability of representing a population can be calculated statistically (Babbie, 2007; D'astous, 2005). In contrast to random sampling techniques commonly used in quantitative studies, purposive sampling was the method chosen to recruit the questionnaire respondents. Because this study was not intended to be statistically significant, but rather had the purpose of exploring performance in energy efficiency within a specific context, this alternative form of sampling was deemed appropriate.

The specific method of sampling that was used for selecting the candidates for the first phase of the study was initially expert sampling. This form of sampling is ideal when attempting to elicit the views of persons who have specific experience or expertise within the field of study (Longhurst, 2010; Babbie, 2007). The purpose was to recruit candidates who were able to examine and comment on the appropriateness and validity of the hypotheses. In this case, the candidates were municipal employees responsible for making various decisions with regards to, or affecting, energy efficiency.

Selecting potential respondents consisted first of conducting an internet search to establish a list of Ontario municipalities, their locations and respective populations. A search for municipal websites within the targeted area and having a population of less than 400,000 was then conducted. Potential contacts were selected from websites which contained employee contact information. Specific individuals were selected as potential respondents based on the likelihood of their involvement with various decision-making procedures and/or energy efficiency practices within Southern Ontario municipalities. Potential respondents consisted of various municipal employees, including decision-makers such as CAOs, finance officers, energy managers and facility managers.

Once a list of contact information from 204 municipalities had been compiled, emails inviting participants to complete a questionnaire on www.kwiksurveys.com were sent. In larger municipalities, this required emailing several municipal employees within several departments. The original email stated that if employees felt other municipal staff members could provide valuable input, they may pass along the email and questionnaire link. This additional form of purposive sampling, known as snowball sampling, was used to gather additional expert information from municipal employees who may have been less accessible. For example, contact information for every employee within a municipality may not have been available on the municipal website. In this case, snowball sampling helped recruit other experts within the municipality that may have been hidden from the researcher.

An issue did arise in one case, where an employee was being inundated with emails being forwarded by colleagues who thought he would be the most appropriate person to answer the questionnaire. Consequently, to prevent any additional people from experiencing this issue, some changes to the recruitment process were made. These changes consisted of:

- making it clear and unambiguous that multiple members of the same municipality were being contacted; and,
- altering the information letter to clarify that one of the goals of the research was to gather various perspectives across the same organisation, which required responses from various levels of municipal employees.

Following these changes, snowball sampling became the primary method of recruitment. Only the CAO of the remaining municipalities was contacted and was asked to forward the email to appropriate responders. The changes to the recruitment letters can be viewed in Appendix A. In total, 204 municipalities were emailed with a request to participate in the study. While it was possible for more than one employee from each municipality to complete the questionnaire, the answers to the demographic questions did not indicate this. In total 26 respondents (or 13% of municipalities approached) provided answers to at least some of the questions. However, because

of the ability for participants to skip unknown or inapplicable questions, not all questions received 26 valid responses. The questionnaire's sampling frame composition will be detailed more extensively in section 3.4. and is reproduced in figure 3.1. The specific number of responses to each question is provided in chapter 4.

The second phase of the study consisted of a semi-structured phone interview with the purpose of further substantiating the significance of the proposed barriers and to gather opinions on the effectiveness and efficiency of various tools needed to overcome the barriers. These candidates were selected based on:

- their involvement in management decisions or knowledge on energy efficiency within municipalities; and,
- their stated interest in further participating in the study.

At the end of the questionnaire, candidates were prompted to state their willingness to be interviewed. If interested, the respondents filled out a contact form and received interview information within the following weeks. In total, six interviews were conducted with an energy, or environmental manager, or the equivalent (representing 23% of the questionnaire respondents, or 3% of the total number of municipalities approached). Figure 3.1 summarises the sampling frame composition. The interview sampling frame composition is detailed extensively in section 3.5.

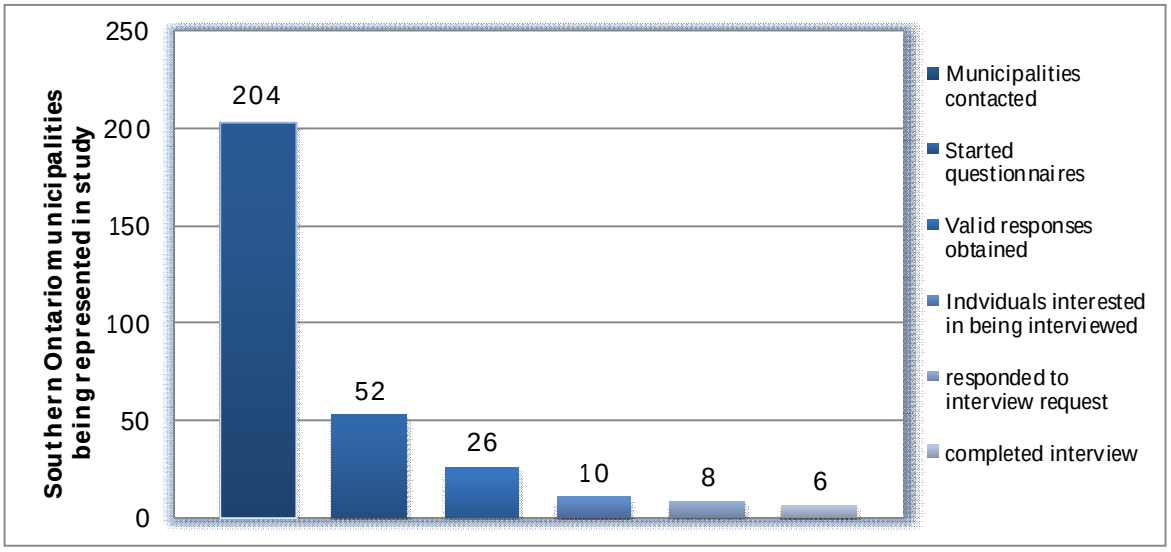


Figure 3.1: Sampling frame composition

3.4. The Questionnaires

Once the background research had been completed, and the contact information from the various municipalities had been organised, the questionnaires were distributed via email.

Standardised questionnaires are commonly used when acquiring information about the "characteristics, behaviours and attitudes of a population" (McLafferty, 2010, p. 77). While other methods of research, such as observational methods and secondary data can uncover some of this information, questionnaires are particularly useful when complex behaviours and social interactions are of interest, especially in regards to views on social, political and environmental issues (McLafferty, 2010, pp. 77-78).

In this particular study, Sorrell et al's Energy Management Questionnaire for the Mechanical Engineering Sector served as a template for this study's questionnaire design (2004). In light of the similarities in frameworks between studies, the structure of the questionnaire and many of the questions were directly relevant to this study. Some questions were altered to increase clarity or appropriateness for this study's context while other questions were simply added or removed. For example, municipalities are often responsible for multiple buildings, including, but not limited to, town or city halls, arenas, waste facilities and libraries. Many of these buildings vary in size, age and energy consumption levels. Employee responsibilities within these buildings also differ and will therefore affect the information they provide. One method of ensuring the collected data were not too generalised for the purposes of this study was to include questions pertaining to the types of buildings with which employees were involved. All questions were designed and worded to ensure clarity by avoiding too much technical jargon (except when necessary), keeping questions concise and specifying when necessary. These steps also ensured the responses given were useful and measurable to the researcher. The questions were both open-ended, which use qualitative methodologies to understand opinions and insights, and fixed-response questions, to gather demographic information. The questions can be viewed in Appendix B.

An online questionnaire using KwikSurveys.com was administered. The popularity of Internet surveys as a distribution method has grown significantly since the 1990s (De Vaus, 2002, p. 123). Computer-assisted web surveys consist of creating questions and placing them on a server and inviting participants to visit the associated web page to fill out the questionnaires. All responses are automatically coded and stored in an online database. Once the survey is closed, the researcher is able to conduct detailed analysis, using the collected data. In this case, consent was given by selecting "yes" or "no" to the consent questions prior to completing the questionnaire. A copy of the consent page is available in Appendix B.

Web based questionnaires have many advantages, such as the ability to filter responses and direct respondents to particular parts of a questionnaire. The ability to personalise many aspects of the surveys render them an attractive and professional option. Finally, low costs, short response delay and high selectivity have been noted as strong reasons for selecting web-based collection methods (McLafferty, 2010; D'astous, 2004; De Vaus, 2002; Sackmary, 1998), all of which were advantageous to the research. When comparing web-based methods with other distribution methods, such as phone or mail, studies have shown that both the quality and quantity of the information gathered is similar to other methods (Coderre and Mathieu, 2004). Having said this, the use of web-based data collection methods has also raised concerns among researchers and it is important to highlight any disadvantages this method of surveying may have on the results of the study. Internet use is growing rapidly. In 2009, 80% of Canadians aged 16 and up used the internet for personal use. While this increase in usage continues to narrow the digital divide, gaps amongst different groups still exist. Larger communities tend to be more "connected" than smaller and rural communities. In addition, income, education and age still play an important role in gaps in Internet usage (StatCan, 2010b). Those without regular Internet access or who were less Internet savvy may have been hesitant, or unable to respond to the survey. Because the Internet was the primary source for researching contact information, municipalities without websites, or poorly navigable websites were neglected from this study. These were more often, smaller and more isolated communities. This creates issues of misrepresenting the population. However, while one smaller community may have had limited access to the Internet, another with similar demographics may have had access.

Another issue that has been raised relates to problems with software (Solomon 2001). Within this study, only one participant reported a broken link, or inability to access the site. They were resent the direct link, with a request to follow up if any other issues arose. It is unclear from where stemmed the issue, but it appeared to have been resolved.

Finally, web-site based questionnaires require respondents to visit the site. However, quite often, only a small proportion of visitors actually complete the questionnaire (Coderre and Mathieu, 2004; Solomon, 2001). This was in fact the case with this study. In total, 52 people visited the website and responded to the first question. However, because of the respondents' ability to abandon the questionnaire prior to its completion, only responses from 26 participants could be used when analysing the data. In addition, the ability to skip questions when answers were unknown meant that not all questions received 26 answers. The number of responses per question is listed in chapter 4. Figure 3.1 summarises the sampling frame.

A final note relates not only to web-based questionnaires, but as a research method in general. It is important to note that while questionnaires can be useful in this type of research, they do limit

the number of variables to be analysed (Sorrell et al., 2004). Because of the complexity of barriers to energy efficiency, it is difficult to explain many of the phenomena in simple survey format. This justified the use of detailed interviews as a supplementary research method, and will be discussed in greater detail in the following section of this chapter.

The first surveys using the original methods of contact, as described in section 3.3, were sent out in September of 2010 to 14 municipalities across five counties. Approximately 130 emails were sent to various municipal employees within these 14 municipalities. Following the changes to the recruitment process, only the CAO of an additional 190 municipalities across 36 counties was contacted with a request to forward an attached email to appropriate municipal employees (recruitment documents can be viewed in Appendix A). It is assumed that these changes seriously limited the questionnaire's response rate. Originally, 2 to 34 employees per municipality were being contacted. Following the changes, only one person per municipality was contacted. Whether or not they chose to forward the email, is not known in many cases. In addition, in cases where the email was forwarded, the appropriateness of the responder was chosen by the CAO. In other words, the CAO's own biases may have hindered his or her willingness to email certain employees whom the researcher may have deemed appropriate. From September to December 2010, 40 potential participants visited the website, of which 18 provided valid responses to the questions that applied to them. A follow-up request to the CAO was sent in June of 2011, in which an additional 12 potential participants visited the website. Eight of them provided valid information.

In the end, the response rate was lower than originally anticipated. The limitations imposed by the low response rate will be discussed in section 3.7. However, by combining the use of documentary evidence, questionnaire and interview responses, the researcher was able to address a broad range of data. In other words, while the response rate of the questionnaires and the interviews was lower than anticipated, any findings, or conclusions were likely to be more accurate and well-supported (Yin, 2009, p. 98). Data collected will be presented in the next chapter, while the results will be discussed in chapter 5.

At the end of the questionnaire, candidates were prompted to state their willingness to participate in the second phase of the study. If interested, the respondents filled out the contact form and were presented with the interview information within the following weeks. These details will be discussed next.

3.5. The Interviews

The second phase of the study consisted of a semi-structured phone interview with energy or environmental managers, or in the case of one participant, a project manager, as this was the

individual who was responsible for providing environmental or energy input, as there was no department or individual dedicated to the task. This evidence helped to further substantiate the significance of the proposed barriers and gather opinions on the effectiveness of various tools needed to overcome them, in addition to allowing a compare and contrast between views of various municipal employees.

These candidates were selected based on:

- their involvement in energy management within municipalities; and,
- their stated interest in participating in the interview phase of the study.

Using multiple sources of data collection may help maximise understanding of a research question (Valentine 2005, p. 112). Given the detail needed to answer the research questions and the possible reluctance from municipal employees to respond to certain questions during the first phase of the study, interviews were selected as the appropriate data collection method to fill any gaps in knowledge. In contrast to other research methods, interviews may help establish much closer and personal contact with participants and, consequently, allow a more profound investigation into personal behaviours and motivations (Longhurst, 2010; D'astous, 2005, p. 70).

In line with the above three arguments presented by Dunn (2005, p.112)state that the interview may be used:

1. to fill a gap in knowledge which other methods are unable to bridge efficaciously;
2. to investigate complex behaviours and motivations; and,
3. to collect a diversity of opinions and experiences.

Finally, the ability to restate questions and probe answers throughout the interview process provide additional insights and help clarify the results (Yin, 2009). All of the above arguments contributed to the choice of the interview as one of the methods of research for this study.

Interviews were of a semi-structured nature, utilising Sorrell et al.'s *Interview Protocol for Energy Manager* to guide the interview process (2004). While most of the questions from this protocol were pertinent to this study, some adaptations were made when necessary. The original studies conducted by Sorrell et al., related to the European market. While some studies did pertain to the public sector, their focus was not on municipalities. To acquire the information pertinent to this study, some questions were added, reworded or built-on to render them more relevant to the Canadian, or Southern Ontario municipal context. For example, the final question within the set of questions pertaining to energy policy in *Interview Protocol for Energy Manager* asks: “Is your company a subsidiary of another company?... If yes, what impact does it have on energy management and decision-making?” By definition, a municipality is governed by its

council members and can therefore not be the subsidiary of another organisation. For this reason, the question was irrelevant to this research. However, municipal governments are subject to provincial and federal policies, including those related to energy efficiency. Changes in policies may have impacts on municipalities. This includes the adoption of the Ontario Green Energy and Green Economy Act, which sees a change in energy efficiency targets and will set out new rules directly applicable to municipalities. The questions "Has this municipality considered changes needing to be implemented due to the adoption of the Green Energy Act? If so, what changes are being considered?" were considered very important in understanding municipal decision-making related to energy efficiency.

The interview protocol consisted of a combination of open and closed-ended questions with the objective of acquiring specific information on energy use and practices and their relation to various topics on energy efficiency. While the interview questions were quite precise, the nature of the interview process permitted some freedom to the interviewer and respondent when an answer was unexpected and required adaptation to meet the objectives of the research.

In total, six interviews were completed. During the first wave of interviews, seven questionnaire respondents stated their interest in participating in an interview. Of the seven respondents, two did not reply to a follow up phone call and email and one failed to meet the criteria for participation in this phase of the study. In total, four respondents were selected. To allow time to ask questions and research some less accessible information, respondents were emailed the interview questions a week to two weeks prior to the interview. Due to the distance between the researcher and the participants, telephone interviews were conducted. The first wave of interviews was conducted between December 2010 and January 2011. Three of the interviews lasted approximately one hour, while one lasted two. Following the second request for questionnaire participants, three more participants indicated an interest in conducting an interview, two of which responded to a follow-up phone call. In total, five interviews were conducted over the phone, while one respondent chose to answer the questions via email, due to a busy schedule. One of the respondents suggested an outside source with extensive knowledge in energy matters within Southern Ontario municipalities be contacted. Contact over the phone was made and the interview questions were sent to the individual via email. However, given the inability of the participant to provide responses to the majority of the questions, these results are not presented, as they don't appear to contribute anything new to the research.

Results from these interviews will be discussed in chapter 4. Responses from the telephone interviews were audio-recorded from two different sources and later transcribed and revised by the researcher. Participants all agreed to the use of anonymous quotations by the researcher. A

copy of the completed confidentiality agreement is found in Appendix C and the interview questions are found in Appendix D.

Some methodological issues pertaining to these interviews were taken into consideration when evaluating the data. These issues should be noted as well as subsequent steps taken to reduce any weaknesses. For one, the small sample size must be considered when interpreting results. Given the range of sizes, ages and types of buildings within and across municipalities the interviews on their own provide limited information. This is a major contributor to the decision to use multiple methods of data collection, such as an extensive background examination, including the use of other studies related to energy efficiency within Southern Ontario municipalities.

A second consideration relates to the self-selection of participants. The study may have attracted those who are personally interested in energy efficiency thereby limiting the accuracy of answers. In addition, as representatives of their municipalities, and employees hired specifically to focus on environmental or energy related issues, self-reports for socially desirable behaviours may have been exaggerated (Robinson, 2007, citing Scott, 1999). Similarly, Singleton and Straits (2005) refer to reflexivity as a potential weakness, where respondents give "socially desirable answers to sensitive questions". While certain strategies were used to reduce these weaknesses, such as assurances of confidentiality and significance of results, they must be kept in mind when drawing any conclusions.

3.6. Data Analysis

The primary purpose of the analysis is to find patterns within the data to support or disprove the hypotheses (as presented in table 2.3). These patterns are revealed through coding methods. Coding is essentially the art of converting the answers of questions into categories for data retrieval (D'astous, 2005; De Vaus, 2002). Depending on the type of questions asked, categories can take on various forms. However, it is important to note that classification is essentially a human construct, and is culturally and historically relative (De Vaus, 2002). Coding is an effective method of analysing data, but reveals another reason for not applying the results beyond the purpose of exploring performance in energy efficiency within the context of the participants. This section describes the coding methods used to produce the results presented in the next chapter. First, the questionnaires will be discussed.

In many respects, analysing the data for the questionnaires was much more straightforward. Questions designed with fixed answers are programmed into the web-based programme and are automatically coded. They simply require the researcher to download, and if necessary print, the already formatted results.

In the case of the open-ended questions within the questionnaire, data is coded following the completion of the questionnaires. There are two options when developing a coding scheme for open-ended questions:

- Using a pre-existing coding scheme; or,
- Developing a unique coding scheme based on respondent answers.

Given the complexity of the subject, and the detailed taxonomy of barriers developed in the previous chapter, this study opted to use only the latter option.

The web-based programme automatically divided the open-ended questions into a spread sheet. The organised data were then printed and terms were associated with the primary categories of barriers, the specific instances in which they were found and the issues pertaining to municipal performance in energy efficiency. For example, barriers associated with capital were grouped together. Comments associated with the instances in which capital were identified as being a barrier, such as issues with allocation, were then grouped together under that category. Finally, the issue associated with municipal performance, such as complex hierarchal structures, were grouped together.

Participant audio-recorded interviews were first transcribed. Coding the interviews was conducted in much of the same manner as the open-ended questions from the questionnaire. Once the interviews had been transcribed, common themes and concepts were grouped together. Coding began by analysing explicit terms asked in the interviews. Issues pertaining to municipal performance in energy efficiency were central to the research question. Therefore, concepts pertaining to policies, investment, awareness, organisational structure, accountability, etc. were labelled. The next step was to identify less obvious categories, reflected by ideas frequently mentioned by respondents and uncover relationships between concepts. For example, a lack of information on methods to reduce energy efficiency may translate to reduced staff awareness and consequently increase inefficient energy use. However, issues pertaining to organisational structure, such as a lack of a committee or department wholly or partly responsible for energy matters may indicate a lack ofstaff resources dedicated to finding information on reduction methods or to presenting awareness campaigns, thereby resulting in missed energy efficiency opportunities. It is assumed, that given the complexity of studying barriers to energy efficiency, demonstrating causality requires more than proving if 'x' is present, 'y' will result (Sorrell et al. 2004). Consequently, the study sought to assess the depth of the proposed contributory mechanisms in each case to establish the validity of the barriers. The coding process required rereading the transcript multiple times and creating and reworking multiple categories and sub-categories of concepts and themes. This allowed a clearer picture of any cross-fertilisation

between contributory mechanisms and helped decide whether the taxonomy of barriers presented was "workable" within the context of this study. As both the interviews and questionnaires were strongly based on the questions used in Sorrell et al's (2004) studies, pre-testing of the questions was limited. A mock interview was conducted with a fellow student whose thesis focus pertained to energy issues within Ontario. This helped to ensure the questions were unambiguous and that the time required to answer the questions was similar to the time indicated in the introduction letters.

3.7. Limitations

It is important to highlight any limitations found within this study and to consider their impacts on any results presented.

One of the primary limitations to this study relates to issues of representativeness. The sampling frame composition is both small, and was not selected at random. Given these factors, it is highly unlikely that the data collected are representative of the population being studied. Therefore, the ability to make generalisations from the sample collected to the broader Southern Ontario municipal population is significantly impaired.

An additional concern pertains to the lack of demographic information collected. While the questionnaire did request some demographic information, many of the participants chose not to provide it. There are two potential reasons for this:

1. The information was unavailable to them.
2. Certain participants may have believed that providing this information placed their anonymity at risk.

This did limit the ability to stratify responses based on physical characteristics of the municipalities and their associated buildings. This would have been preferred in case certain barriers were more prevalent, or certain behaviours were more often exhibited, within specific types of buildings or municipalities.

Nevertheless, the data have been collected from a number of municipal employees involved in decision-making and/or energy issues from a relatively precise grouping of municipalities. It can therefore be argued that the results still provide important insight into the factors affecting energy efficiency performance in this under-researched area.

Another limitation to this study pertains to issues of double counting. The questionnaires and the interviews were designed to study the same phenomena. The fact that interview participants had

also responded to the questionnaires raises issues of over-reporting certain results. It is important to note, however, that questions in both stages of the research differed in many respects. While the questionnaires attempted to reveal factors associated with municipal performance in energy efficiency, the interviews were intended to provide reasoning for their existence. In other words, the purpose of providing answers to the interviews was to build on the questionnaire results. Therefore, while issues pertaining to double counting must be considered when analysing any results, the information gathered from both sets of questions provides unique and valuable insights.

The original request for participants was sent out at the end of 2010. Given the limited response rate, a reminder was sent out in mid-2011, in an attempt to increase the number of respondents. There are certain concerns associated with the results being collected on two separate occasions. The first pertains to changes in organisational structure. Over the period in which the first set of data results was gathered, and the second set was gathered, municipalities may have experienced changes in municipal structure: new buildings may have been built, new staff may have been hired, and new technologies may have been adopted. Therefore, the conclusions drawn may have differed had the information been gathered at the same time. A second concern pertains to participants' attitudes. The first round of questions was conducted in winter, while the second round was conducted during the summer. Although a psychological evaluation was not part of this study, differences in weather, workloads, and other such factors may interfere with people's moods or attitudes, and may be reflected in their answers.

A final limitation pertains to the terminology used in this study. The questions used to gather data were largely based upon the questions provided in the appendices found in Sorrel et al. (2004). There are two possible issues with regards to the use of these questions. The first is that the studies by Sorrel et al. (2004) were conducted within European energy service markets. The terms used to describe certain words were in British English. Therefore, some of the terms may have been misconstrued by respondents. This was less of a concern for interview respondents, as they were able to ask for clarification. A second concern is associated with the technological terms used. Technology evolves rapidly. The studies by Sorrel et al. (2004) were conducted in the early 2000's. With this entails the possibility of the terminology being outdated. Some of the technologies listed may no longer be considered to be economically, or energy efficient, or may not have been commonly used in municipal buildings. This could potentially affect the degree to which the efficiency gap is assessed within these organisations. However, as discussed in chapter 1, the purpose of this study was not to quantify the economic or energy efficiency potential of individual technologies. Rather, the purpose was to understand overall municipal performance to energy efficiency, and to explore the reasons for this performance.

3.8. Summary

Understanding organisational performance in energy efficiency is inherently complex. The organisation itself lies on one end of a complex supply chain for energy services. Once design and purchasing decisions made by architectural designers, building contractors, system programmers and suppliers have been decided, the final users' decisions have already been greatly impacted. Because of this, it is important to ensure that any research related to performance in energy efficiency be conducted in a clear and effective manner and methodologies themselves are selected from sound arguments.

The objective of this chapter was to present the methodologies used to answer the research questions and explain the reasons for selecting them. To not limit important factors explaining organisational performance in energy efficiency, a multidimensional case study approach was selected. While case studies can render individual hypotheses testing more difficult, it arguably permits a richer depiction of issues and influences related to the subject of this thesis.

The research methods chosen to collect the data were required to establish the legitimacy and significance of each proposed barrier. Case study research often requires the use of multiple sources of data collection to explain complex phenomena. For this reason, data were collected through semi-structured telephone interviews with energy managers and were supplemented by pre-interview questionnaires and additional documentary evidence. While interviews and questionnaires have some disadvantages, properly designed, their ability to investigate complex phenomena render them ideal methods for collecting the data.

Purposive sampling was used to select the candidates for the various stages of this study. Within exploratory research, this form of sampling is ideal when attempting to elicit the views of persons who have specific experience or expertise within the field of study.

Once the data had been collected, the final stage was to bring together the results from the surveys and interviews. The use of coding methods, which requires converting the answers to the questions into categories for data retrieval, is well supported. Answers were categorised and analysed to eventually characterise the Southern Ontario municipal sector, to describe energy management practices within the sector, to discuss the evidence for, and relevance of, different types of barriers, and to discuss the policy implications and relevant tools that may overcome such barriers. The following chapters present and discuss these results.

4. Results

4.1. Introduction

In chapter 2, a comprehensive literature review helped produce a framework through which the factors affecting municipal performance in energy efficiency could be explored. These factors, which were described as the taxonomy of barriers in table 2.3, tentatively explain the reasons Southern Ontario municipalities neglect energy efficiency measures. The framework guided the development of a series of questions that would test this hypothesis. It has been argued that the nature and significance of the barriers to energy efficiency are dependent on the context in which they arise and the framework through which they are studied. For this reason, their existence within Southern Ontario municipalities has yet to be proven.

The questions presented in the questionnaires and interviews helped gather information on characteristics, roles and behaviours related to energy consumption, energy management practices and the rates of adoption of specific technologies related to energy efficiency. The data collected during this phase of the study further defined the Southern Ontario municipal landscape while establishing the likelihood of certain barriers within this context. Additional evidence was collected during the interview phase of the study from municipal employees whose responsibilities included implementing, informing and promoting energy efficiency within municipal buildings. This evidence helped to further substantiate the significance of the hypothesised barriers, in addition to allowing a compare and contrast among views of various municipal employees.

The purpose of this chapter is to summarise the data collected from the online questionnaires and telephone interviews. Section 4.2 summarises the data acquired from the online questionnaires. In total, the results of 26 questionnaires are presented in a summarised format. Section 4.3 presents the data collected from the interviews. The implications of these results will be explored and discussed in detail in Chapter 5.

4.2. Summary of the Questionnaire Results

Data were obtained through an online questionnaire on energy management practices, decision-making processes and perceived barriers to energy efficiency within Southern Ontario municipalities. The emails were sent to 204 municipalities within Southern Ontario, from which 26 valid replies were obtained.

The purpose of these questionnaires was to summarise energy performance and energy management practices within Southern Ontario municipalities and to gather data on perceived barriers to energy efficiency. The results are summarised in terms of the percentage of valid replies to each question in the following sections.

4.2.1. Demographics

The first series of questions in the questionnaire pertained to municipal demographics, notably associated with municipal size and energy expenditures. As was indicated in section 3.7, many of the participants chose not to answer them. Checkmarks indicate a useable response was received. Empty boxes indicate no answer was received. All other answers are direct answers from responses. The demographic information that has been collected is presented in the form of ranges and overall averages. It has been presented in this manner to ensure the answers cannot be traced back to publicly available information on the municipality's website. Findings are available in table 4.1.

Table 4.1 Questionnaire responses to demographic questions

	What is this municipality's current population?	Approximately how many people are employed by this municipality?	What is the approximate annual turnover of municipal staff?	What is the approximate number of buildings owned and operated by this municipality?	What is the combined square footage of these buildings?	Please indicate your municipality's approximate annual consumption of electricity (in units)?	Please indicate your municipality's approximate annual consumption of natural gas (in units)?	Please indicate your municipality's approximate annual expenditure ($) on electricity?	And as a percentage (%) of total expenditures?	Please indicate your municipality's approximate annual expenditure ($) on natural gas?	And as a percentage (%) of total expenditures?
1	√	√	unsure	√	√	√	√	√	√	√	√
2	√	√	?	√	√	√	√	√	√	√	√
3	√	√	√	√		√	√	√	√	√	√
4	√	√	?	√	√	√	√	√	√	√	√
5	√	√	√	√	√						
6	√	√	√	√							
7	√	√		√	√	√	√	√	√	√	√
8	√	√	don't know	√	√	√	√	√	√	√	√
9	√	√	√	√	unknown	√	√	√	unknown	unknown	unknown
10	√	√		√		√		√	√	√	√
11	√	√		√	√	TBD**	TBD**	TBD**			
12	√	√	minimal	√							
13	√	√	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
14	√	√	√	√				√	√	√	√
15	√	√		√							
16	√	√	√	√	√	√	√	√	√	√	√
17	√			√							
18	√	√		√		√	√	√	√	√	√
19	√	√		√				√	√		
20	√	√	√	√	√		N/A			N/A	
21	√	√	√	√	√	√	√	√	√	√	√
22	√	√		√							
23	√	√		√	√	√	√				
24	√	√	?	√	√	√	√	√	?	√	?
25											
26											
Average and range (if applicable)	range = 3,200 - 360,000 average = 90,385 (n=23)	range = 11 - 2,500 average = 605 (n=22)	range = 0% - 10% average = 4.5% (n = 8)	range = 3 - 238 average = 67 (n=22)	range = 8,000 sq ft - 2,500,000 sq ft (n = 11)	range = 110 MWh - 108,000 MWh average = 31,989 MWh (n=12)	range = 0 - 5,000,000 m^3 average = 1,282,188 m^3 (n=12)	range = $18,000 - $10,000,000 average = $3,464,190 (n=13)	range = 0.005% - 6% one answer indicating "48" * average = n/a	range = $0 - 2,000,000 average = $484,595 (n=11)	range = 0% - 1% one answer indicating "16" * average = n/a

Checkmarks indicate a valid and numerical reply was provided by the participant

**due to the nature of responses, averages could not be calculated*

*** (to be determined during upcoming audit)*

4.2.2. Self-assessment matrix on energy management practices within municipalities

Respondents were asked to fill-in a chart on energy management. The chart, reproduced from Annex A in Sorrell et al. (2004) on barriers to energy efficiency, and originally developed by the UK's Energy & Environmental Management Division, provides a standardised tool for building and energy managers to evaluate, or grade, the energy management activities within their organisations and their perceived performance in energy efficiency (BRESCU, 1993). The chart can be viewed in figure 4.1.

	0	1	2	3	4
Policy	No explicit policy	Unwritten set of guidelines	Unadopted energy policy set by energy manager or senior departmental manager	Formal energy policy, but no active commitment from top management	Energy policy, action plan and regular review with commitment of top management
Organisation	No energy management or any formal delegation of responsibility for energy consumption	Energy management the part-time responsibility of someone with only limited authority or influence	Energy manager reports to ad-hoc committee, but line management and authority are unclear	Energy manager reports to ad-hoc committee, but line management and authority are unclear	Energy management fully integrated in management structure. Clear delegation of responsibility for energy consumption
Information Systems	No information system. No accounting for energy consumption	Cost reporting based on invoice data. Engineer compiles reports for internal use within technical department	Monitoring and targeting reports based on supply meter data. Energy unit has ad-hoc involvement in budget setting	Monitoring and targeting reports based on supply meter data. Energy unit has ad-hoc involvement in budget setting	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking
Awareness	No promotion of energy efficiency	Informal contacts used to promote energy efficiency	Some ad-hoc staff awareness training	Programme of staff awareness and regular publicity campaigns	Marketing the value of energy efficiency and the performance of energy management both within and outside the organisation.
Investment	No investment in energy efficiency	Only low cost measures taken	Investment using short term payback criteria	Same payback criteria as for all other investment	Positive discrimination in favour of "green" schemes with detailed investment appraisal of all new building and refurbishment opportunities

Figure 4.1: Self-assessment matrix

Source: Sorrell et al. (2004), p. 323

Each box describes the current practices within different organisations. The columns represent the extent to which the practice has been implemented. The rows list the different practices which constitute organisational performance in energy efficiency.

The categories are graded from 0 to 4, where '0' implies the measure has not been implemented by the municipality and '4' implies that it has been extensively implemented. Each box in table 4.2 is represented as a percentage of valid replies and the proportional relevance of each component is summarised in terms of average scores in the last column.

Table 4.2 Self-assessment matrix on energy management as a % of valid replies (n=20)

	0	1	2	3	4	Overall average score
Policy	30	20	40	5	5	**1.35**
Organising	5	50	25	15	5	**1.35**
Information systems	10	50	30	5	5	**1.45**
Awareness	5	35	45	5	10	**1.80**
Investment	0	15	40	15	30	**2.60**
Mean Score						**1.71**

Note: scores from 0 (not implemented) to 4 (extensively implemented)

4.2.3. Benchmarking and information systems

Respondents were asked to indicate whether their municipalities used information systems and benchmarking tools for monitoring trends in energy consumption and targeting areas where improvements could be made. These results are summarised in table 4.3. Only 5% of survey respondents claimed to have a comprehensive system in place. The majority (76%) of municipalities surveyed had conducted energy audits in some (43%), or all of their buildings (33 %). Sub-metering was generally well established (table 4.4). In the majority of cases, both electricity and natural gas were monitored at the building level. These results correspond to the results in table 4.3 which demonstrate that 76% of organisations monitored energy trends in either some, or all of their buildings, and 67% of municipalities charged individual buildings for their energy consumption.

Electricity consumption, as demonstrated by table 4.5, was generally recorded monthly. No municipalities clearly stated that their data consumption was recorded more often than that. However, in 24% of cases with electricity and 20% of cases with natural gas, the frequency at which data was recorded varied from building to building. Consequently, it is possible that data

were recorded more often than monthly in some municipal buildings. This will be explored further when presenting the interview results.

Table 4.3 Monitoring and targeting schemes implemented in some, or all buildings (as a % of valid replies) (n=21)

	Yes (in all buildings)	Yes (in some buildings)	No	Unknown/ Not applicable
Do you monitor trends in energy consumption?	33	43	24	0
Are weather conditions documented with consumption records?	19	0	76	5
Is a monitoring and targeting scheme employed?	14	0	71	14
Is energy performance shared with staff?	19	38	33	10
If present, are cost centres charged for the energy they consume?	48	19	19	14
Is consumption compared with benchmarks?	14	19	48	19
Have you conducted energy audits?	33	43	19	5
Do you use contract energy management?	14	5	62	19

Table 4.4 Level at which energy use is metered (as a % of valid replies)

Energy Type	Site	Building	Individual Equipment	Differs in Every Building
Electricity (n=18)	5	78	0	17
Natural Gas (n=16)	6	75	6	13

Table 4.5 Frequency with which energy is recorded (as a % of valid replies)

Energy Type	Annually	Monthly	Differs in every building
Electricity (n=17)	6	70	24
Natural Gas (n=15)	0	80	20

4.2.4. Investment in energy efficiency and technology adoption

The participants were asked to rate the extent to which certain technologies, which have been demonstrated to yield paybacks of less than five years, had been implemented throughout their municipalities. In total, 37 measures were listed, and can be viewed in Appendix B. Participants were asked to assign each option a number from 1 (not at all implemented) to 5 (extensively implemented). The results can be found in table 4.6. Only seven of the 37 measures had been assigned a '4' or '5' by 50% or more of the municipalities. Three of seven of these more widely adopted measures involved the use of higher efficiency florescent light bulbs. Of the remaining four options, three measures were directly related to the consideration of energy efficiency in equipment replacement or purchasing. Finally, 50% of municipalities claimed to programme heating, ventilation and air-conditioning (HVAC) controls to match occupancy patterns.

Despite the seemingly low implementation rate of many of the energy efficiency measures, few of the respondents disagreed with the statement that “a wide range of efficiency improvements could be implemented with a payback of 5 years or less”. The extent with which they agreed varied with the type of municipal building (table 4.7). Aside from fire halls, at least half of the respondents either agreed, or strongly agreed with the above statement. The number of unknown or inapplicable responses was notably higher in the last two categories of municipal building types. Over half of the respondents claimed to have no responsibility within these types of buildings.

4.2.5. Valued information sources on energy efficiency

The participants were asked to indicate, which information sources are used to gather information on energy efficiency opportunities? A list of ten sources were compiled, and participants were asked to rate its usefulness on a scale from “Poor” or “Don't use”, to “Excellent”. These results are summarised in table 4.8. These results will be discussed in chapter 5.

Table 4.6 Implementation of different energy efficiency measures within Southern Ontario municipalities as a % of valid responses (n=18, except where otherwise indicated)

Measure	1	2	3	4	5	Un-known	Overall average score
Drought-proofing windows, doors and roof-lights?	27	20	20	33	0	17	**2.17**
Fitting windows with double or secondary glazing?	8	15	38	23	15	28	**2.33**
Fitting door closers to external doors?	20	13	20	20	27	17	**2.67**
Use of plastic or forced air curtains in loading bays? (n=17)	88	0	13	0	0	53	**0.59**
Installation of fans in high ceiling rooms to reduce temperature gradient?	29	29	36	0	7	22	**1.78**
Retrofitting insulation to walls and roofs?	13	47	7	20	13	17	**2.28**
Insulation of distribution pipes, valves and flanges?	13	40	27	7	13	17	**2.22**
Use of boiler sequencing controls?	15	23	23	31	8	28	**2.11**
Replacement of central general hot water with point of use application?	67	17	17	0	0	33	**1.00**
Installation of thermostatic radiator valves?	63	25	13	0	0	56	**0.67**
Programming HVAC controls to match occupancy patterns?	0	13	38	31	19	11	**3.17**
Use of weather compensation and optimum start controls?	29	29	21	14	7	22	**1.89**
Use of Building Energy Management Systems?	20	20	20	20	20	17	**2.50**
Replacement of 38mm fluorescents with 26mm?	0	8	8	42	42	33	**2.78**
Use of high frequency fluorescents in new and replacement fittings?	14	0	14	21	50	22	**3.06**
Replacement of tungsten filament lamps with compact fluorescents?	7	7	21	29	36	22	**2.94**
Replacement of fluorescents with SOX/SON discharge lighting?	70	10	0	10	10	44	**1.00**
Use of localised task lighting in preference to general lighting?	33	13	27	13	13	17	**2.17**
Installation of time controls with manual override?	20	7	47	20	7	17	**2.39**
Use of photocell, acoustic or movement sensors?	14	21	29	21	14	22	**2.33**
Integration of lighting controls in Building Energy Management Systems?	47	20	7	13	13	17	**1.89**
Switch off when there is no demand for air?	7	33	20	33	7	17	**2.50**
Regular inspection and elimination of leaks?	38	31	13	6	13	11	**2.00**
Regular maintenance and condition monitoring?	0	25	31	31	13	11	**2.94**
Generation of compressed air at the minimum required pressure?	25	25	0	50	0	78	**0.61**
Consideration of energy consumption and part load operation when purchasing new compressors?	9	9	18	36	27	39	**2.22**
Pre-cool inlet air or duct air from outside?	33	25	33	0	8	33	**1.50**
Compressor heat recovery?	50	8	17	0	25	33	**1.61**
Insulation of furnaces to economic thickness?	45	18	27	0	9	39	**1.28**
Accurate control of furnace temperature pressure and air/fuel ratio? (n=17)	45	18	27	0	9	35	**1.35**
Heat recovery from furnaces and process plant?	50	8	25	0	17	33	**1.50**
Power factor correction?	50	30	10	10	0	44	**1.00**
Ensuring replacement motors are not over-sized?	7	21	29	29	14	22	**2.50**
Specification of high efficiency motors on motor replacement?	20	7	7	33	33	17	**2.94**
Use of variable speed drives?	7	29	21	21	21	22	**2.50**
Automatic switch off of pumps, fans, conveyors and their equipment when not required? (n=17)	20	13	40	20	7	12	**2.47**
Purchase of energy efficient computers, photocopiers and other office equipment?	7	20	20	20	33	17	**2.94**
Mean Score							**2.05**

Note: due to rounding, numbers may not add up to exactly 100%

Table 4.7 Extent to which respondents agree with the statement: "a wide range of efficiency improvements could be implemented with a payback of 5 years or less" within the building types listed below (as a percentage of valid replies)

Building Type	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Town/ City Hall (n=17)	12	41	18	12	18
Community/ Recreation Centres (n=17)	24	35	29	6	6
Fire Halls (n=16)	12	29	41	12	0
Arenas (n=14)	36	43	7	7	7
Libraries (n=12)	17	42	25	8	8
Water and Waste Water Facilities (n=12)	17	33	50	0	0
Recycling and Waste Facilities (n=9)	0	67	33	0	0
Public Transportation Buildings (n=8)	0	50	38	13	0
Total Average	**15**	**43**	**30**	**7**	**5**

Note: due to rounding, numbers may not add up to exactly 100%

Table 4.8 Valued information sources on energy efficiency opportunities (n=20)

	Excellent	Good	Average	Poor	Don't use	Overall average score
Colleagues within the municipality	10	55	30	5	0	**1.7**
Network of contacts in the sector	20	60	20	0	0	**2**
Governmental agencies	5	75	20	0	0	**1.85**
Energy manager groups/networks	20	45	5	5	25	**1.55**
Professional Associations	10	55	20	0	15	**1.6**
Trade/Technical journals Excellent	10	35	45	0	10	**1.45**
Technical conferences seminars	15	55	20	0	10	**1.75**
Energy supply industry	10	50	30	5	5	**1.6**
Equipment suppliers	5	45	35	10	5	**1.4**
Consultants	30	40	30	0	0	**2**

Note: "Poor" or "don't use" are assigned a value of "0", "average" is given a value of "1", "Good" is "2" and "Excellent" is "3".

4.2.6. Perceived barriers to energy efficiency

Participants were asked to rate the importance of different reasons commonly cited throughout the literature for not adopting cost-effective energy efficiency measures in their municipality. Participants rated the importance of each statement to their municipality on a 3 point scale (1- rarely important, 2 - sometimes important, and 3 - often important). Table 4.9 presents the results.

Issues related to capital were most consistently reported as being an "often important" barrier to energy efficiency. Energy objectives not being integrated into operating, maintenance or purchasing procedures was also considered to be "often important" scoring an overall average of 2.71 out of a possible "3". A lack of technical skills, staff awareness and department accountability regarding energy costs, and the possible poor performance of equipment scored an overall average of 2.44, 2.31, 2.33 and 2.35 respectively.

Table 4.9 Barriers to energy efficiency (n=18)

Barrier	Often important	Sometimes important	Rarely important	Don't know	Overall average score
Technology inappropriate at this site	33	17	28	22	**2.07**
Cost of production disruptions/hassle/inconvenience	17	56	17	11	**2.00**
Cost of identifying opportunities, analyzing cost effectiveness and tendering	39	39	17	6	**2.24**
Cost of staff replacement, retirement, retraining	22	39	33	6	**1.88**
Possible poor performance of equipment	39	50	6	6	**2.35**
Lack of capital	61	17	11	11	**2.56**
Strict adherence to capital budgets	61	33	0	6	**2.65**
Other priorities for capital investment	78	17	0	6	**2.82**
Technical risk	22	50	17	11	**2.06**
Business/market uncertainty	11	17	44	28	**1.54**
Lack of information/poor quality information on energy efficiency opportunities	11	39	39	11	**1.69**
Difficulty/cost of obtaining information on the energy consumption of purchased equipment	11	28	50	11	**1.56**
Lack of time/other priorities	33	39	17	11	**2.19**
Lack of technical skills	50	28	11	11	**2.44**
Lack of staff awareness	44	28	17	11	**2.31**
Department/individuals not accountable for energy costs	39	33	11	17	**2.33**
Energy objectives not integrated into operating, maintenance or purchasing procedures	67	28	0	6	**2.71**
Low priority given to energy management	33	50	11	6	**2.24**
Energy manager lacks influence	11	33	33	22	**1.71**
Conflicts of interest within the municipality	11	39	28	22	**1.79**
Mean Score					**2.16**

Note: "Rarely important" is assigned a value of "1", "sometimes important" is "2", and "often important" is "3"

4.3. Summary of the Interviews

In this section, the data from the interviews are summarised. Data were collected from six participants who had extensive knowledge of energy management practices within municipalities. The purpose of the interviews was to supplement the information gathered in the questionnaires and literature review and to elaborate on the connections between municipal performance and perception of barriers. While a wide range of factors contribute to organisational performance in energy efficiency, neglected opportunities may result from the coexistence of a multitude of contributory mechanisms. Terms were associated with the primary categories of barriers, the specific instances in which they were found and the issues pertaining to municipal performance in energy efficiency, some of which overlapped across categories. Connections and implications will be described in the following chapter.

Primary interview participants have been assigned a number at random so as retain the specific identification of responses without sacrificing anonymity. Given the large number of questions and the specific answers provided by participants, results are presented in a number of tables reflecting a large number of categories. Results appearing in these tables are transcribed in a summarised format. In some circumstances, specific details have been omitted or edited to further ensure anonymity.

4.3.1. Municipal performance in energy efficiency

Results from this section describe participants' perceptions of their own municipal energy efficiency performance and the reasons for it. Participants were asked to provide their own “scale” for evaluating this performance. The purpose of this step was not to necessarily “rank” energy efficiency performance on any type of quantitative scale. Rather, it was to establish a foundation for evaluating municipal performance in energy efficiency. Table 4.10 presents these results. The following sections will detail the various factors involved in establishing these perceptions.

Table 4.10 Perceptions on municipal performance in energy efficiency

	How would you rate the municipality's performance in energy efficiency?	Summary of perceived reasons for this municipality's performance
Participant 1:	"Low"	No resources
Participant 2:	"Improving"	Lack of bandwidth/capacity
Participant 3:	"Medium"	Lack of capital
Participant 4:	"If it (the scale) were a 10, I'd give it a 6"	Lack of capacity, human resources
Participant 5:	"It's hard to say because I don't know how we're doing without the information. I think I'm going to skip that question because I don't want to mislead you."	Lack of human resources, fiscal capital, information
Participant 6:	"Above average to good - I guess, I am now looking for new technologies and kind of cutting edge things to do because all the low hanging fruit, as they call it, has been done."	High level of commitment/priority

4.3.2. Energy and environmental policy

To gain a better understanding of what influenced municipal performance in energy efficiency, it was important to identify and understand a range of factors that affected municipal decision-making. Because of the number of factors, several questions were asked throughout the interview process to attempt to cover as much ground as possible. Throughout the data collection process, other themes or sub-themes that had been mentioned by participants, but that the researcher did not consider including in the questionnaire or interviews, and were perceived as having an influence on municipal decision-making, were coded and presented. The first category recognised as significant to the research question was the extent to which environmental and/or energy policies had been implemented within the municipality. An environmental or energy policy is described as being formal guidelines for influencing and determining energy efficiency or environmental decision-making. Various words were used by participants to describe their policies. These included words such as plan, strategy or target. Table 4.11 summarises policy details and the degree to which municipalities have implemented them.

The extent to which many of the policies were followed reflected the degree to which the policies had been developed and implemented, the number of components considered in these policies, such as outside certification standards, the degree to which these policies were considered with regards to other policy documents, and finally the number of energy efficiency practices or measures these policies helped achieve. Among the participating municipalities, only participants 1 and 5 had clearly stated that an environmental policy was in place. Participant 6 stated that they "didn't do policies", although they had multiple programmes in place, one in particular which outlined certain targets. As was stated by the participant:

> ...it's our own version of an energy policy, without being called an energy policy.

Currently perceived by the participant as a “consultation document”, the plan was to be formally implemented after input from the municipality's citizens.

Although many of the policies incorporated energy issues, only participant 5 stated clearly that an energy plan had been developed and was to be released in 2011. Participant 2 had developed a sustainability plan which incorporated several long term targets related to energy. However, the strategies for achieving these targets were still in the development phase and the plan itself had yet to be implemented. Participant 4 stated their municipality was developing a plan, but it had yet to be adopted and the details were not made available.

Other aspects of energy or sustainability targets were incorporated into other policies, such as purchasing, and less often maintenance.

The achievements made by the various policies, plans and targets, whether formal or informal, ranged from energy audits throughout buildings, to the implementation of LEED standards in the design of new buildings, to the adoption of renewable energy projects throughout the municipalities. The specific details pertaining to these achievements will be discussed in detail in section 4.3.6.

All municipalities stated that changes were being considered due to the adoption of the Ontario Green Energy and Green Economy Act, although the degree of changes varied significantly. Participant 5 did state that the adoption was the “catalyst” for having to complete the municipality's energy plan. Participant 2 indicated concerns with respect to planning and the limitations the Act put on “municipalities' ability to regulate renewables in their jurisdiction” and to how they will deal with these limitations as they arise:

> We feel that there will be some issues that come in the future, access to sunlight, right to light. We've also had a couple applications from residents to remove trees to make way for renewable energy systems. So we're trying to grapple with how to deal with that because we feel that trees probably provide a higher net environmental benefit than a renewable energy system does in their lifetime. It's something that we've been working on for a while here and we're probably gonna have to bring up a by-law forward for it... In regards to right to light... we're probably gonna see, say, a large warehouse, a low light, like someone putting a renewable energy system on it. And then adjacent properties, someone wants to develop a tower that's going to shade that renewable energy system, which is going to be an interesting issue. So we need to grapple with how that's going to happen with respect to zoning.

Table 4.11 Municipal environmental and energy policy

	Existence of energy/ environmental policy	Comment:	In place since:	Certified to an environmental management standard:	Intention to certify:	Environmental policies integrated into other documents:
Participant 1:	Yes	1. Living document indicating goals, strategic objectives, indicators, completed and on-going actions and opportunities for improvement in different "environmental areas", including energy. Guides corporate decision-making 2.Building policy establishes "green" standards for new building design and construction	1. Approved 2010 2. Approved 2008	No	A specific certification is identified in strategy document, but no resources provided to proceed	Yes
Participant 2:	Under development	Sustainability document has been created – includes future net zero targets, policies for achievement are under development	N/A	No	Considering ISO 50001	Yes, under review
Participant 3:	Under development	N/A	N/A	No	No	Yes, but limited
Participant 4:	No	Informal policies incorporated into an environmental/sustainability plan, intended to guide municipal decision making, by addressing environmental, cultural, social and economic issues.	Approved 2009	No	No	Some language incorporated into purchasing documents – must demonstrate green provisions have been considered
Participant 5:	Yes/under development	1. Progress plan outlining implementation models, methods of measuring progress and potential external funding sources in different "environmental areas" 2. Energy plan 3. Developing a sustainability plan	1. Approved 2005 2. Approved 2010 3. Under development	No	Considering ISO 50001	Yes, in purchasing policies, but can be improved upon
Participant 6:	No	While not formally referred to as a policy, an energy programme, which outlines certain targets, is being developed. More of a consultation document at this point.	Approval pending, waiting citizen input	No	No	Yes

None of the participating municipalities were registered to an environmental management standard, or believed the municipality intended to do so. Participant 1 did indicate that an ISO standard was mentioned in their environmental strategy, but no resources had been provided to proceed with certification. Two participants did indicate that they were interested in the ISO 50001 standard, which applies to management of energy.

All participants indicated that they were aware of various governmental programmes that promoted energy efficiency through grants or subsidies, tax breaks or information. Participant 1 indicated that the municipality did, at times, benefit from the use of government programmes and commented that government policy was effective but that not enough assistance had been provided to meet newly established policies. Participant 4 voiced their frustrations over the lack of regulations that were being imposed:

> We're regulated to do certain things and we do them... but when it's just something that we say, but there are no regulations, nothing happens... They should enact those regulations. And, I have no idea, five years after passing that legislation and then incorporating it into the Green Energy Act, why they still have not passed regulations... Every time it's 'well, we think it's going to happen this year'... But, you know, I've heard that at least three or four times and it's never happened... I mean normally (a municipality's) position isn't for the government to create regulations for municipalities. But in this case, we would just like to see it actually happen in some form. I don't know what the problem is.

All participants indicated that improvements and additions could be made to these policies. Box 4.1 summarises a list of instruments that interview respondents would consider useful for encouraging energy efficiency within municipalities, and would like to see more extensively implemented.

Box 4.1 List of instruments for encouraging energy efficiency within municipalities

Improving information:

- Providing information on new technologies and conducting tests on said technologies
- Providing (municipalities with a list of) best practices in energy management
- Putting together tools that are easy to use, easy to understand, portable and simple as far as analysing energy use at any given time - having the information easily accessible
- Improving the information that is currently available, to best suit municipalities
- Easier accessibility to information on subsidies and tax breaks

Funding and incentives:

- Providing training for key staff
- Funding for data acquisition systems to maximise reporting potential
- More subsidies or tax breaks for energy efficiency investment
- Providing guidance and compiling case studies with regards to how other municipalities have funded projects
- Providing strong incentives for those that have developed a (energy conservation) plan
- Incentives for retrofit activities

Regulation:

- Requiring conservation plans
- Standardising energy efficiency requirements
- Higher minimum efficiency standards required for newly zoned buildings
- Enacting the (Green Energy and Green Economy Act) regulations
- Passing Greenhouse Gas legislation that limits emissions

Other:

- Paying the true cost on energy and paying costs on carbon

4.3.3. Organisational structure and energy management

Comments provided by participants indicated management and decision-making processes are structured similarly throughout municipalities. This was confirmed by the organisational charts found on many Southern Ontario municipal websites. However, the information presented by the participants demonstrates that organisational management and decision-making in terms of adopting energy efficiency measures varies widely throughout the participating municipalities. A summary of the findings on organisational management and decision-making can be viewed in table 4.12. All but participant 1 had a designated staff person working on environment and energy

initiatives full-time, although this participant stated that the municipality was considering the integration of a “sustainability office” into the CAO's office.

Of the time devoted to energy issues, participants' primary responsibilities were to establish, or help municipalities reach, energy reduction targets or to advise on opportunities throughout the municipality (where there was a staff member dedicated to energy or environmental initiatives) for specific building projects. In other words, those interviewed were responsible, to varying degrees, for overseeing the implementation of initiatives related to energy efficiency. This included supporting project managers and engineers who were responsible for the design and construction of buildings, except in the case of participant 1, whose responsibilities as project manager included supporting energy matters in city owned buildings.

Municipal structure is complex. The various facets of energy management were always spread throughout different departments. Every participant interviewed had the unique opportunity to interact with several municipal members and departments regularly. Participants 2, 3 and 6 indicated that they did interact regularly with building operators, and managers, or the directors that managed them. The significance of these interactions will be discussed later in this chapter.

Table 4.12 Organisational structure and energy efficiency

	% of participant time dedicated to energy issues	Department / staff person dedicated to environment / energy issues	Participant areas of responsibility	Regular interaction with staff	Energy efficiency supported by senior staff	Competing interests, or conflicts, within the municipality / among departments
Participant 1:	5%	No	Participant acts as project manager on construction projects impacting city owned buildings	Regular interaction with representatives of all departments	Yes	Participant's department does not manage staff in other departments and energy consumption / management is out of participant's control
Participant 2:	Over 50%	Yes – participant	Managing corporate energy usage and leading strategies on climate change	Finance department, project managers in asset management responsible for building construction, building operators and their managers and directors, commissioners and the CAO to keep them informed	Yes	Conflict arising from competition for capital
Participant 3:	70-75%	Yes – participant	Energy conservation within facilities, setting goals and targets including green house gas reduction / water conservation, administering programmes, any assigned engineering duties	Managers of facilities, managers of infrastructure planning, facilities supervisors, environmental operations manager	Yes	Facilities mandated to provide a service for public - Providing that service may be in contradiction with energy efficiency measures
Participant 4:	15%	Yes – participant	Responsible for moving environmental / sustainability strategies forward and reporting progress to municipal members, responding to the public regarding environmental issues.	Regular interaction across all departments, including but not limited to engineering, planning, strategic planning, communications, both internally and externally. Participant's department started a team with representation from every department, including waste management, purchasing, parks and recreation.	Yes	No
Participant 5:	80%	Yes – participant	Management of all energy projects and climate change concerns, issues and strategies.	Interaction with more people than most other departments, including council, puchasing department, finance department, assets department, public works and recreation departments	Yes	Individual priorities can lead to conflicts between departments
Participant 6:	100%	Yes – participant	Managing and paying invoicing of energy; ensuring procurement strategies are in place; and, undertaking the corporation's energy efficiency retrofits and renewable energy initiatives	All programme managers, maintenance, facility workers, technologists that undertake projects, water and sewer management, traffic signals and street lighting workers, city engineers, CAO, community services and LEED buildings as impacting participant's department – Participant summarised interaction as being "across all sections of the corporation"	Yes	Competing interest between departments and staff members for resources in energy management activities

All six participants indicated that improvements in energy efficiency were well supported by senior staff and valued throughout their respective municipalities. Responses from participants 1, 3 and 4 indicated that they did hold some reservations as to the extent to which their senior staff supported the improvement of environmental performance within the municipality. Participant 1 stated that, while senior staff supported energy efficiency measures, they needed to balance other needs as well. Participant 4 indicated that, overall, energy efficiency was a priority but that improvements relied on individual commitment, and due to a lack of understanding, was not always present. Finally, while participant 3 did not openly state any reservations, the response generated by this individual did imply some level of reservation:

> Certainly in words and our mission statements, I would have to say 'yes' (senior management is seriously committed to improving the environmental performance of the organisation).

Apart from participant 4, all participants stated that there was some degree of conflict within the municipality. Interestingly, all of the participants, except for participant 1, demonstrated some hesitation with regards to the wording of the question: “Are there conflicts of interest within municipalities that inhibit energy management activities?” Participant 4 disagreed with the notion that there were conflicts within the municipality as the word “conflict” was a “very strong word”. Participant 6 replaced the word “conflict” with “competing interests” and participant 2 stated that the only conflict was with regards to competition for capital, which was believed to be “standard in business”. Participant 3 described the conflict as being a contradiction between the mandate to operate a facility in compliance with public expectations and at optimal levels with regards to energy efficiency. These notions, as revealed by the participants, will be discussed in greater detail in subsequent sections of this chapter.

Each participant was asked to rate the status of energy management activities within their municipality on a scale of low, medium or high and to describe energy management activities within their municipality, as summarised in table 4.13. While the levels of energy management varied somewhat throughout municipalities (with most of them hovering around the medium status), all participants agreed that for energy management activities to move forward resources had to be dedicated to, and prioritised for, the task.

Committees that were wholly or partly responsible for energy matters were generally in the process of being formed or had only recently been formed. Only participants 1 and 6 stated that they had established committees that met regularly to discuss matters pertaining to energy or to more general environmental issues, in which energy plays a part. Committees consisted of different types of members, ranging from staff, to councillors to citizens. The purpose of these

committees, in all cases, was to advise on environmental or energy issues in various contexts. The purpose of the committee as stated by participant 1 was strictly to help move their environmental plan forward. The other committees were responsible for more general and wide-ranging issues, such as procurement, strategic planning and reporting recommendations.

All of the participants, except for participant 3, maintained the opinion that the use of outside sources for energy management provided a level of expertise, or capacity that was at times necessary. Participant 1 stated that it was necessary for the municipality, as staff resources were too limited to be dedicated to energy management. In the other cases, energy management was generally an in-house activity. However, all but participant 3 argued that external companies needed to be used at times, since their expertise was often required and resources were often too limited for the municipality to undertake certain tasks. The municipality being represented by participant 3 had undertaken energy systems contracts in the past, but were unsatisfied with the results. The concerns, as revealed by the participant, were the municipality's loss of control with regards to the ability to operate the facilities. While the participant agreed that physically, the contractors could not prevent a facility operator from running a facility the way they deemed appropriate, there could be financial impacts based on the terms of the contract. In cases where the municipality felt changes needed to be made, contracts had to be renegotiated, or financial penalties would result. The participant did agree that the projects almost certainly were completed quicker and that pay-back periods were likely shortened when using outside sources, but in the end, this particular municipality believed the costs outweighed the benefits.

Table 4.13 Energy management practices

	Status of energy management within the municipality	Comment:	Presence of an environmental/ energy committee	Form:	Use of outside sources for energy management activities	Influence of participant on municipal energy management activities	Comment:
Participant 1:	low	Without dedicated resources it takes time for energy management activities to move forward	Yes	Representatives from each department provide annual updates and help move environmental strategy forward	Yes	Yes – Very limited	No staff resources specifically dedicated to environmental/ energy issues
Participant 2:	medium	Energy management is well supported, but lack of capacity, bandwidth and monitoring and targeting tools limits efforts	Ad hoc	Random members piloting various energy projects, driven by the interview participant	Yes	Yes	Limited by time and capacity
Participant 3:	medium	Budget cuts/ limited financial resources often hinder energy management activities	Yes	Newly formed and has yet to meet, consisting of community and council members (possibly some staff) with the purpose of providing environmental recommendations on reports	No	Yes	Environmental recommendations are established in many cases but may be limited by bureaucratic processes
Participant 4:	medium	Energy management is limited by technical/ human resources and priority will automatically fall if individual departments don't have an environmental/energy "champion"	Environmental/ Energy issues fall under another committee	Bi-monthly meetings with committee of councilors to discuss municipal priorities and stategic initiatives, which include environmental/energy issues	Yes	Yes	Difficult to influence every aspect of energy management, needs to be integrated into organisational culture
Participant 5:	medium/low	Lack of information/staff knowledge limits the ability to pursue the best projects	Yes	Newly created committee dedicated to energy issues	Yes	Yes	Position permits influence, but timely decisions needed for building operations and purchasing limit influence
Participant 6:	medium/high	Municipality wants to be a "leader" and with presentation of proper business case, significant resources/ effort are put into energy management	Yes	Energy committee functions with meetings and updates and subgroups of this committee meet to discuss other issues, such as procurement	Yes	Yes	There are roadblocks to having influence everywhere

4.3.4. Information and Information Systems

Of the six participating municipalities, sub-metering was established in all but two municipalities, although participant 2 stated their municipality had allotted a budget dedicated to its implementation within the coming year. In half of the cases, the information available to municipalities on energy consumption was most often in the form of utility data that had to be inputted manually to some form of spreadsheet. The process was described as being “a lot of labour” and “rudimentary”. Participants 3 and 4 stated that their municipalities anticipated improving on the system in the near future.

For participant 3, electronic billing and interval data for various facilities were available online. Natural gas was only available in paper format, and similarly to the other municipalities, data had to be manually inputted to a spreadsheet. Participant 4 was implementing a sophisticated energy information system in a building under construction. Their community halls and pools were also considered to have relatively sophisticated information systems in place. However, the participant stated that the municipality did not have a great handle on how to manage the data. Participant 6 indicated energy consumption was tracked and monitored using a dedicated energy software suite. An energy analyst filtered the information and the system flagged significant increases in energy consumption. The system provided outputs such as reports on annual energy consumption and comparisons which included weather normalisation. Only participant 5 stated the municipality didn't record trends at all, but that it was part of their upcoming energy plan. The remainder were able to track energy trends, but only participant 6 referred to it as being a standard practice. Reasons cited for not tracking trends in energy consumption were that formats used to gather and record data rendered the task too time consuming.

Benchmarking appeared to be used in various contexts throughout municipalities, though views on its effectiveness differed. Half of the interviewed municipalities did not currently use any benchmarking tools but two stated it was something they would like to start exploring. Participant 4 wanted to explore the different benchmarking tools available for both building and municipal comparisons, instead of using generic benchmarks that may or may not be applicable to their specific circumstances. Participant 3 said it was done on a case by case basis within some of their buildings. The sophisticated information system, as referenced by participant 6, rendered it possible to measure energy consumption and compare it to similar building types. However, the concern was raised that differences between buildings types, sizes and occupancy levels make it very difficult to establish a standardised set of data against which to compare. Even when these factors are included, human error or bias may alter results rendering them less useful. Only participant 5 had stated that their municipality had participated in the Local Authority Service's

Energy Performance Benchmarking Project, which gathered and compared energy consumption data from 393 facilities across 140 Ontario municipalities.

Generally, the information gathered on energy consumption was not disseminated to upper management, because the formats in which data were kept were inappropriate. Only participant 6 indicated that information was often shared. Their advanced system's ability to put everything into an easily comprehensible report rendered information sharing with upper management and council easier. Additionally, programme managers received reports regarding energy matters on a monthly basis:

> ...there's an energy cap system. On a monthly basis we report out to the programme manager that runs the arenas (for example) and who programs and hires staff.... He gets a report on each arena every month telling him how his arenas are doing. It's a pretty cool system... and that opens a conversation, right?

Aside from participant 6, participants voiced dissatisfaction with the current levels of information available to them. Concerns expressed were that time and resources were limited and that data needed to be available in a simple format with someone responsible for analysis. Even participant 6 agreed that having an effective system in place required adequate staff, time and money. Many obstacles to adopting an effective system were mentioned and are summarised under the "comments" column of table 4.14, but will be discussed in greater detail in section 4.3.2.

All of the municipalities had conducted energy audits, or were planning on conducting energy audits on their buildings. One participant explained that the energy audits helped supplement the available information on efficiency opportunities and helped decipher which of that information was most applicable to their municipality. Several other information resources were considered to be helpful, and included consultants, experience, input from facility supervisors, service providers, and the Internet. However, word of mouth and experiences from colleagues and other municipalities were considered to be the most trustworthy sources of information. They are summarised in the table 4.15.

Table 4.14 Use of information and information systems

	Information available on energy data consumption	Extent of sub-metering	Availability of previous energy trends/ energy savings	Energy savings achieved	Use of monitoring	Use of targeting	Information sharing	Use of benchmarks	Comments
Participant 1:	Utility billing in Excel spreadsheets	One meter per building in most buildings. Some have multiple	Yes, but not in best format	Unknown, resources unavailable	No	No	None	No	Municipality needs better information system with dedicated resources to monitor energy consumption
Participant 2:	Daily information input into a data spreadsheet by the finance department	Not yet. To be implemented in two largest buildings in 2012	Yes, but capacity to analyse data is limited under current format	Not readily available	No	No	None	No	Benchmarking, use of monitoring and targeting scheme will start once sub-metering systems are installed and information becomes available in a more concise format
Participant 3:	Individual bills for each facility and interval data for larger facilities is available for electric consumption online. Natural gas is only available through paper bill which is located in finance department, photocopied and manually entered into a separate excel sheet	Yes	Year to year comparisons but nothing that has set a baseline or normalise data	Estimates established for individual projects	No	No	None	Case by case basis.	
Participant 4:	Yes, individual systems implemented in individual buildings and some sophisticated systems for equipment, such as pools	Extensively	Ability to track, but has not really been done	Not readily available	Yes	No	Not yet	Beginning in 2011. Challenge is coming up with benchmarks types to use	Energy systems are in place, but still developing best methods to analyse data
Participant 5:	Basic information available from bills and spreadsheets	No	No. very reactive approach	No	No	No	Limited due to limited ability to use data	Hoping to establish peak performance indicators and complete some internal comparisons with facilities in the coming year	
Participant 6:	Monthly energy consumption is tracked and monitored using a dedicated energy software suite. Energy analyst filters information, and monitors monthly changes in consumption. System provides annual reports, which includes patterns for weather normalisation	Extensively	Yes, software does model against baseline energy data	Not readily available	Yes	Yes	Yes. Reports from system disseminated to top management and council. Facility managers provide monthly reports to participant on energy consumption/facility operation	Yes, internal benchmarking may be used to compare similar building types,but is anecdotal	

Table 4.15 Trustworthy sources of information on energy efficiency opportunities

	Regional energy dept.	Audits	Facility supervi-sors	Web	Consul-tants	Propo-sals	Word of mouth	Peers	Experi-ence	Suppli-ers	Service provi-ders	Part-ners	Other munici-palities	Maga-zines	NRCan	Semin-ars	Service provider sponsored workshops
Participant 1	√√																
Participant 2				√	√	√	√√	√	√√								
Participant 3		√	√√														
Participant 4				√						√	√	√	√√	√	√		
Participant 5		√						√√					√√			√	
Participant 6				√				√√			√√					√	√

Note: Single check marks indicate the sources are considered trustworthy. Double check marks indicate the participant has stated they place the greatest trust in these sources of information.

4.3.5. Investment

Investing in energy efficiency is a complex process for municipalities. Like all municipal investment, approving projects and purchasing or retrofitting equipment must be approved by council. The approval process is complicated by the strong bureaucratic processes present within municipalities. A strong business proposal must be developed. This is usually accompanied by extensive product research and further inquiry within departments and with operational staff. A report supporting the business case is then drafted and is usually reviewed by senior management before being sent to council for final approval. The approval process is further complicated by the size and cost of the project. Energy audits aid with identifying worthy projects. To increase investment in energy efficiency, participants 3 and 6 stated that they had attempted to integrate energy efficiency standards into other projects with strong business cases, or that were more likely of being approved by council, such as equipment or building upgrades.

As revealed by participant 6, subcommittees consisting of council members were created to “filter” the validity of reports, prior to them going to council for formal approval. Any requests were required to outline a triple bottom line. Participant 1 stated that council had established a citizen task force to advise on the development, implementation and evaluation of the current budget.

All participants stated, as with other categories of investment, projects with shorter paybacks were usually prioritised over projects requiring longer term payback periods, (responses with regards to payback periods are summarised in table 4.16). Resource capacity, and the ability to incorporate the project into other investments (such as equipment replacement), were secondary

considerations. All participants also stated that projects and departments must compete for capital. Half of the participants voiced frustrations over a lack of full cost analysis, such as the incorporation of life-cycle costs, when appraising energy efficiency investments. A complete list of factors affecting investment in energy efficiency can be found in table 4.17.

Written rules and procedures were extremely important in terms of purchasing decisions and were rigorously followed by all municipalities. However, only participant 1 had a formal "green" purchasing bylaw which mandated green procurement and energy reduction measures. In the rest of the cases, energy efficiency featured very little, if at all, within the purchasing guidelines. Participants 2 and 4 were both moving forward with the development of green purchasing policies, while participant 5 did indicate that, while not formally incorporated, energy efficiency was considered voluntarily.

Table 4.16 "Do you think that shorter-term financial savings get more recognition within this municipality than longer-term savings as a result in the investment of energy efficiency projects?"

	Yes	No	Not necessarily	Comment
Participant 1:	√			
Participant 2:			√	"...it depends on the (resource) capacity of it as well...you can spend more, but save more in the long run. So, it's a balance that needs to be made."
Participant 3:	√			
Participant 4:	√			"So far. But that's an awareness piece. I think that's gotta change. I think it has to be a balance between the two. So much emphasis on the short term financial wins."
Participant 5:			√	
Participant 6:			√	

Half of the participants stated that they were allotted a budget for energy efficiency projects. Participant 5 indicated that council would be allotting a budget as part of their corporate energy plan. Participant 2 still had remaining funds from an endowment of a million dollars received from their local distribution company five years earlier, which could be used towards strategic programming or concept investments.

Participant 6 indicated their municipality had set a budget of a half a million dollars a year in addition to their reserve fund. Participant 3 stated their budget was initially set at $350,000, but the participant was almost positive that funding had been cut since then.

Generally, energy efficiency budgets, or funds approved for projects could be carried over to the following year, if unused, except as indicated by participant 3. None of the municipalities borrowed for the purpose of investment in energy efficiency from outside sources, although participant 2 did state that the municipality borrowed from a reserve fund established for the purpose of strategic investment. Although none of the participants were able to provide a number for the amount of energy savings achieved over the past few years, accomplishments varied across municipalities from the implementation of low hanging fruit to extensive renewable projects. Box 4.2 summarises these accomplishments.

Table 4.17 Factors influencing energy efficiency investments

	Decision-making process	Criteria used to appraise investments	Prioritisation of investments	Participant influence on investment decisions	Energy efficiency considerations in investment/ purchasing documents	Significance of written rules and procedures
Participant 1	Council approves the final budget. Projects are put together by staff and vetted by different levels of management. Council approves final budget.	Primarily based on payback periods	n/a	Participant has some influence with mechanical/lighting. Purchases are sometimes made by others or chosen by consultants assisting with tendering packages	Participant typically request consultants (architects/ engineers) to include energy efficient equipment when possible in tendering packages, but does not participate in all purchases	Yes – municipality has green purchasing bylaw
Participant 2	Managers from finance and asset management, engineers from asset management and possibly outside consultants to assist in business case development. Business case revised by senior management and CAO and commissioners and sent to council for final approval of spending	Simple payback is used everywhere unless legislated otherwise	Projects are prioritised by rate of return - scheduling and resource capacity do weigh-in	Participant will participate with project development, including specification writing for bid documents, as well as evaluation process with regards to purchasing decisions	n/a	Extremely important, however, energy issues weigh in very little. Municipality is working on developing procurement guidelines and policies which consider energy efficiency
Participant 3	Projects identified through audits. Participant develops list of priorities for implementation and meets with facility supervisors to determine how they fit in with capital plans. Once priority list is established, manager of facilities integrates project into budget, and sends it to senior management for approval.	Return on investment and simple payback as well as capital projects plans	Audits are conducted and project recommendations based on internal rate of return and simple payback. Consultant also asked to provide investment timeline. Municipality will also base investment criteria on other capital plans	Very little	Yes - in the facilities. Self-motivation plays a significant role	Very strict purchasing rules - energy is not featured
Participant 4	Present a strong business case to council and attempt to integrate spending with other prioritised projects	Generally, shorter payback periods, but initial capital must be available	Cost and the ability to follow protocols	Very little, more anticipated when new policy is in place	Will vary based on individual awareness	Definitely important. It is a rigorous process and staff will follow written rules when established
Participant 5	Participant, purchasing department, treasurer, and project manager generally are responsible for designing business case	Generally, net-present value. Counter arguments are required when going against the lowest bid. Life-cycle cost analysis may be used	Priority is primarily cost. Government regulation, community requests and necessity (such as leaking roofs) will take precedence	Limited. Participant does not have authority but staff will coordinate efforts when a good case is established. Participant remains aware of projects happening throughout the municipality and will argue for more sound (energy efficiency solutions) when deemed necessary	Rarely	Written rules/ policies are important, however energy factors in voluntarily
Participant 6	Subcommittees of council act as a prefilter for council. the decision making process would start with participant or participant's department and the facilities group or group responsible for the project. A business case is created and outlining a triple bottom line and sent to the relevant subcommittee for review.	The criteria used are financial, social and environmental, if not factoring in incentive dollars from other organisations, such as their local distribution company (LDC). Payback is still an important criteria	It is project specific	Participant generally has significant information available on energy efficiency needs	Yes, participant believes to have helped established a sense of cultural conservation among programme managers	Very. Does energy efficiency feature in these rules? Not really.

Box 4.2 Energy efficiency investments implemented throughout Southern Ontario municipal buildings

- LEED Silver standards for newly built municipal buildings
- Energy audits/building upgrades at existing City buildings
- 250 KW solar PV system
- PC upgrades towards more efficient equipment
- Changing all traffic signals from incandescent lights to LED lights
- Changing arena pad lighting from metal hay light to T5 high output florescent lights
- Systemically changing boiler systems in city hall to a more efficient boiler.
- Digitally adjusting ballast so that they turn down to a very low level, based on occupancy and outdoor light levels
- Changed lighting to more efficient systems in transit terminals
- Saving on the energy used to plug in operating vehicles (such as sanders and snowplows) from mid-November to mid-April by implementing a simple system that turns that power off and on for half of the units, every 15 minutes, so that it actually reduces the demand and consumption by 50% without impacting the vehicle battery.1.1 MW of solar power being installed during the year of the study on seven facilities roofs in conjunction with the local utility.
- Conducting a study to place wind turbines at a landfill site.
- Using the methane gas that's generated at a sewage treatment plant to generate electricity, and expand the ability to use that gas by adding a dome to store it.
- Capturing gas created at a landfill site.
- Combining four different buildings into one new City Hall building that is supposed to be 45% more efficient than a normal building of that size.
- LED lighting in parks and walkways
- 1400 high pressure sodium bulbs replaced with LED
- Conducting a district energy feasibility study.
- Placement of a solar wall in a pool.
- Replacement of standard boilers, HVAC systems.

4.3.6. Accountability and incentives

While all of the participants stated their municipalities were motivated to increase energy efficiency, municipal structure and politics often made it difficult for many employees to take steps to reduce energy consumption. Budgeting, invoicing and the ability to control one's energy

consumption varied throughout municipalities. Aside from participant 1, participants stated that individual subdivisions or departments could, to an extent, influence the costs associated with their energy consumption, but that many factors needed to be considered. Participant 5 stated that facility managers who wanted to reduce energy consumption likely could to some degree, but weather patterns and occupancy levels in the buildings would still affect their ability to do so.

In theory, facility managers could request the purchase of energy saving equipment, or influence staff behaviour through, for example, the dimming of lights. Policy issues were mentioned by participant 3, who claimed that many facility managers would probably appreciate having more control over their energy consumption. However, without proper guidelines and information, issues related to safety and permission could arise. These factors are summarised in table 4.18.

Energy costs, in half of the cases, were charged directly to facilities or departments and they were responsible for paying the bills. But without tools for benchmarking or sub-metering information, follow-ups were virtually non-existent once bills were paid. Participants 1 and 2 indicated their finance departments were responsible for paying energy bills, and unless requested, facilities or departments never saw their energy costs. Only participant 6 was responsible for managing and paying energy invoices.

Departments or facilities that had made conscious efforts to reduce energy consumption did not benefit from the cost-savings directly. None of the municipalities had any incentive programmes in place for facility managers that went above and beyond what is expected with energy management. Participants 2, 5 and 6 stated that these types of incentives were something to be considered, but of the three, participants 5 and 6 brought up issues regarding tax implications:

> ...let's say if I tell the manager for every 100$ we save in energy, the town will give them 10$. Do they have to claim that? Or even other things, other types of incentives, if they have to claim that.

> ...it is very difficult as a municipal employee to (motivate) your other staff members. With anything other than congratulations, like 'wow, good job' and give them a pat on the back ...if I give somebody a 2$ Tim Hortons gift card because they're doing a good job in energy that's coming from the taxpayer's dollar.

Participants 2 and 6 had some form of a corporate energy reserve where a percentage of energy savings or estimated energy savings would be reserved for investment in energy projects. Participant 3 stated that such a reserve should be developed within their municipality and participant 5 indicated they would be commencing a reserve fund starting in the next year. Participant 6 did voice concerns with regards to reserve funds and changes in municipal council:

> In a perfect world ... I've got a budget for capital investments in energy efficiency. So let's say I put these lights in at this arena.... the lighting costs 100 000$ and every year they save 10 000$. So the next 10 years, I should be taking that money back from them and paying for my program, and then reinvesting that money. And so you're creating a revolving door, a perpetual cycle of investments and payback. It all depends... our latest mayor promised a 0% tax increase... all of a sudden that money that's been saved for energy purposes has to go back to the direct tax law involved, right? Other times, I would take the investment and put it back into my energy reserve fund... to cover any emergency energy spikes.

4.3.7. Culture and awareness

All of the participants indicated that their municipalities took up energy savings measures for reasons other than to simply reduce energy consumption. On top of being environmentally motivated, participant 6 had also coordinated efforts with their asset management department to implement management software intended to track and monitor the age of equipment and the estimated time of replacement. Asset management would then pay the basic replacement costs of the equipment (such as a boiler). Any incremental costs of the project associated with energy efficiency would be paid from the energy management budget. This was somewhat similar to participant 1 who indicated energy efficiency was a result of replacing old equipment. Participant 3 acknowledged that growing public awareness of climate change translated into political motivation for councillors and a need to demonstrate corporate leadership. The frequency of these motivations, as mentioned by participants is summarised in table 4.19.

All of the participants acknowledged the growing importance of environmental performance in regards to decision-making. However, as indicated by table 4.20, only participants 1 and 5 believed their municipalities' valued environmental performance and cost-savings equally. Although, participant 5 believed that was only from council's perspective and that upper management still favoured cost-savings.

All municipalities expressed growing pressure to improve energy efficiency measures from both internal and external sources (listed in table 4.21). As summarised by one participant:

> ...there is a consciousness, out there, in the public. I think it's important that we have a certain external pressure, because that external pressure, it causes some internal pressure in here – People putting pressure on councillors and certain members of the team.

Table 4.18 Accountability and incentives

	Arrangements for charging energy costs	Extent to which sub-divisions can influence energy consumption/ costs	Energy management and energy budgets devolved to sub-divisions	Benefits of energy efficiency distributed	Creation of incentives	Energy awareness campaigns for staff
Participant 1:	Utility budgets under Asset Management department. Facilities are not responsible for usage	n/a	No	No	No	Yes
Participant 2:	Finance department responsible for bills. No distribution	If motivated, participant estimates 10% of energy costs could be saved by facilities	No	Generally, savings are returned to general operating budget. Informal policy in place that one quarter of savings goes into individual fund.	No	Yes
Participant 3:	Charged to the facility that uses the energy	To the extent that they are able to control their actions.	Facility managers have ability to budget spending. Participant may provide energy management and investment advice.	No	No	No
Participant 4:	Individual accounts are the responsibility of various departments to which they belong	Individuals can influence their consumption, but extent will be influenced by corporate policy	Yes	No	No	Yes
Participant 5:	Some facility managers responsible for paying energy bills for various groups of buildings.	Participant believes facility managers could control half of building energy consumption, with regards to reduction, equipment purchasing, maintenance,recommissioning, but occupancy levels, weather will influence that ability	Yes	No. Corporate energy reserve fund to commence next year	No	Yes
Participant 6:	Individual buildings have individual meters and department responsible for those buildings are charged and billed individually	Yes, by turning off lights, changing temperature when facilities not in use, etc.	Yes, but the extent varies with the departments	Often, energy savings will benefit the programme by lowering budgeted costs or be returned to a reserve fund. However, ability to do so will vary depending on various internal and external factors	No	Yes

Table 4.19 Motivations for adopting energy efficiency within municipalities

	Environment	Greenhouse gas emission reduction	Political motivations	Demonstrating leadership	"Right thing to do"	Equipment replacement
Participant 1:						√
Participant 2:	√			√	√	
Participant 3:	√	√				
Participant 4:	√	√	√	√		
Participant 5:	√					
Participant 6:	√	√		√		

Table 4.20 Importance of cost-savings vs. environmental performance

	Cost-savings more important	Environmental performance more important	Both equally valued	Comment
Participant 1:			√	
Participant 2:	√			
Participant 3:	√			
Participant 4:	√			
Participant 5:	√		√	"At council, I'd say environment would almost be close to even; however at management, it's more cost"
Participant 6:	√			"Cost savings is more important in the end decision making process, but environmental performance is definitely considered important"

As indicated in the second last column of table 4.11, every participant indicated that, overall, senior management was committed to addressing environmental issues, whether it is in mission statements, endorsing plans and policies, or at a personal level. However, participants 4 and 6 both stated that, like any company, there are varying points of view. Individual commitment is a key factor in deciding the extent to which energy efficiency will be implemented. Participants 2, 4 and 6 did state that to some degree individual motivation was a key factor in encouraging investment.

All participants stated that they could provide, and often were sought after, for advice related to energy and environmental issues:

> People are really open to our suggestions and our work. It comes down to the capacity to be able to provide that.

Although this influence was at times limited:

> There are places where I feel I could do better, I do not feel like there are any road blocks to me having influence anywhere, 'I guess' would be an answer to that. There are areas where I would like to have more influence, yeah. Yes, there are.

> ...I don't know whether it's a problem with process here or not in that, for instance, the new construction, there is input into the design. We do have requirements that they're designed to a LEED silver standard. There is a focus on a certain amount of energy efficiency when the building is being built. But a lot of times decisions are made with the project manager and the architect consultant, and as construction is underway, changes are made. (Suggestions) aren't necessarily passed down. And I believe, and there may be a difference in opinion here, in general there is an energy efficiency design philosophy when the building is built. But it doesn't necessarily pass through to operational philosophy. And we've seen that, I think, in a couple of buildings. We build them with all these energy efficient features, and they're not used to their full advantage when the building gets operating. I think there's some kind of step we're missing in there.

Participant 1 supported environmental initiatives, but the fact that there was no position dedicated to the task meant that senior management was required to balance this with other municipal needs. All municipalities agreed that changes in management had helped move energy and environmental issues forward. Participants 5 and 6 occupied positions that had been created in the last few years specifically for responding to energy or environmental issues.

Overall, participants agreed that a culture of awareness was growing, especially among senior management and council, though participant 5 did state that this was still not necessarily shared throughout all municipal levels. Participant 4 did comment on the importance of influencing overall corporate culture in order to provide the most influence over purchasing decisions:

> You can't get to everything; we couldn't control everything. It just doesn't happen. So you have to integrate it into the culture – make sure that people understand that, 'yes, energy is important when you make your decisions. So, let's bring that to the decision-making process beforehand'... it goes back more on the individual who now recognises, 'hey, this is the corporate culture that we're trying to integrate here and I have to do something about it'.

Table 4.21 Sources of pressure to improve municipal performance in energy efficiency

	Internal Pressures					External Pressures						
	Council	Upper management	Other staff	Internal policies/ strategies	Own reputation	NGOs	Community	Sales people	Other municipalities	Media	External policies/ strategies	Comments
Participant 1:				√			√					
Participant 2:		√	√				√					"Every body wants to do better"
Participant 3:	√							√				
Participant 4:	√		√			√	√		√			"External pressure creates internal pressure"
Participant 5:	√			√	√	√	√		√		√	
Participant 6:		√					√			√	√	

4.3.8. Barriers to energy efficiency in Southern Ontario municipal buildings

Participants were ask to indicate whether they agreed with the suggestion that there are a large number of energy efficiency opportunities that are highly cost-effective at current prices that could be implemented within municipalities and to indicate any obstacles they perceived to implementation. All participants indicated that "yes" they believed there were such opportunities available. However, the extent to which they believed this was possible for their municipality varied. Table 4.22 summarises these opinions and discusses the obstacles affecting their municipality's investment in such options.

Table 4.22 Perceived barriers to energy efficiency within Southern Ontario municipalities

	Do you agree that there are a large number of energy efficiency opportunities that are cost-effective at current prices?	Comments	Perceived Barriers
Participant 1	Yes	Low-hanging fruit	Lack of staff/ internal resources to move forward
Participant 2	Yes	Municipality has implemented many opportunities and is now encountering higher cost measures.	Lack of education, engagement and access to information needed for energy management
Participant 3	Yes		Budget constraints and competing mandates for facilities
Participant 4	Yes	Studies indicating that these opportunities exist are likely not conducted internally. The question is not whether they exist, but rather how can a municipality access the money upfront and convince staff to undertake them.	Lack of tools to access new technologies for older buildings increasing staff awareness and information for newer buildings
Participant 5	Yes	Everyone's case is different, and requires information on how the municipality is using energy.	Lack of information on building consumption, lack of money ensuring the quality of the services remains unchanged
Participant 6	Yes	Municipality has implemented most existing opportunities and believes this is no longer the case for them	n/a

4.4. Summary

The purpose of this chapter has been to summarise the results of the online questionnaires and interviews conducted with a multitude of employees from various municipalities across Southern Ontario municipalities. The purpose of these questionnaires and interviews was to evaluate municipal performance in energy efficiency and reveal the barriers which are relevant to this performance.

As stated in the beginning of this chapter, the data collected further defined the Southern Ontario municipal landscape while establishing the likelihood of certain barriers within this context.
The remainder of this thesis will discuss the results presented in this chapter and the implications of these findings on improving energy efficiency measures within Southern Ontario municipalities.

5. Discussion

5.1. Introduction

In chapter 4, results from the interviews and questionnaires on municipal performance in energy efficiency and perceived barriers were presented systematically. The purpose of this chapter is to reflect upon the results of the research to answer the research questions outlined Chapter 1:

- To what extent are Southern Ontario municipalities neglecting simple, well-proven and cost-effective energy efficiency measures?
- Why are Southern Ontario municipalities neglecting these measures?
- How do the barriers, as hypothesised by previous research, affect decision-making in energy efficiency within different Southern Ontario municipal contexts?

The evaluation of the questionnaires and interviews, as presented by this chapter, support the argument that a number of cost-effective measures to improving energy efficiency within Southern Ontario municipalities do in fact exist, but are being inhibited by a number of barriers. These barriers are described in the following sections of this chapter. Each section defines the barrier, its contributory mechanisms and discusses its effect on municipal performance in energy efficiency.

5.2. Presence of Barriers to Energy Efficiency within Southern Ontario Municipalities

The identification of barriers to the adoption of energy efficiency measures within Southern Ontario municipal buildings occurred in three stages: The literature review, which established a taxonomy of barriers to energy efficiency and a framework through which the phenomena could be studied, and the results compiled from the questionnaires and from the interviews. Each stage provides a level of information regarding these barriers and when analysed together, the researcher is able to gain a valuable perspective of their influence on the respondents' decisions with regards to energy efficiency within their respective municipalities.

There is much interdependence between the various categories of barriers and the effects they have on organisational performance in energy efficiency. Therefore, it is important to note that while the barrier itself may not appear to merit policy intervention, when evaluating its contributory mechanisms, or the paths through which the barrier is brought into being; policy intervention may be a rational mitigation tool.

Table 5.1 Barriers to Energy Efficiency within Southern Ontario Municipalities

Primary Barrier	Contributory Mechanism	Examples Identified by Participants	Comments
Imperfect Information	Non-existent information	Lack of technical skills	A lack of in house energy expertise and implementation experience creates technical uncertainty.
		Lack of specifications	Regulatory information and written policies for equipment purchasing/ energy usage is non-existent
		Lack of information on the *right* measures	Much of the general information on to energy efficiency is irrelevant when applied to specific circumstances.
	Inaccessible information	Difficulties in obtaining information on the right measures	Of the information available, constraints on time/resources limit the ability to research equipment or funding opportunities
		Difficulties in obtaining consistent and easily analysable benchmarking data	Formats in which data on energy consumption are gathered are inefficient and require more time and resources to analyse and share it.
	Asymmetric information	Doubt regarding hidden agendas of information providers	A lack of trust in certain sources disinclines users from seeking certain information.
Hidden Costs	General overhead costs of energy management	Costs of hiring specialists/ employees with adequate technical skills	Additional salary costs
		Cost of identifying opportunities	Additional time/ resources are required to filter through information to identify opportunities.
		Costs of seeking approval for spending	Bureaucratic processes require additional time/ resources for creating and presenting proposals.
	Costs associated with individual technology decisions	Costs for negotiating contracts	Time and resources are required to negotiate terms and conditions for certain new equipment purchases and servicing contracts
	Loss of utility	Possible poor performance of equipment	
Capital Constraints	Limited accessibility to funds	Competition for capital	Municipal projects are often funded from the same capital spending pool.
		Strict budgeting procedures	
Risk or Uncertainty	Legal/ Political uncertainty	Energy objectives and policies are not specified	Energy saving measures may lead to safety risks with legal repercussions.
		Risk of change in municipal priorities	Changes in elected officials or unforeseen external events.
		Risk of public scrutiny	Perceived misuse of public dollars entails risk for officials in terms of being reelected.
Split Incentives	Investor/ User dilemma	Department/ individuals not accountable for energy costs	Any savings are not redistributed and there are no consequences for inefficient energy use.
		Lack of staff awareness	Departments are unaware of potential savings.
	Conflicting objectives	Building maintenance/ operation priorities differ from energy efficiency	Departments must fulfill various roles, not necessarily related to energy efficiency and ensure they are responding to all needs of the community.
		Project researchers differ from project approvers	
Bounded Rationality	Bounded rationality	Lack of time/ other priorities	Leads individuals to fall back on habitual decision-making in order to save on time.
		Lack of objectives/ policies	Leads individuals to fall back on habitual decision-making in order to diminish risks.

Table 5.1 compares the existence of barriers as hypothesised by the literature review, presented in table 2.3, and the barriers that were considered to be relevant to questionnaire and interview participants within this case study. These were based on the results presented in table 4.9 and the comments presented throughout the interviews (see comments in tables 4.10, 4.12, 4.13, 4.14, 4.16, 4.17, 4.18, and 4.22). Each section discusses the mechanisms which contribute to the primary barrier as described by the participants. They are summarised in the third column of table 5.1. The mechanisms belong to one, or more of the categories in the second column of table 5.1. Each may be linked back to one or more of the theories discussed in chapter 2. Through these theories, the nature and significance of these barriers are demonstrated and the appropriateness of policy intervention can be argued. It is difficult to demonstrate the complex connections between barriers in a single table; they are therefore described in greater detail in each of the following sections.

5.2.1. Imperfect information

Imperfect information and its impact on energy efficiency performance within Southern Ontario municipalities were described in detail in Chapter 2. The literature review helped develop several hypotheses for testing barriers to energy efficiency and overall energy saving potential for Southern Ontario municipalities. Three categories of imperfect information were identified and are summarised in the first three rows of the second column of table 5.1. Each category is based upon the different frameworks presented in chapter 2, and therefore reflects the nature of its contributions to an efficiency gap. The third column in table 5.1 summarises the barriers resulting in imperfect information as perceived by the participants. The last column briefly summarises their contribution to imperfect information. The results indicate that various components of the imperfect information barrier were prevalent within Southern Ontario municipalities.

Questionnaire participants were asked to rate the importance of several statements on barriers to energy efficiency within their municipality. Overall, non-existent information did not appear to be a significant barrier to energy efficiency. These results are supported by the interview participants. The general consensus is that information on energy efficiency opportunities does in fact exist indicating that the public good attributes of information do not act as a barrier to energy efficiency. Therefore issues of non-existent information do not appear to contribute to an efficiency gap. Categories of non-existent information that were identified related to a lack of technical skills and specifications; which overlapped significantly with issues of hidden costs, leading to increased risk and boundedly rational decision-making.

Participants indicated that the barriers resulting in imperfect information were more reasonably explained by non-market failures, and related to issues of inaccessibility from limited municipal resources and complex organisational structure. As highlighted in the third column of table 5.1, a lack of time and resources inhibited its ease of access. The information that was accessible was described by five of the six interview participants as being inappropriately formatted. This rendered the task of sifting through it time consuming and difficult to pass along to those responsible for approving budgets and projects. They were further complicated by bureaucratic processes required for obtaining funding approval.

Audits helped identify relevant opportunities for municipalities. However, some issues pertaining to asymmetric information were revealed. Three of the interview participants highlighted concerns over the reliability of information, if auditors were being sponsored by certain companies. The level of scepticism with regards to the value of the information provided by the auditors did at times encourage decision-makers to doubt the need for certain measures. This may explain why, as revealed by the interview participants as well as the questionnaire respondents, the most valued information is often gathered from already "filtered" sources, or those who are able to "cut to the chase" and present their experiences and results. These include personal contacts in other municipalities and colleagues within the municipality. Despite the multiple sources of information, the interview participants indicated that, even when information sources were considered trustworthy, such as with information provided by the Office of Energy Efficiency, they were often too generalised to benefit municipalities. The orthodox economic approach to market failures would indicate that circumstances of asymmetric information would rightfully merit public intervention. Consequently, the development of certification schemes and minimum standards for equipment purchasing could arguably have increased economic efficiencies while reducing uncertainty associated with imperfect information. Barriers to inaccessibility generally resulted from bureaucratic structures which hindered a municipality's ability to obtain clear and relevant data, leading to numerous transaction costs. Orthodox approaches would therefore argue that policy intervention is not merited in this particular situation. However, as argued in chapter 2, the ability for orthodox economic reasoning to fully describe decision-making related to energy efficiency is limited. The potential for overcoming barriers to inaccessibility may be evaluated more extensively by examining the role of hidden costs on municipal decision-making.

5.2.2. Hidden costs

As discussed in chapter 2 and demonstrated in the previous section there is considerable overlap between the existence of imperfect information and hidden costs. This is reflected through the number of transaction costs associated with the need to find, analyse and apply information on efficiency opportunities. As demonstrated in the second column of table 5.1, hidden costs may be

summarised in the three following categories: the overhead costs of energy management; the costs associated with the investment of a specific technology; and, the costs associated with the loss of utility from the adoption of an energy efficiency measure. The latter two appeared to be less significant in this case study and will be presented first.

To begin, of the 20 identified barriers to energy efficiency investment indicated in the questionnaire, "production disruptions, hassle, or inconvenience" and "costs associated with staff replacement and retraining" ranked 14th and 15th in importance, respectively, in terms of an overall average score. This indicated it was not a major concern when compared to other potential barriers. However, over half of respondents indicated production disruptions, hassle, or inconvenience were sometimes an important reason for not adopting energy efficiency measures. Similarly, roughly 40 percent of questionnaire respondents indicated that staff replacement and retraining were also considered to be a somewhat important reason for not adopting energy efficiency measures.

To clarify the context in which these barriers are present, the interview participants were also asked a series of questions pertaining to hidden costs. In terms of loss of utility, such as products being less effective or less reliable from the adoption of energy efficiency measures, interview participants did indicate that overall, these costs were not incorporated into energy management decisions except by participant 4. One participant indicated that this needn't be considered if well-informed decisions were made.

> ...as far as buying a bad product and being not useful, we try not to do that (Participant 2).

Interestingly, all interview participants indicated that technical risk associated with energy efficiency technologies had surely at some point inhibited investment. However, none could identify the nature of the risk, or why it had been perceived as being riskier than the alternative. This is an interesting finding as it alludes to the notion that the neglect of energy efficiency is considered procedurally rational, not because technological risks associated with loss of utility or production costs are considered greater for energy efficiency technologies, but because transaction costs encourage decision-makers to fall back on bounded-rationality as a way of minimising potential technological risk. This supports the assumptions of prospect theory which argue that potential losses generally hold more weight than potential gains. Consequently, decision-makers will tend to favour the status quo.

The most relevant category of hidden costs was associated with identifying opportunities and having them approved. Almost 80% of questionnaire respondents indicated that the cost of

identifying opportunities, analysing cost-effectiveness and tendering were either an often, or sometimes important reason for neglecting efficiency opportunities. This theme was also identified by interview participants who indicated that opportunities in energy efficiency were being missed, not because the information did not exist, or because municipalities were financially incapable of supporting energy efficiency investment. Rather, the time and resources needed to identify opportunities, prepare business proposals, seek approval and implement measures were lacking.

Interview participants indicated that the bureaucratic processes required for accessing the capital needed for investment drove costs up, due to allocated time and resources to the task. Time and staff constraints were therefore a good indicator of the significance of overhead costs associated with energy management. These constraints were the most recurring themes expressed throughout interview responses. For this reason, many municipalities had created departments or positions which had some focus on energy issues, although more often, these were incorporated into overall sustainability strategies. Municipalities that had departments, or individuals solely responsible for energy matters tended to have advanced information systems already implemented, or were in the processes of being implemented. Their expertise was also often sought by other departments or staff and helped advance project proposals.

Participant 1, whose municipality had yet to create a department that would handle energy matters, indicated that energy efficiency regulations had been implemented into other purchasing and maintenance documents. This may have been done in an attempt to reduce the hidden costs associated with approval processes.

Overhead costs of energy management are difficult to quantify, since the bureaucratic structure of a municipality means that investment and approval procedures are often split among departments (this will be discussed in greater detail in the section 5.2.5 pertaining to split incentives). Therefore, it is difficult to say if the energy savings generated from additional investment saved on salary costs.

> They just assume I'm working here and my salary is paid, my computer is paid for, and stuff is turned on here. But everything I do is kind of above and beyond that. I guess it's just understood that I better make my cost back in energy savings (Participant 6).

All interview participants, except for participant 1, indicated that the use of outside consultants was limited whenever possible. Costs associated with paying outside consultants, or renegotiating contracts were the primary rationale for this decision. This may be more directly associated with capital constraints. While the use of outside consultants may cost more initially, participants did

reveal that the use of energy service companies almost certainly would improve the overall efficiency of the project.

> I do believe that there is an advantage in terms of actually getting the project done much quicker. And, they'd actually get done (Participant 4).

Energy audits were supported and commonly used as indicated by both interview and questionnaire respondents. However, once conducted, restrictions on time and capital constraints left municipalities picking which of the recommended opportunities were most feasible.

Finally, as previously indicated, the overhead costs of gathering and analysing data on energy consumption and efficiency opportunities were a significant barrier to investment when advanced energy information systems were not in place. The theoretical ideas from which the aforementioned barriers were derived define the nature of any policy intervention that may help mitigate them. Production costs and loss of utility are possibilities when adopting any product of service, whether they promote energy efficiency or not. Consequently, any form of policy intervention is unlikely to reduce them. However, given the highly bureaucratic nature of municipalities, it has been demonstrated that hidden costs associated with time and other resources offer a far more plausible explanation as to why certain cost-effective measures are neglected. These forms of hidden costs are contingent on internal and external structures surrounding an organisation or technology. Consequently, they do contribute to the presence of an efficiency gap. And, while the highly bureaucratic nature of municipalities is considered an essential component to ensuring the proper spending of public funds, some internal changes may reduce some of the inefficiencies resulting from it. Integrating energy efficiency regulations into other municipal policies and information sharing among departments are relatively simple ways of reducing hidden costs associated with information gathering. However, this would require initial capital to access the information needed to integrate these policies. Therefore, additional insight into the capital constraint barrier will need to be addressed.

5.2.3. Capital constraints

There were several components of the "lack of capital" barrier that were highlighted by both questionnaire and interview respondents. Respondents identified a lack of capital as being problematic in terms of investing in energy efficiency. However, when probed further, it became apparent that it was in fact a lack of "accessibility" to capital due to rigid budgeting procedures and the competition for capital throughout municipal departments that prohibited investment.

As presented by the questionnaire responses, issues related to capital were most consistently reported as being an “often important” barrier to energy efficiency. While a lack of capital was ranked as being an important reason for not investing in energy efficiency measures by almost 80% of questionnaire participants, over 90% of participants indicated it was strict adherence to capital budgets and other priorities that impeded investment. Interview participants indicated that a lack of capital available to municipalities was not necessarily the reason for neglecting energy efficiency. Rather strict and complex budgeting procedures were primarily responsible for the slow uptake of these measures by causing a delay or all-together inhibiting the release of funds for certain projects.

Interview participants did indicate that in many circumstances energy efficiency is supported in theory. However, capital is actively pursued by many departments throughout a municipality. Portfolios of properly costed and justified projects are presented from a multitude of departments and it often boils down to who presents the best business case. This requires access to quality information on both efficiency opportunities and building consumption. Acquiring this information, ironically, requires investment in the proper information systems, and adequate staff. With differences in municipal staffing needs, other issues may take precedence when positions dedicated to energy or environmental issues are not adequately funded. Despite these frustrations, participants who commented on this aspect of the process also recognised that it was currently a necessary step when working with public funds:

> I don't know how you do it different, because in a big organisation everybody can make that argument and there are all kinds of different things, not just energy, and they're making decisions on it all. But, you know, that is to me, an unfortunate part of the process (participant 4).

Although government funding is available to municipalities in the form of a number of grants and subsidies, and do help with initial borrowing costs, increasing their availability does not alleviate many barriers associated with imperfect information and hidden costs. This would explain why, as hypothesised in section 2.3.3, the availability of incentives are rarely a decisive factor. During times of economic recession, natural disasters, or public support for zero tax increases, funding for energy efficiency investment may be reduced:

> Luckily enough, most people who are fiscally concerned also understand, if they're smart enough, the benefits of properly implemented energy efficiency measures because there is a long term additional benefit. That said, if it gets bad enough and people are screaming for money, that capital cost will be cut (Participant 6).

> ...like everything, the main thing is 'do you get the money you feel you need to properly do the job?'. And that's always an issue. Energy management has certainly felt the brunt of cuts in the budget in the past, and probably will in the future (Participant 4).

Simple payback, while not the "be all, end all" of approval, was still the primary criterion for gaining council approval for an energy efficiency budget or a specific project. This was an interesting finding as, contrary to profitable institutions, municipalities are mandated to provide services to protect and enrich their communities. Often, energy efficiency had a better chance of being approved when incorporated into other projects, such as equipment replacement, as competition among departments or projects was reduced along with the associated hidden costs. This would explain why half of the interviewed participants indicated that they had begun integrating LEED standards for any new building projects. However, both interview participants and questionnaire respondents indicated that energy objectives were rarely formally integrated into operating, maintenance or purchasing procedures which would encourage both council and staff members to fall back on boundedly rational decisions-making procedures. Additionally, a dedicated budget for energy efficiency projects could help remove some of the barriers resulting from competition. However, as it stands, strict investment criteria associated with public spending almost guarantees that approval is likely to be based on typical criteria such as simple paybacks.

5.2.4. Risk or uncertainty

As indicated in chapter 2, the most relevant risks associated with energy efficiency, as indicated by the literature review, concern whether investments are rationally overlooked because they are considered riskier than other investments.

In the case of Southern Ontario municipalities, risk associated with investment in energy efficiency was considered a barrier. Questionnaire results indicated that, as suggested by the literature, technological and financial risks were factors that inhibited investment. Similarly, when probed on perceived risks, interview participants did indicate that financial and technological risks may inhibit investment in energy efficiency.

Of the 20 identified barriers to energy efficiency investment indicated in the questionnaire, poor performance of equipment ranked fifth in importance in terms of an overall average score, with a 2.35 out of a possible "3". Technical risk, while scoring only slightly lower than poor equipment performance, was ranked 13th overall, indicating that several other barriers to energy efficiency were considered more important.

When asked if municipalities have ever rejected a project because of the technological risks involved, all interview respondents answered "yes". However, nowhere else throughout the interview had participants implied that technical risk was considered a barrier to energy efficiency and when probed further, none were able to provide examples.

When asked to identify what they viewed as the primary risks to investment, natural disasters, population growth, and political decisions at various levels of government, and economic recessions were topics that arose. In all of these cases, the future revaluation and reallocation of funds in situations such as the ones mentioned above were considered a risk, as the time and resources needed to revaluate these budgets were already strained.

While the need to revaluate or reallocate funds is a rational reason for neglecting energy efficiency, it was revealed in section 5.2.2 that barriers associated with technological risk were in response to various transaction costs, much of which could be alleviated through changes in bureaucratic procedures.

Interestingly, it was the reoccurring theme of political risk found throughout several of the interview responses that seemed to weigh most heavily on decision-making. Municipalities are not profit generating organisations and are mandated to represent and support the citizens of their community. Ultimately, the citizens are funding the municipalities through tax dollars. This funding also supports the salaries of councillors who are responsible for approving budgets and projects representative of the needs and desires of their represented community members. In terms of answering the question "are investments in energy efficiency riskier than other investments, and are therefore rationally overlooked?" within Southern Ontario municipal buildings, the answer would appear to be "yes". If tax dollars are perceived as being misused by citizens a risk for council in terms of being elected is created. Despite a growing awareness around energy efficiency, other municipal responsibilities, such as providing adequate health services, and, as adamantly indicated by one participant, maintaining roads, are likely to be viewed as being more important than energy efficiency within municipal buildings.

5.2.5. Split Incentives

The split incentives barrier is twofold: one refers to an actual physical divide which exists between municipal departments and buildings which may inhibit investment in energy efficiency, and the other is much more closely associated with organisational structures.

Departments and individuals not being accountable for the costs of energy was considered one of the most significant reasons for neglecting energy efficiency in the questionnaire. It was also stated

as being a reason for neglecting energy efficiency by interview participants, although it appeared to be less of a concern for them. This may be explained by the fact that the questionnaire had been completed by different staff members, notably those overseeing entire municipal responsibilities, such as the CAO, who may have been able to speak more candidly regarding issues pertaining to individual staff roles. The interviews, on the other hand, were conducted by municipal employees with specific knowledge, or expertise, on energy management practices and technologies. Therefore, as demonstrated by many of the themes revealed throughout interview responses, these respondents may have been commenting more specifically on how other contributory mechanisms associated with energy efficiency, such as a lack of information, may lead to a lack of accountability. In other words, the interview participants may have perceived the lack of information as being the more significant barrier, creating the issue of split incentives.

As previously mentioned, half of the departments were charged for their energy consumption. However, energy managers did work closely with facility managers regularly and advised on energy opportunities. The lack of information available to facility managers on consumption, coupled with inadequate policy guidance, are considered the most significant reasons for neglecting energy efficiency on the facilities' end. If energy efficiency was integrated into other policy documents, such as purchasing and maintenance, where facility managers are directly involved in decision-making, the incentives for energy efficiency would likely be more evenly distributed. This would also alleviate some of the work load for energy managers, allowing them to provide extensive information on opportunities to facility managers.

These measures would also reduce conflicting objectives within municipalities. The competition for funds between departments is one part of the issue. Energy managers are responsible for promoting energy efficiency within municipalities. However, facility managers must work within their budgets to ensure that their buildings are functioning at optimal levels. If "optimal levels" do not incorporate efficiency standards, facility managers may be less inclined to argue the need for efficiency in their businesses cases, especially where increasing energy efficiency entails risk. Similarly, other department objectives, such as providing adequate services to community members, such as comfortable temperature settings within municipal facilities, or safe roads, may disincline council from approving energy efficiency projects.

This is not to say that other departments do not value energy efficiency throughout municipal buildings. However, as long as energy efficiency is considered a separate investment, rather than a standard to be incorporated into other investments, conflicts associated with competition for capital will arise.

All interview participants stated they had adequate information on the needs of their building and equipment users. However, a lack awareness of building and equipment energy consumption meant that building and equipment users were often unable to make informed decisions themselves. This also would render it more difficult to present well-drafted investment proposals to council, even when energy management was a priority for municipalities or building managers.

> You can put these systems in place, but if you have no one to enter the data, and you have no one whose job it is to analyse the data and disseminate it ... on a regular basis in reports to management, what's the point (Participant 4).

For these reasons, the interview participants explained that advanced energy information systems, with their ability to monitor energy consumption patterns across buildings and equipment, and target areas for improvements and provide relevant information to the decision-makers, were considered essential if informed decisions related to energy efficiency were to be made.

5.2.6. Bounded Rationality

This project treated bounded rationality as a barrier in itself, rather than a framework through which other barriers could be studied. As discussed in chapter 2, just as the existence of certain barriers, such as asymmetric information, may lead to a decision-maker to fall back on bounded rationality, the barrier itself may result in the existence of other barriers, such as hidden costs.

The results of the interviews and questionnaires have demonstrated that when effective policies or information on energy efficiency is nonexistent, or not easily accessible, decision-makers do in fact rely on standard routines or rules of thumb, such as simple payback, when making purchasing or maintenance decisions. Interestingly, many respondents indicated that senior staff and council are generally supportive of integrating energy efficiency into purchasing and maintenance decisions. However, time constraints associated with gathering information and lengthy approval processes may limit the use of full costs analysis when assessing the economic reasoning for integrating energy efficiency into other decisions. Bounded rationality is used to facilitate information handling, and minimise transaction costs, often unintentionally stifling progress.

Given the complex and often necessary bureaucratic procedures, little thought is often given when assessing these measures. Consequently, integrating minimum energy efficiency standards into all levels of organisational policy is one way to prevent decision-makers from choosing measures with lower initial cost, but higher life-cycle costs. However, to date, these measures are featured little in the majority of institutions.

5.3. Conclusions

There is a growing awareness of the need to integrate energy efficiency into all aspects of municipal decision-making. Growing public awareness and provincial efforts to reduce energy consumption through policies such as the Ontario Green Energy and Green Economy Act are encouraging municipalities to adopt measures to support efficiency. However, even with increased support on behalf of municipal decision-makers, a plethora of barriers still inhibit municipalities from investing in cost-effective energy efficiency measures for their buildings.

The results discussed in this chapter have demonstrated that, to varying degrees, all of the primary barriers identified in chapter 2 affect decision-making related to energy efficiency within the Southern Ontario municipalities studied.

There continues to be a considerable scope for improving energy efficiency and energy management practices. While energy efficiency no longer appears to be a marginal concern for the participating municipalities, the degree to which policy intervention may successfully overcome these barriers must be carefully evaluated. Chapter 2 provided a theoretical framework for evaluating these barriers and understanding the degree to which certain forms of policy intervention may help overcome them. The orthodox argument dictates that intervention is only merited when a barrier results from a market failure. This study's results have demonstrated that some of the barriers described by participants do in fact result from market failures. These are predominantly associated with issues of asymmetric information and may be rationally overcome through the integration of public policies such as certification schemes, minimum standards, and the provision of clear, concise, and relevant information on efficiency and funding opportunities.

It has also been revealed that many of the perceived barriers to energy efficiency described by participants result from complex bureaucratic structures, which lead to additional transaction costs and encourage particular behaviours and perceptions. Because these barriers do not result from market failures, orthodox economics argue that the non-adoption of energy efficiency measures is rational and public intervention is not justified. However, it has been argued that orthodox economics is an important but still inadequate framework for understanding barriers to energy efficiency and for evaluating the potential for overcoming them.

Assigning an absolute value to many of the barriers which are present within these Southern Ontario municipalities is virtually impossible. The use of mathematical models for evaluating their relevance and the potential for policy intervention is therefore irrelevant. Transaction cost economic and behavioural economic reasoning offer more realistic arguments for evaluating these barriers and understanding the potential for policy intervention to overcome them.

While bureaucracy is considered an important component to the proper functioning of a municipality, some changes in structure such as: rendering individual departments accountable for their energy costs; integrating advanced energy information systems into municipal buildings; and providing incentives for energy savings, may help minimise them.

Similarly, human components of decision-making, such as issues of bounded rationality and increased risk, are virtually impossible to quantify. Humans will often make decisions based upon simplicity, habit and how options are presented. Because issues of perceived risk and bounded rationality were revealed as being relevant to these participating municipalities, it is important to acknowledge the significance of these "psychological underpinnings". Consequently, simplifying information and information sharing and increasing awareness are also plausible methods for increasing energy efficiency.

The following chapter will conclude by elaborating on some of the policy measures discussed in this chapter, and introducing future areas of research that would be valuable in helping resolve the barriers debate.

6. Conclusions and Final Remarks

6.1. An Introduction to Resolving the "Efficiency Gap" within Southern Ontario Municipalities

Increasing energy efficiency is considered a core strategy for ultimately achieving a sustainable energy system. However, the slow execution of energy efficiency solutions are said to be reflective of a much wider debate within energy economics, and lead to what is commonly referred to as the "efficiency gap". This thesis set out to help reduce that gap within Southern Ontario municipalities by better understanding potential for, and costs of, energy efficiency within the sub-sector. This required identifying a number of existing simple, well-proven, and cost-effective technologies and practices that had been adopted by Southern Ontario municipalities for their buildings; examining Southern Ontario municipal decision-making structures, and their influence on performance in energy efficiency; and, identifying the nature, operation and determinants of barriers to energy efficiency from the perspective of Southern Ontario municipalities. This helped establish the extent to which Southern Ontario municipalities were neglecting these measures; the reasons for the neglect; and, the impact barriers to energy efficiency had on overall municipal energy performance.

The results of this case-study indicate that, although varying from municipality to municipality, an "efficiency gap" does appear to be present within these Southern Ontario municipalities. In other words, there is room for these Southern Ontario municipalities to improve energy efficiency cost-effectively.

This neglect results from a number of the primary barriers which have been hypothesised by previous research. However, in order to demonstrate the extent to which these barriers were leading to economically inefficient outcomes, their determinants and their effect on municipal decision-making needed to be established.

It was discovered that, while all barriers are present to some degree, the primary reasons for neglected cost-effective investment in energy efficiency were extensive hidden costs associated with accessing information and capital. These barriers resulted directly from complex municipal structures. Decision-makers then perceived investment in energy efficiency as being riskier than other forms of investment and were encouraged to fall back on back on bounded rationality. Although the majority of these barriers did not directly result from market failures, they still led to economically inefficient decision-making. This would support the claims of "bottom-up" models that standard economic reasoning is ineffective for deciding appropriate policy intervention. Rather, the "gap" stems more directly from inefficiencies at the organisational and individual

levels. Mitigating the impact these barriers have on overall municipal performance in energy efficiency may need to come from changes at these levels.

The following sections discuss which of these barriers may be overcome through policy intervention and suggest some of the policy options available for encouraging both economic and energy efficiency within these Southern Ontario municipalities.

6.2. Internal Measures

The self-assessment matrix presented in chapter 4 (table 4.1) provides an effective starting point in determining an energy efficiency profile for the responding municipalities. The results suggest a positive discrimination in favour of "green" schemes. This may be explained by a growing awareness surrounding the need for energy efficiency and other "green" investments in order to support environmental well-being, economic growth and for meeting upcoming provincial mandates.

In response to the Ontario Green Energy and Green Economy Act, issues pertaining to energy management plans were given much consideration by respondents. The purpose of these written and formal documents demonstrates the commitment of an organisation, and their senior management, to following certain rules. In the case of an energy policy, the purpose is to provide a framework for establishing sustainable targets and performance indicators for integrating energy efficiency into overall goals of the organisation. However, there appears to be a gap between awareness surrounding the need for energy efficiency and actual references to energy efficiency throughout municipal policy and procedure documents. The development of formal policies and plans, which are highly regarded and strictly followed throughout municipalities, and clear guidelines related to energy management and decision-making procedures appear to be proportionately low.

Activities related to energy management are often dispersed throughout various municipal levels. As explained by respondents, municipalities usually function along conventional operating lines. Each department is responsible for their area of expertise. For example, the finance or asset management departments are often responsible for bill payments; sustainability/ environmental/ energy departments, when present, are often responsible for researching and recommending energy projects; engineers are responsible for implementing them; and, facility managers are responsible for ensuring the projects are used to their full potential, by monitoring and controlling energy consumption. Finally, before any project can proceed, council must approve any project or budget. These complex bureaucratic structures have been demonstrated to lead to a number of hidden costs as well as increased risk and split incentives. In response, municipal members are inclined to fall back on boundedly rational decision-making to by-pass bureaucratic procedures. Consequent-

ly, opportunities to integrate simple and cost-effective energy efficiency measures are often neglected and lead to economically inefficient outcomes.

Written rules are followed with great detail in municipalities, and this transparency is necessary when working with public funds, as is the need for bureaucratic processes for approving projects. Setting targets or standards for departments may also effectively reduce issues of bounded rationality and other inefficiencies, by mandating shifts in behaviours and eliminating redundancies in the approval process.

With the passage of Bill 150, the province may require public agencies to prepare an energy conservation and demand management plan (Schedule A, Part II, (6)), which must include information pertaining to annual energy consumption, expected results and the summary of any progress and achievements pertaining to energy conservation. However, in order for municipalities to measure performance and ensure targets are being met, regular maintenance must be undertaken. This requires the ability to monitor trends in energy consumption, target areas of improvement and easily transfer information among departments. Given the existence of issues associated with split incentives, and the emphasis placed upon the importance of written and formal policies within municipalities, a successful energy management system must include the development of clear internal policies that also establish links between the various departments. Rendering departments responsible for their energy costs is an effective starting point for supporting awareness and information sharing while effectively reducing issues of split incentives.

The adoption of advanced energy information systems would support and facilitate the sharing of relevant, sector specific information. It also provides opportunities for individual departments to monitor and achieve maintenance targets. In cases where monitoring energy trends is commonly practiced, sharing energy information with staff would likely be the most practical step to encourage energy efficiency. However, at present, it would appear that capital constraints still impede the wide-spread implementation of these systems. Solutions to this barrier will be discussed in the next section.

Finally, rewards and incentives are obviously effective ways of increasing department and individual participation in energy efficiency. While, it is common practice in non-public sectors to offer rewards for going “above and beyond” organisational expectations, it would appear that the implications of funding incentives with public money are complex and, for the most part, unknown. Municipalities should assess the use and impact of rewards and incentive programmes and consider the integration of such programming into municipal structure. However, as a more general incentive, at least a percentage of savings generated by investment in energy efficiency should be

allocated to that departments' budget, for investment in future projects. This would also help reduce barriers associated with capital competition.

6.3. External Measures

The aforementioned internal measures can be supported, and encouraged at the provincial or federal level. The integration of the Green Energy and Green Economy Act provides an important opportunity for municipalities. However, details on regulations remain vague. Currently, municipalities are aware that changes are expected, but remain unaware of what changes to expect. There is a hesitation on behalf of many municipalities, especially those with larger budgetary restrictions, and less access to information, to making extensive changes in energy structure; even when non-adoption leads to economic inefficiencies.

6.3.1. Standards, certification, reporting, and monitoring

Section 5.2.1 introduced issues of imperfect information on municipalities, as perceived by the participants. The primary examples of imperfect information as given by participants resulted from barriers associated with acquiring and filtering through available information. These resulted in hidden costs which were emphasised by complex bureaucratic structures. As these barriers are not directly explained by concepts of market failures, public policy can arguably not overcome them. However, when internal efforts were undertaken to reduce these issues, such as when auditors were hired, issues associated with hidden agendas, or sales pitches, casted some doubt over the legitimacy of the information being provided. A lack of government specification increased this uncertainty.

As previously discussed, purchasing and maintenance procedures are meticulously followed within municipalities. The province may, by regulation, require public organisations to consider energy conservation and energy efficiency in their acquisition of goods and services and to comply with these requirements (Schedule A, Part II, (6)). Additional minimum requirements for municipalities when purchasing equipment, such as Energy Star standards, as set by the province, may effectively reduce consumption.

Some municipalities have already begun establishing LEED certification standards when approving the construction of new buildings. While LEED certification standards may be growing in popularity among municipalities, high energy efficiency standards for buildings are not always required for LEED certification. Generic certification standards for municipal buildings, such as LEED, are a good starting point. However, the criteria for LEED certification are based on a cumulative point system. Therefore, it is possible to have a LEED certified building, which is not overly

energy efficient. In order to have energy efficiency standards consistently implemented throughout buildings, set energy standards should be imposed for new building projects. A LEED point system offers a realistic template for government to impose these standards. Certification could easily be based on a point system, similarly to LEED standards, only specifically with regards to energy efficiency. Unlike LEED standards, which are voluntarily established, regulation of such efficiency standards through the Green Energy Act would ensure standards are met. Minimum standards could fluctuate based on municipal income and additional subsidies may be offered to those municipalities. It is also important to consider that the establishment of minimum efficiency standards in the design phase of construction does not necessarily pass through to the construction itself.

The actual certification process is important for ensuring the criteria established which certification standards are realised throughout the construction process, and again are followed operationally. Currently, some municipalities do design new buildings with certain standards in mind. However, the certification process can be lengthy and expensive. Consequently, in some cases, while the building is designed to such standards, the municipality itself does not actually receive certification. And without the actually certification process, it becomes difficult to gauge whether all design principles have been followed through to the construction and operation processes. Mandatory certification, under Canada's Energy Efficiency Regulations also ensures that efficiency standards are in fact being implemented and used to their full potential.

Because the Provincial Government may require public agencies to prepare energy conservation and demand management plans, the introduction of mandatory reporting requirements for energy use, including energy intensity and greenhouse gas emissions, obliges municipalities to invest in improved energy information systems. These systems reduce issues of imperfect information and hidden costs by increasing the relevancy of the information and rendering it easy to monitor and transfer.

6.3.2. Incentives

Unfortunately, there remains heavy internal competition for capital within municipalities and their departments with regards to undertaking energy efficiency projects. While the bureaucratic processes, as previously indicated, are considered a frustrating, yet essential component of working with public funds, there are methods of encouraging investment without jeopardising organisational transparency. The capacity at present for many municipalities to invest in advanced energy information systems is limited. Financial incentives were therefore commonly recommended by participants.

While studies have argued that the availability of subsidies is rarely a decisive factor (Gruber and Brand, 1991), if coupled with legislation, it would be economically irrational for municipalities not to utilise them. Provided they are easily accessible and targeted for certain legislation, additional grants, tax breaks, or low interest borrowing opportunities from provincial, or federal government, could help reduce the barriers associated with capital constraints. Offering additional incentives for purchasing efficient products at the time of replacement helps stimulate a powerful market shift by establishing a reliable entry market for energy efficiency products and services. National policies are already in effect, such as the ecoENERGY Efficiency Initiative, which provides incentives and rebates for investment in efficiency. Promoting these incentives may also reduce internal competition by reducing discrepancies between capital and operational budgets.

6.4. Implications and Areas of Future Research

This thesis has attempted to shed some light on the existence of an energy efficiency gap within Southern Ontario municipalities and the reasons for it. This research suggests that there are numerous barriers to implementing economically efficient measures aimed at reducing energy consumption for the Southern Ontario municipalities studied. These barriers are determined by a number of economic, organisational, and behavioural factors surrounding municipal structures and decision-making. It has been revealed that all of the primary barriers identified throughout previous research were applicable to the contexts found throughout the Southern Ontario municipalities studied. However, upon further investigation, it became apparent that organisational structures often created issues of imperfect information and complicated processes for accessing capital, which increased implementation costs. These lead to issues of split incentives and increased risk which encouraged decision-makers to fall back on bounded rationality.

These findings suggest that the nature of many of these barriers are directly, or indirectly associated with inefficiencies at the organisational level. Therefore, public intervention will not necessarily resolve all of these barriers and reinstate economic efficiency. Rather, organisational restructuring coupled with adequate legislation and incentives may effectively overcome some barriers associated with accessing information and constraints, which in turn mitigate many of the other barriers identified by participants.

Understanding the barriers debate through these detailed investigations is only one step in resolving the energy gap. Focusing on other areas that inform issues associated with energy efficiency is invaluable.

For one, and as previously mentioned in chapter 3, understanding barriers only explains one side of the gap. Maximising the adoption of energy efficiency measures requires an understanding of

the factors that drive adoption. This research focused solely on barriers as it is believed that by eliminating the focus on drivers, a more thorough examination of the barriers in question is permitted. The policy recommendations discussed in this chapter were made to help encourage future research in energy efficiency drivers. Establishing the effectiveness of these proposed policies requires additional research pertaining to the nature of drivers to energy efficiency. Coupled with comprehensive policy evaluations within various contexts, these measures may provide additional information on the potential effectiveness of both internal and external policy intervention.

Another area of potential research lies within the complex network of intermediaries affecting the end results of energy efficiency. As previously discussed, the design of an energy efficient building, the construction of said building and the operation of the building by the final user all affect the degree to which energy efficiency is considered, and implemented. While a building may be designed to advanced efficiency standards, certain criteria may be lost in the construction process. Additionally, where a building is constructed with the ability to meet certain efficiency standards, users may not use equipment to its full potential. As discussed in Sorrell et al.'s work, an alternative research design would be to "examine the contribution of different actors along these supply chains" (2004) for example, by identifying impacts of partnering agreements.

Finally, an interesting research topic would be to understand why, in so many instances, energy efficiency is treated as a capital expenditure, rather than a standard to be integrated within other decisions.

In all of these instances, the purpose is not to develop one unified theory with which to assess energy efficiency. As reducing, or even eliminating, the efficiency gap requires an interdisciplinary approach to studying energy efficiency; the purpose is to develop "complementary insights", which may be integrated into various fields of research (Sorrell et al. 2004, p.313).

6.5. Final Remarks

The debate between "technical optimists" and "economic pessimists" is unlikely to be resolved any time soon. However, the need to reduce greenhouse gas emissions and transition to a safer and more reliable energy system requires immediate attention.

Combining the findings from previous research with questionnaire and interview results from various Southern Ontario municipal employees, this research was able to contribute to previous studies by better understanding the performance of various municipalities within Southern Ontario in relation to energy efficiency, and to determine the reasons for this performance.

Bearing in mind that investment decisions and consequential performance in energy efficiency are influence by a broad range of factors, this was accomplished in part by illuminating the factors that inhibit Southern Ontario municipalities from investing in simple and cost-effective measures that could improve overall organisational performance in energy efficiency.

The findings indicate that there is considerable room for improving energy efficiency within Southern Ontario municipal buildings, and that these municipalities are inhibited by a range of barriers affecting their ability to adopt such measures. The primary barriers, as postulated by this research, are in line with the general barriers to energy efficiency as postulated by previous studies. However, the contributory mechanisms, or the way these barriers affect municipal performance, are dependent on specific characteristics found within Southern Ontario municipalities. As demonstrated, many of the contributory mechanisms surrounding these barriers co-exist in various forms. The types of barriers resulting in this neglect are most often associated with lacking information and capital constraints, which are very much associated with the hidden costs associated mostly with overhead costs to energy management. These barriers often force various municipal members to rely on bounded rationality when approving decisions, especially to reduce risks associated with this type of investment.

Overall, success will need to be supported by a combination of sector and provincial/ federal measures. However, there is more work that needs to be done to bridge the efficiency gap, which remains prominent in Southern Ontario municipalities. Continuing to understand the barriers to energy efficiency within various contexts is an appropriate objective for further academic research. However, the ultimate goal is to implement adequate policies to effectively overcome these barriers. Therefore, additional research pertaining to all levels of energy efficiency, such as examine drivers to energy efficiency, and understanding the effectiveness of various policies on municipalities and beyond is urgently needed.

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Appendices

Appendix A: Original Letter of Introduction and Subsequent Changes

Original - Letter of Introduction

Dear _____,

My name is Amanda San Filippo, I am a masters student conducting research out of the Department of Environment and Resource Studies at the University of Waterloo on energy efficiency within municipal buildings. My supervisor is Professor Ian H. Rowlands.

As part of this research I hope to learn about decision-making processes and developments in energy efficiency from stakeholders and professionals who are responsible for municipal buildings in Southern Ontario.

After reading some of your work in this area / After speaking with ____ it was recommended that / As an expert with _____, your insights would prove very helpful. I am therefore writing to request your participation in an online questionnaire. It should take approximately 20 minutes.

Prior to the questionnaire, you will be prompted to complete a consent form. The consent form requires you to read through the information letter, which is found at the top of the first page of the questionnaire. The consent form protects your confidentiality while the information letter provides you with important information regarding the details of this study. I recognise your busy schedule and would very much appreciate you taking the time to respond.

To read the information and to complete the questionnaire, please select the following link (http://www.kwiksurveys.com?s=KMNJOI_a194a12). Please be advised some questions may require retrieving information on past energy usage and expenditures from your municipal records or reports.

All of the data will be summarised and no individual could be identified from these summarised results. The website is programmed to collect responses alone and will not collect any information that could potentially identify you (such as machine identifiers).

If you feel that there are others in your department whose insights may be invaluable to this research, please do not hesitate to forward this questionnaire along to them.

If you have any questions please do not hesitate to contact me by email at [redacted]@uwaterloo.ca or by telephone at [redacted]. You may also contact Professor Ian Rowlands if you have any additional questions. He can be reached by telephone at ([redacted] ext. [redacted], or by email at [redacted]@uwaterloo.ca.

This study has been reviewed by, and received ethics clearance through, the Office of Research Ethics, University of Waterloo. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes, the Director of this office, at [redacted] Ext. [redacted] or [redacted]@uwaterloo.ca.

Thank you for your interest and I look forward to receiving your responses. Again, you may complete the survey at http://www.kwiksurveys.com?s=KMNJOI_a194a12.

I hope to hear from you.

Thank you kindly,
Amanda San Filippo
M.E.S Candidate
Department of Environment and Resource Studies
University of Waterloo
[redacted]
[redacted]@uwaterloo.ca

Revised - Letter of Introduction

Dear _____,

My name is Amanda San Filippo, I am a masters student conducting research out of the Department of Environment and Resource Studies at the University of Waterloo on energy efficiency within municipal buildings. My supervisor is Professor Ian H. Rowlands.

As part of this research I hope to learn about decision-making processes and developments in energy efficiency in Southern Ontario municipalities. This includes gaining valuable insight from many different types of municipal employees.

I am, therefore, writing to you to request:

a) your participation in an online questionnaire, which should take approximately 20 minutes, and;
b) your help in contacting different members of your municipality, whose insights would also prove to be invaluable to my research.

The reason for the latter request is simply to ensure appropriate individuals are contacted and to avoid any redundancies among recipients. I recognise your busy schedules and want to avoid any miscommunication.

Though not all of the questions will be pertinent to all respondents, the opinions of those that are will greatly help my research. In other words, depending on the individual completing the survey, only some questions will require answers. I am specifically looking for responses from individuals responsible for municipal buildings, operations, finances, energy or environmental policies and general decision-making (including council members). Attached you will find the introductory letter, which includes the link to the survey, that may be forwarded on to your colleagues.

Prior to completing the questionnaire, respondents will be prompted to complete a consent form. The consent form requires them to read through the information letter, which is found at the top of the first page of the questionnaire. The consent form protects confidentiality while the information letter provides important information regarding the details of this study. I recognise your busy schedule and would very much appreciate you taking the time to respond.

To read the information and to complete the questionnaire, please select the following link (http://www.kwiksurveys.com?s=KMNJOI_a194a12). Please be advised some questions may require retrieving information on past energy usage and expenditures from your municipal records or reports.

All of the data will be summarised and no individual could be identified from these summarised results. The website is programmed to collect responses alone and will not collect any information that could potentially identify you (such as machine identifiers).

If you have any questions please do not hesitate to contact me by email at [redacted]@uwaterloo.ca or by telephone at [redacted]. You may also contact Professor Ian Rowlands if you have any additional questions. He can be reached by telephone at [redacted] ext. [redacted], or by email at [redacted]@uwaterloo.ca.

This study has been reviewed by, and received ethics clearance through, the Office of Research Ethics, University of Waterloo. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes, the Director of this office, at [redacted] ext. [redacted] or [redacted]@uwaterloo.ca.

Thank you for your interest and I look forward to receiving your responses. Again, you may complete the survey at http://www.kwiksurveys.com?s=KMNJOI_a194a12.

I look forward to receiving your responses.

Thank you kindly,
Amanda San Filippo
M.E.S Candidate
Department of Environment and Resource Studies
University of Waterloo
[redacted]
[redacted]@uwaterloo.ca

Attached Letter of Introduction

Dear _____,

My name is Amanda San Filippo, I am a masters student conducting research out of the Department of Environment and Resource Studies at the University of Waterloo on energy efficiency within municipal buildings. My supervisor is Professor Ian H. Rowlands.

As part of this research I hope to learn about decision-making processes and developments in energy efficiency from stakeholders and professionals who are responsible for municipal buildings in Southern Ontario. This includes gaining valuable insight from many different types of municipal employees such as individuals responsible for municipal buildings, operations, finances, energy or environmental policies and general decision-making (including council members).

I am therefore requesting your participation in an online questionnaire. It should take approximately 20 minutes. Please note while not all of the questions will be pertinent to you, the opinions of those that are will greatly help my research. In other words, depending on your role within the municipality, only some questions will require answers.

Prior to completing the questionnaire, you will be prompted to complete a consent form. The consent form requires you to read through the information letter, which is found at the top of the first page of the questionnaire. The consent form protects your confidentiality while the information letter provides you with important information regarding the details of this study. I recognise your busy schedule and would very much appreciate you taking the time to respond.

To read the information and to complete the questionnaire, please select the following link (http://www.kwiksurveys.com?s=KMNJOI_a194a12). Please be advised some questions may require retrieving information on past energy usage and expenditures from your municipal records or reports.

All of the data will be summarised and no individual could be identified from these summarised results. The website is programmed to collect responses alone and will not collect any information that could potentially identify you (such as machine identifiers).

If you have any questions please do not hesitate to contact me by email at [redacted]@uwaterloo.ca or by telephone at [redacted]. You may also contact Professor Ian Rowlands if you have any additional questions. He can be reached by telephone at [redacted] ext. [redacted], or by email at [redacted]@uwaterloo.ca.

This study has been reviewed by, and received ethics clearance through, the Office of Research Ethics, University of Waterloo. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes, the Director of this office, at [redacted] ext. [redacted] or [redacted]@uwaterloo.ca.

Thank you for your interest and I look forward to receiving your responses. Again, you may complete the survey at http://www.kwiksurveys.com?s=KMNJOI_a194a12.

I look forward to receiving your responses.

Thank you kindly,
Amanda San Filippo
M.E.S Candidate
Department of Environment and Resource Studies
University of Waterloo
[redacted]
[redacted]@uwaterloo.ca

Appendix B: Online Survey

Municipal Building Energy Efficiency Survey

*** indicates answer is required to proceed**

University of Waterloo

200 University Avenue West
Waterloo, ON N2L 3G1
(519) 888-4567

This letter is an invitation to consider participating in a study I am conducting through 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.

Issues such as climate change, the 2003 blackout, the removal of coal plants and the cost of replacing nuclear facilities have many questioning Ontario's energy future.

Ontario Bill 150, the Green Energy and Green Economy Act, is an important example that the province recognises the necessity of redesigning current energy systems. Progress continues to be made through the adoption of renewable energy sources as well as the development of increasingly efficient technologies. Although the rate of increase of energy consumption is slowing, overall consumption continues to rise. This demonstrates a need to continue to study ways of increasing the adoption of energy efficient measures, which is considered a relatively simple solution to decreasing overall energy consumption. While many studies on barriers to energy efficiency (EE) have been conducted throughout the last two decades, slow adoption rates demonstrate a need for more comprehensive analyses on the subject.

The purpose of my research is to address these gaps by studying the literature on EE, and understanding its relevance to specific contexts. The number of Southern Ontario municipal buildings and municipalities' ability to "lead by example" render it an interesting and important sector to study. The aim is to understand the circumstances in which barriers to EE arise within Southern Ontario municipalities, and the implications of these barriers on the use of tools aimed at reducing consumption. Your feedback is crucial to this process! Participation in this study is voluntary. Questions focus on organisational performance in energy efficiency and will explore a broad range of decision-making processes and energy efficiency options within municipal buildings. It will involve completing an online questionnaire, which should take approximately 20 minutes. If you prefer not to complete the survey on the web, please contact us and we will make arrangements

to provide you with another method of participation. You may decline to answer any of the questions if you so wish. Further, you may decide to withdraw from this study at any time without penalty by not submitting your responses or by contacting the researcher. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study. Furthermore, anonymous quotations will be used only if you explicitly permit. Data collected during this study will be retained for two years on a password protected online storage system. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant 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 [redacted] or by email at a2sanfil@uwaterloo.ca. You can also contact my supervisor, Professor Ian Rowlands at 519-888-4567 ext. [redacted] or email [redacted]@uwaterloo.ca.

I would like to assure you that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. 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. Susan Sykes, the Director of this office, at 519-888-4567 Ext. [redacted] or [redacted]@uwaterloo.ca.

I hope that the results of my study will be of benefit to those employed in municipalities across Southern Ontario and that will be involved in future energy management research, as well as to the broader Canadian contexts.
I very much look forward to receiving your survey. Thank you in advance for your assistance in this project.

Yours Sincerely,

Amanda San Filippo

****

CONSENT

I have read the information presented in the information letter above about a study being conducted by Amanda San Filippo under the supervision of Professor Ian Rowlands, 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 also aware that quotations from the questionnaires 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, the Office of Research Ethics at the University of Waterloo. 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. [redacted].

Question 1

By clicking "Yes" I am agreeing to the terms of this research

	YES	NO
With full knowledge of all foregoing, I AGREE, of my own free will, to participate in this study	☐	☐
I AGREE to the use of anonymous quotations in any thesis or publication that comes of this research	☐	☐

Page 2

Question 2

The following questions pertain to general municipal information.
If answers are unknown, please leave blank

What is this municipality's current population?

Approximately how many people are employed by this municipality?

What is the approximate annual turnover of municipal staff?

What is the approximate number of buildings owned and operated by this

municipality?

What is the combined square footage of these buildings?

Please indicate your municipality's approximate annual consumption of electricity (in units)?

Please indicate your municipality's approximate annual consumption of natural gas (in units)?

Please indicate your municipality's approximate annual expenditure ($) on electricity?

And as a percentage (%) of total expenditures?

Please indicate your municipality's approximate annual expenditure ($) on natural gas?

And as a percentage (%) of total expenditures?

Question 3

Please indicate the municipal department for which you work?

Question 4

* Please indicate how many municipal buildings with which you are personally involved in decision-making.
Decision-making refers to decisions related to finances, purchasing and policy development

- ☐ I am involved in decision-making within ALL municipal buildings
- ☐ I am involved in decision-making within SOME municipal buildings
- ☐ I am NOT involved in decision-making within municipal buildings

Page 3

Question 5

Please indicate the number of buildings with which you are involved.

Question 6

Please describe the total approximate annual consumption of electricity of the buildings for which you are responsible (in units)?
If unknown, please leave blank

Question 7

Please describe the total approximate annual consumption of natural gas of the buildings for which you are responsible (in units)?
If unknown, please leave blank

Page 4

Question 8

Please check off the building types for which you are involved in decision-making.

- ☐ Town/City Hall
- ☐ Community/Recreation Centres
- ☐ Fire Halls
- ☐ Arenas
- ☐ Libraries
- ☐ Water and Waste Water Facilities
- ☐ Recycling and Waste Facilities
- ☐ Public Transportation Buildings

Other (please specify)

Page 5

Question 9

	Yes (in all buildings)	Yes (in some buildings)	No	Unknown/Not applicable
Do you monitor trends in energy consumption?	☐	☐	☐	☐
Are weather conditions documented with consumption records?	☐	☐	☐	☐
Is a monitoring and targeting scheme employed?	☐	☐	☐	☐
Is energy performance shared with staff?	☐	☐	☐	☐
If present, are cost centres charged for the energy they consume?	☐	☐	☐	☐

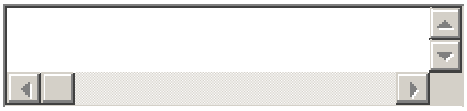
Is consumption compared with benchmarks?	☐	☐	☐	☐
Have you conducted energy audits?	☐	☐	☐	☐
Do you use contract energy management?	☐	☐	☐	☐

Question 10

If you use contract energy management, could you briefly describe the information/services offered under the contract?

Question 11

* To the best of your ability, please describe the general decision-making process related to municipal building management. (Please clearly state your role in this process)



Question 12

* Referring to the buildings for which you are involved in decision-making processes at what level is energy use generally metered?

	Site Building		Individual Equipment	Differs in Every Building	Unknown
Electricity	☐	☐	☐	☐	☐
Natural Gas	☐	☐	☐	☐	☐

Question 13

* Referring to the buildings for which you are involved in decision-making processes, how frequently is energy use generally recorded?

	Annually	Monthly	Bi-Weekly	Weekly	Daily	Differs in every building	Unknown
Electricity	☐	☐	☐	☐	☐	☐	☐
Natural Gas	☐	☐	☐	☐	☐	☐	☐

Question 14

How much do you agree with the following statement:
"There are a wide range of energy efficiency measures that could be implemented within _____ that would yield paybacks of less than five years at current energy prices."

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/ Not applicable
Community/Recreation Centres	☐	☐	☐	☐	☐	☐
Fire Halls	☐	☐	☐	☐	☐	☐
Arenas	☐	☐	☐	☐	☐	☐
Libraries	☐	☐	☐	☐	☐	☐
Water and Waste Water Facilities	☐	☐	☐	☐	☐	☐
Recycling and Waste Facilities	☐	☐	☐	☐	☐	☐
Public Transportation Buildings	☐	☐	☐	☐	☐	☐
Other (please specify)	☐	☐	☐	☐	☐	☐

Question 15

* Please rank the usefulness of each of the following information sources on energy efficiency opportunities:

	Excellent	Good	Average	Poor	Don't Use
Colleagues within the municipality	☐	☐	☐	☐	☐
Network of contacts in the sector	☐	☐	☐	☐	☐
Governmental agencies	☐	☐	☐	☐	☐
Energy manager groups/networks	☐	☐	☐	☐	☐
Professional Associations	☐	☐	☐	☐	☐
Trade/Technical journals Excellent	☐	☐	☐	☐	☐
Technical conferences seminars	☐	☐	☐	☐	☐
Energy supply industry	☐	☐	☐	☐	☐
Equipment suppliers	☐	☐	☐	☐	☐
Consultants	☐	☐	☐	☐	☐

Question 16

The following chart is a "self-assessment" exercise developed by the UK Energy and Environmental Management Division. Please read down each column in turn.

	0	1	2	3	4
Policy	No explicit policy	Unwritten set of guidelines	Unadopted energy policy set by energy manager or senior departmental manager	Formal energy policy, but no active commitment from top management	Energy policy, action plan and regular review with commitment of top management
Organi-sation	No energy management or any formal delegation of	Energy management the part-time responsibility of	Energy manager reports to ad-hoc committee, but line management	Energy manager reports to ad-hoc committee, but line management	Energy management fully integrated in management structure. Clear delegation of

	responsibility for energy consumption	someone with only limited authority or influence	and authority are unclear	and authority are unclear	responsibility for energy consumption
Information Systems	No information system. No accounting for energy consumption	Cost reporting based on invoice data. Engineer compiles reports for internal use within technical department	Monitoring and targeting reports based on supply meter data. Energy unit has ad-hoc involvement in budget setting	Monitoring and targeting reports based on supply meter data. Energy unit has ad-hoc involvement in budget setting	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking
Awareness	No promotion of energy efficiency	Informal contacts used to promote energy efficiency	Some ad-hoc staff awareness training	Programme of staff awareness and regular publicity campaigns	Marketing the value of energy efficiency and the performance of energy management both within and outside the organisation.
Investment	No investment in energy efficiency	Only low cost measures taken	Investment using short term payback criteria	Same payback criteria as for all other investment	Positive discrimination in favour of "green" schemes with detailed investment appraisal of all new building and refurbishment opportunities

Now, using the matrix below, please select the box that corresponds to the self-assessment box most closely related to current practice in your municipality.

	0	1	2	3	4
Policy	☐	☐	☐	☐	☐
Organising	☐	☐	☐	☐	☐
Information systems	☐	☐	☐	☐	☐
Awareness	☐	☐	☐	☐	☐
Investment	☐	☐	☐	☐	☐

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Question 17

The following tables list some common measures for reducing energy consumption. **Please indicate the extent to which your company has implemented each measure by assigning it a number on a scale from 1 (not implemented) to 5 (extensively implemented).**

	1	2	3	4	5	Unknown
Drought-proofing windows, doors and roof-lights?	☐	☐	☐	☐	☐	☐
Fitting windows with double or secondary glazing?	☐	☐	☐	☐	☐	☐
Fitting door closers to external doors?	☐	☐	☐	☐	☐	☐
Use of plastic or forced air curtains in loading bays?	☐	☐	☐	☐	☐	☐
Installation of fans in high ceiling rooms to reduce temperature gradient?	☐	☐	☐	☐	☐	☐
Retrofitting insulation to walls and roofs?	☐	☐	☐	☐	☐	☐
Insulation of distribution pipes, valves and flanges?	☐	☐	☐	☐	☐	☐
Use of boiler sequencing controls?	☐	☐	☐	☐	☐	☐
Replacement of central general hot water with point of use application?	☐	☐	☐	☐	☐	☐
Installation of thermostatic radiator valves?	☐	☐	☐	☐	☐	☐
Programming HVAC controls to match occupancy patterns?	☐	☐	☐	☐	☐	☐
Use of weather compensation and optimum start controls?	☐	☐	☐	☐	☐	☐
Use of Building Energy Management Systems?	☐	☐	☐	☐	☐	☐
Replacement of 38mm fluorescents with 26mm?	☐	☐	☐	☐	☐	☐
Use of high frequency fluorescents in new and replacement fittings?	☐	☐	☐	☐	☐	☐
Replacement of tungsten filament lamps with compact fluorescents?	☐	☐	☐	☐	☐	☐
Replacement of fluorescents with SOX/SON discharge lighting?	☐	☐	☐	☐	☐	☐
Use of localised task lighting in preference to general lighting?	☐	☐	☐	☐	☐	☐
Installation of time controls with manual override?	☐	☐	☐	☐	☐	☐
Use of photocell, acoustic or movement sensors?	☐	☐	☐	☐	☐	☐

Integration of lighting controls in Building Energy Management Systems?	☐	☐	☐	☐	☐	☐
Switch off when there is no demand for air?	☐	☐	☐	☐	☐	☐
Regular inspection and elimination of leaks?	☐	☐	☐	☐	☐	☐
Regular maintenance and condition monitoring?	☐	☐	☐	☐	☐	☐
Generation of compressed air at the minimum required pressure?	☐	☐	☐	☐	☐	☐
Consideration of energy consumption and part load operation when purchasing new compressors?	☐	☐	☐	☐	☐	☐
Pre-cool inlet air or duct air from outside?	☐	☐	☐	☐	☐	☐
Compressor heat recovery?	☐	☐	☐	☐	☐	☐
Insulation of furnaces to economic thickness?	☐	☐	☐	☐	☐	☐
Accurate control of furnace temperature pressure and air/fuel ratio?	☐	☐	☐	☐	☐	☐
Heat recovery from furnaces and process plant?	☐	☐	☐	☐	☐	☐
Power factor correction?	☐	☐	☐	☐	☐	☐
Ensuring replacement motors are not over-sized?	☐	☐	☐	☐	☐	☐
Specification of high efficiency motors on motor replacement?	☐	☐	☐	☐	☐	☐
Use of variable speed drives?	☐	☐	☐	☐	☐	☐
Automatic switch off of pumps, fans, conveyors and their equipment when not required?	☐	☐	☐	☐	☐	☐
Purchase of energy efficient computers, photocopiers and other office equipment?	☐	☐	☐	☐	☐	☐

Question 18

*** The following questions pertain to barriers to energy efficiency improvements.**

Studies by technology researchers commonly identify energy efficiency opportunities that appear to be highly cost effective. The following have been suggested as reasons why such investments are not made. In your view, how important is each suggested reason.

	Often Important	Sometimes Important	Rarely Important	Don't Know
Technology inappropriate at this site	☐	☐	☐	☐
Cost of production disruptions/hassle/inconvenience	☐	☐	☐	☐
Cost of identifying opportunities, analyzing cost effectiveness and tendering	☐	☐	☐	☐
Cost of staff replacement, retirement, retraining	☐	☐	☐	☐
Possible poor performance of equipment	☐	☐	☐	☐
Lack of capital	☐	☐	☐	☐
Strict adherence to capital budgets	☐	☐	☐	☐
Other priorities for capital investment	☐	☐	☐	☐
Technical risk	☐	☐	☐	☐
Business/market uncertainty	☐	☐	☐	☐
Lack of information/poor quality information on energy efficiency opportunities	☐	☐	☐	☐
Difficulty/cost of obtaining information on the energy consumption of purchased equipment	☐	☐	☐	☐
Lack of time/other priorities	☐	☐	☐	☐
Lack of technical skills	☐	☐	☐	☐
Lack of staff awareness	☐	☐	☐	☐
Department/individuals not accountable for energy costs	☐	☐	☐	☐
Energy objectives not integrated into operating, maintenance or purchasing procedures	☐	☐	☐	☐
Low priority given to energy management	☐	☐	☐	☐

Energy manager lacks influence	☐	☐	☐	☐
Conflicts of interesting within the company	☐	☐	☐	☐

Do you have any further comments on barriers to energy efficiency improvement?

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Question 19

* This questionnaire is the first part of a two part study on barriers to energy efficiency within Municipal buildings. The second phase of this study will consist of a telephone or Skype interview or personal interview where possible which should take approximately 45 minutes. The purpose of the interview is to help interpret the responses to the questionnaire. This will help clarify the contexts in which these barriers are found and decipher the most effective and efficiency tools needed to overcome these barriers.

Similar to the questionnaire you have just completed, any information or quotations you provide will remain anonymous. Again, the interview should take approximately 45 minutes and can be scheduled at your convenience.

Would you be interested in participating in an interview?

☐ Yes

☐ No

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Question 20

Thank you for your interest in participating in an interview! In order to schedule an interview, your contact information is needed. This information will be secure and will not be shared with any other parties. Please indicate your preferred method of communication.

Personal information will strictly be used to contact you for the purpose of conducting the interview. Quotations and information used in any publications will remain anonymous. Names and contact information provided will be stored separately from the questionnaire responses

and will not be linked in any way.

Name

Municipality

Email:

Phone number:

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Question 21

Thank you for taking the time to complete the questionnaire!

If you are interested in receiving more information regarding the results of this study, or if you have any questions or concerns, please contact me either by phone at [redacted] or by email at [redacted]@uwaterloo.ca. If you would like a summary of the results, please let me know, and I will send it to you by email when the study is complete. The study is expected to be completed by December 2011.

Should you have any comments or concerns you could also contact Dr. Susan Sykes of our Office of Research Ethics by phone at 519-888-4567 Ext. [redacted] or by email at [redacted]@uwaterloo.ca. This project was reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. Please let me remind you that all information collected from participants in this study will be kept anonymous.

Please do not hesitate to contact me if you have any further questions or concerns.

Amanda San Filippo

Appendix C

Interview Introduction and Consent

Dear ***(insert participant's name):***

Thank you for your interest. I am delighted that you are willing to participate in this study.

Attached is a copy of the questions as well as an information-consent letter. Depending on your preferred method of contact, you will be asked to provide either written or verbal consent for your participation in the study at the time of the interview. As a reminder, I would like to assure you that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes, the Director of this office, at [redacted] Ext. [redacted] or [redacted]@uwaterloo.ca.

Once again, thank you for your interest and I look forward to speaking with you.

Sincerely,

Amanda San Filippo

Attached Consent Form and information

University of Waterloo

200 University Avenue West
Waterloo, ON N2L 3G1
(519) 888-4567

Date

Dear ***(insert participant's name):***

This letter is an invitation to consider participating in the second phase of a study I am conducting through 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 study and the significance of your involvement in this research.

Issues such as climate change, the 2003 blackout, the removal of coal plants and the cost of replacing nuclear facilities have many questioning Ontario's energy future.

Ontario Bill 150, the Green Energy and Green Economy Act, is an important example that the province recognises the necessity of redesigning current energy systems. Progress continues to be made through the adoption of renewable energy sources as well as the development of increasingly efficient technologies. Although the rate of increase of energy consumption is slowing, overall consumption continues to rise. This demonstrates a need to continue to study ways of increasing the adoption of energy efficient measures, which is considered a relatively simple solution to decreasing overall energy consumption. While many studies on barriers to energy efficiency (EE) have been conducted throughout the last two decades, slow adoption rates demonstrate a need for more comprehensive analyses on the subject.

The purpose of my research is to address these gaps by studying the literature on EE, and understanding its relevance to specific contexts. The number of Southern Ontario municipal buildings and municipalities' ability to "lead by example" render it an interesting and important sector to study. The aim is to understand the circumstances in which barriers to EE arise within Southern Ontario municipalities, and the implications of these barriers on the use of tools aimed at reducing consumption. Your feedback is crucial to this process!

Participation in this study is voluntary. It will involve an interview which should take approximately 45 minutes. You may decline to answer any of the 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. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study. Furthermore, anonymous quotations will be used only if you explicitly permit. With your permission, the interview will be audio-recorded to facilitate collection of information. Data collected during this study will be retained for one year on a password protected online storage system. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant 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 [redacted] or by email at [redacted]@uwaterloo.ca. You can also contact my supervisor, Professor Ian Rowlands at [redacted] ext. [redacted] or email [redacted]@uwaterloo.ca.

I would like to assure you that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. 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. Susan Sykes, the Director of this office, at [redacted] or [redacted]@uwaterloo.ca.

I hope that the results of my study will be of benefit to those employed in municipalities across Southern Ontario and that will be involved in future energy management research, as well as to the broader Canadian contexts.

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

Yours Sincerely,

Amanda San Filippo

CONSENT FORM (to be completed at time of interview)

I have read the information presented in the information letter about a study being conducted by Amanda San Filippo under the supervision of Professor Ian Rowlands, 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 interview, 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 quotations from the key informant interviews 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, the Office of Research Ethics at the University of Waterloo. 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 [redacted].

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

☐YES ☐NO

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

☐YES ☐NO

I agree to have my interview audio-recorded, for the purpose of ensuring an accurate recording of my responses.

☐YES ☐NO

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

Date: _____

Appendix D

Interview Questions

Background

- What are your principal responsibilities within the municipality?
- What proportion of your time is devoted to energy compared to other issues?
- How long have you been in this post?
- What is your professional background?

Energy policy

- Does the municipality have an Energy/Environmental Policy?
  - *What form does it take (e.g. Use of targets/action plan/designated responsibility and accountability, etc.)?*
  - *How long have these policies been in place? What impact has this policy had on energy decision-making and the municipality's energy performance?*
  - *What have the energy/environmental policies achieved?*
- Is the municipality certified to an environmental management scheme, such as ISO 14000? Does it intend to certify?
- Are provisions for achieving energy/environmental policy objectives included in other policy documents, such as purchasing or maintenance?
- Has this municipality considered changes needing to be implemented due to the adoption of the Ontario Green Energy Act? If so, what changes are being considered?

Energy management

- Could you please describe/draw and email a simplified version of the municipal organisation diagram, describing key individuals and departments' division with responsibility for energy decision-making.
- Does the municipality have a committee wholly or partly responsible for energy matters? *If so, what is the membership/title of this committee? How does it function?*
- Who, within the municipality, do you interact with on a regular basis?
- Is energy management an in-house activity or are energy service companies, consultants or energy suppliers used? What is the rationale for this choice?

Power

- How would you assess the status of energy management within the municipality*(high/medium/low)?
- How does this status affect energy management activities?
- How much does status depend on formal authority and how much does it depend on other factors such as the support of key individuals (a lot/a bit/ not at all)?
- Are there areas where you would like to have influence but do not (ex. Equipment purchasing, building specification)?
- Are there conflicts of interest within the municipality that inhibit energy management activities?

Investment

- Could you describe the decision-making process for investments in energy efficiency? Who are the key individuals/committees involved?
- *What are the biggest obstacles in this process? How could it be improved?*
- What criteria are used for appraising energy efficiency investments? *How do these differ from other categories of investment? What are the reasons for this choice of criteria?*
- *Are the investments criteria feasible or restrictive?*
- Is there a portfolio of properly justified and costed projects that could be implemented?
- How are investment projects prioritised? *What factors are taken into account?*
- Who has the final say?

Energy information systems (relate to answers in Questionnaire)

- What information is available to you on organisational energy consumption?
  - *To what extend is energy sub-metering used in the municipality?*
  - *Is information available on trends in energy consumption?*

    - *Is information available on the performance of previous efficiency investments and the savings achieved?*
- Is the energy performance of the municipality compared against sector of generic benchmarks? *Where are these used?*
- Is a monitoring and targeting scheme in operation*? How is it used?*
- What information is disseminated to top management and other individuals? *How effective are these reporting requirements?*
- Are you happy with the quality of current information systems? *How could they be improved? What are the obstacles to such improvement?*

Information on efficiency opportunities

- Do you consider that you have adequate information on energy efficiency opportunities?
- Have any energy audits been conducted? Are they planned?
- Do you consider that you have adequate information on the needs of building and equipment users?
- Is the primary problem a lack of information, or constraints on using existing information (e.g. lack of technical ability; lack of time)?
- Which information sources on energy efficiency opportunities are used and why?
- Which information sources do you place the greatest trust in and why?
- Are you aware of any government sponsored information programmes? *How useful are they*?
- How could the quality of information be improved?

Accountability

- What are the arrangements for charging energy costs? Are subdivisions (individual buildings, such as town halls or water and waste plants) charged individually?
- To what extent can individual subdivisions influence their own energy costs?
- Are energy budgets and the responsibility for energy management devolved to individuals divisions?
- How are the benefits from efficiency investments distributed?
- Are targets for energy budgets identified?
- Are there any incentives created for subdivisions and staff? How effective are they?

Performance

- Do you know the energy savings achieved by your company over the past five years or so?
- Have energy savings measures been taken up for other reasons than to save energy (environmental reasons, such as emissions, odour)?
- *What types of energy efficiency measures have been implemented?*
- How would you rate your company's performance on energy efficiency?

Capital

- Is there a separate budget for energy efficiency investment?
    - *If yes: How large is it? (Percentage of utility spend?) How is it set? How has this changed over time?*
    - *If no: How is energy efficiency investment funded?*
- *How has this budget been spent over the last financial year?*
- *Is this budget allowed to be carried forward if unused at year end?*
- *How does capital availability affect the type of projects that can go ahead?*
- *Do you borrow for the purposes of investment in energy efficiency?*

Overhead costs of energy management

- Which people are engaged in energy management activities? What are the estimated annual person-hours devoted to energy management?
- Do you know the estimated annual costs devoted to energy management activities?

Hidden costs

- Are the following considered when evaluation efficiency investments? *How do you take account of them?*
    - Overhead costs of energy management
    - Disruptions/hassle/inconvenience
    - Cost of identifying opportunities, analyzing cost effectiveness, tendering and seeking approval for expenditure
    - Staff replacement, retirement, retraining
    - Potential loss of benefit (e.g. unreliability, extra maintenance)
- Have there been cases when additional costs were the reason for rejecting a project?
- *Which technologies are particularly associated with such hidden costs?*

Risk

- What, in your opinion, are the main risks facing your municipality (e.g. economic trends; political decisions, etc.)?
- What impact have these had on energy efficiency investment (e.g. through strict investment criteria)?
- Have there been cases where technical risk has inhibited the adoption of energy efficient technologies?

Equipment purchasing

- What influence do you have over equipment purchasing decisions? How does this vary between different types of equipment?
- *In situations where you have an influence, what level of information is typically available on the energy performance of equipment? How difficult is it to obtain additional information on energy performance?*
- *In situations where you do not have an influence, do you think energy efficiency is considered? If not, why not?*
- How important are written rules and procedures in purchasing decisions? Does energy efficiency feature in these rules?

Culture

- How important is environmental performance compared to cost saving in organisational decision-making on energy efficiency?
- Do you perceive any internal pressures to improve environmental performance (e.g. colleagues, etc.)? *How important are these pressures?*
- Do you perceive any external pressures to improve environmental performance (e.g. government, media, NGOs, local community, industry sector, etc.)?
- Is senior management seriously committed to improving the environmental performance of the company? How widely is this commitment shared throughout the company?
- How important have changes in management and other key posts been in changing organisational performance on energy efficiency?

Awareness

- Have there been any actions taken regarding energy awareness campaigns, energy training and incentive schemes? If yes, how effective have these been?

Perceptions of barriers

- Many studies have suggested that there are a large number of energy efficiency opportunities that are highly cost-effective at current prices. Do you think this is the case within your municipality? If not, why not? If so, why are these opportunities not taken up?
- What d you see as the biggest obstacle(s) to improving energy efficiency in municipal buildings?
- Which energy savings opportunities are currently not taken up but could be profitably taken up in the future? (wish list)

Government Policy and ESCO's

- Do you consider contract energy management to be an attractive option for your municipality? If not, why not? If yes, then for which functions are they most appropriate?
- What are your views on the effectiveness of government policy on energy efficiency, as this impacts your municipality?
- Do you benefit from governmental programmes (information, subsidies, tax breaks, etc.)?
- How should provincial/federal governments act to improve energy efficiency within municipal governments? What do you consider to be the best instruments for improving energy efficiency?

Personal

- How long do you expect to remain in your current position?
- How is your performance in this position rewarded?
- Do you personally benefit from energy savings?
- What influence does this have on you choice of investments projects?
- Do you think that shorter-term financial savings gets more recognition within this municipality than longer-term savings as a result of energy efficiency?