THE ROLE OF LOCAL GOVERNMENTS IN ADVANCING ENERGY EFFICIENCY FOR BUILDINGS: A BRITISH COLUMBIA CASE STUDY

by

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Abstract

There is little doubt that local governments in Canada have a major role to play in addressing greenhouse gas emissions (GHGs). Considering about 50% of the nation's GHGs are under the direct or indirection influence or control of local governments, and the fact that local governments are well-positioned to reduce emissions through land use, energy and transportation planning, the question is not so much whether there is a role for municipalities but rather what ought that role be. The thesis draws on a Community Energy Management (CEM) conceptual framework in order to define the relationship between planning decisions and energy use. Following an analysis of buildings' energy use and associated greenhouse gas emissions, potential energy technologies and design practices that reduce buildings' secondary energy use and emissions are explored. Using British Columbia as a case study, this thesis explores the policy instruments available to local governments to advance effective energy efficiency related policies. Though local governments across Canada and beyond operate in distinct statutory environments, the case study aims to provide some general insight about how to improve the energy performance of buildings, and reduce emissions. From the case study I derive recommendations for all local governments and explore the policy implications of the findings. This thesis demonstrates there is a range of at-hand policy instruments local governments can readily utilize in order to realize the necessary conditions for a more energy efficient built environment.

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1. Introduction

1.1. Context for Local Government Action on Greenhouse Gas Emissions

There is little doubt that local governments in Canada have a major role to play in addressing greenhouse gas emissions (GHGs). Considering about 50% (or 350 megatonnes) of the nation's GHGs are under the direct or indirection influence or control of local governments, and the fact that local governments are well-positioned to reduce emissions through land use, energy and transportation planning, the question is not so much whether there is a role for municipalities but rather what ought that role be (Federation of Canadian Municipalities, 2007).

In Canada, most of the policy that directly controls energy use and emissions exists at the provincial or federal level of government (Natural Resources Canada 2000). However, when it comes to the built environment, local governments exert considerable control and influence. There is broad recognition in the literature of the potential for local governments to influence energy consumption of buildings (Lantsberg 2005, Steemers 2003, Norman et al 2006, Owens 1986, Holden and Norland 2005).

Residential and commercial buildings account for over 30% of Canada's secondary energy[1] use and about 11% of total greenhouse gas emissions (Natural Resources Canada 2006e, Environment Canada 2003). Most of the energy use and related emissions is attributable to space and water heating. Given that local governments are a key point of contact in the building development process, a greater focus on reducing buildings' energy consumption and related emissions will significantly contribute to global emissions abatement.

1.2. Purpose and Objectives

The research question for this thesis is what effective policy instruments are available to local governments to reduce buildings' secondary energy use and the associated emissions. To answer this question, I explore numerous energy technology and design practices that reduce buildings' secondary energy use and emissions. These technologies and practices require

[1] Secondary energy is energy generated or rendered from oil, coal, natural gas and other forms of primary energy to provide energy services such as mobility, light, and heat. Examples of secondary energy include hydrocarbons, electricity and hydrogen.

specific conditions – e.g. density, mixed use, heat load and/or site orientation – in order to be viable. I determine those conditions and then explore how local governments can help create them. I show there are a range of available policy instruments local governments can readily utilize in order to realize the necessary conditions for a more energy efficient built environment.

Specific objectives of this thesis are to:

1. Establish a conceptual framework for interpreting the connection between local planning decisions and energy use;
2. Analyse Canadian residential and commercial buildings' energy use and emissions;
3. Analyse energy technologies and design practices that reduce energy use and emissions, and the necessary conditions for them to be effective and/or viable;
4. Conduct a case study of effective policies available to local governments within the British Columbia, Canada statutory environment;
5. Discuss the policy findings;
6. Recommend a course of action for local governments to play a greater role in reducing residential and commercial buildings' energy use and emissions; and,
7. Explore the policy implications of the findings for achieving greater energy sustainability.

1.3. Energy Planning and Local Government Inertia

Across North America, California is generally regarded as a leader in energy efficiency and greenhouse gas emission abatement at the sub-national level. Some recent advances in Californian local-level urban energy planning can inform our understanding of the opportunities and barriers that generally prevail.

As part of his report to the California Energy Commission on sustainable urban energy planning, Lantsberg (2005) conducted an extensive literature review and interviewed municipal officials and energy experts to understand the barriers to local urban energy planning. He contends:

> Local governments are the primary regulatory decision-makers over urbanization with vast powers to shape where and how land is developed, through the traditional planning tools of zoning and permitting. General plans are the main mechanism for setting local (and to an extent, regional) development priorities; however, energy-related considerations are not a requirement and often do not receive much attention in the overall long-term land-use planning process. (18)

Lantsberg's conclusions are, arguably, applicable to the Canadian local government context, where energy-related planning is for the most part also not required. He notes several obstacles that prevent greater local government participation in sustainable energy management, including lack of knowledge of options, an absence of history in dealing with energy issues, scarce resources, regulatory barriers, and "institutional mismatches between overall system issues and the scope of local action" (1).

Exploring the California example further, some of the reasons for the lack of local government uptake become clearer. In 2004, the California Public Utilities Commission launched an extensive process to clarify barriers and develop decision support tools for local governments to develop community-wide energy efficiency strategies The complexity and extent of the barriers warranted a two-year, state-wide local government-oriented consultation process. Barriers noted in the "Local Energy Efficiency Program Workbook" (CALeep 2006) include:

- Energy efficiency is a low priority relative to other day-to-day issues central to local government responsibility (e.g. maintaining services, providing amenity, government administration, etc).
- Energy efficiency is an unknown concept to many city managers. Municipal staff tend to be "more focused on implementing policy decisions that have already been made and that they are comfortable with, not on developing and implementing new ones" (7).
- Lack of enthusiasm to learn the skills necessary to develop and implement energy efficiency programs.
- Limited resources for new planning activities.
- Limited knowledge of energy efficiency, including a lack of understanding of benefits. "This limits the perception of the value of energy efficiency" (7).

In 2005, the American Planning Association and the Environmental and Energy Study Institute conducted a national survey to assess planners' role in integrating energy issues into community planning. The survey had a 7.9% return rate and was determined to be statistically significant. Sixty five percent of the population felt energy issues are very connected to planning (Lewis et al 2006). However, the authors of the study concluded that "planners are not yet using standard planning regulatory tools to increase energy efficiency and the use of renewable energy," further noting zoning, development controls, and siting as "missed opportunities for planning to address energy issues" (ibid, 17).

Given the leverage local governments have over how and where development occurs, a localized approach appears to be, in theory, an effective way to advance energy efficiency. Yet numerous barriers aid and abet decision-making inertia. Given the lack of policy action on energy issues, it seems reasonable to suggest that energy-related policies that fit within the existing planning framework – namely, what municipal staff already understand and are comfortable with – will likely enjoy greater uptake.

1.4. Research Method

This thesis relies on the literature to adopt a Community Energy Management (CEM) conceptual framework in order to define the relationship between planning decisions and energy use. Research and analysis of Natural Resources Canada data on energy use and emissions follows. I then explore the literature, consulting reports and government publications to identify potential energy technologies and design practices that reduce buildings' secondary energy use and emissions, noting the necessary conditions for them to be viable. I only explore technologies and design practices to identify – at a high-level – threshold conditions to make them viable. These are basic conditions that have to be met in order to make the technology or design practice economically and/or technically viable. However, because this is not a financial or economic evaluation-oriented thesis, I will not delve into an exploration of financial or societal costs and benefits. This thesis attempts to further knowledge in the realm of urban planning and policy, so the thesis is tailored to this knowledge area.

Using British Columbia as a case study, I explore the policy instruments available to local governments to advance effective energy efficiency related policies. The findings of the case study are based on:

- A literature review of the dominant statutes governing local governments in British Columbia (the Local Governement Act and the Community Charter);
- A review of planning and policy documents from over 30 local governments that participated in the Community Action on Energy and Emissions project (CAEE 2007);
- Personal contact (email, telephone calls, and in-person) over two years interacting with local government planners, engineers and building officials as the project consultant for the Community Action on Energy and Emissions project (CAEE 2007);
- Three private consulting projects that I participated in over two years that were specifically aimed at identifying local government policy instruments that can be used to advance energy efficiency for buildings (Canadian Geo-Exchange Coalition 2007, Fraser Basin Council 2007, The Sheltair Group 2006).

Though local governments across Canada and beyond operate in distinct statutory environments, the case study aims to provide some general insight about how to improve the energy performance of buildings, and reduce emissions.

The policy scoping exercise is limited in two ways. First, though the research process is thorough, due to scope it is not possible to fully explore all of British Columbia's local governments' policy documents for energy-related policies. Secondly, many of the policies that local governments are currently using may be legally challenged at some point, and may prove to be beyond the enabling power local governments have. It is critical to note the even though a policy may be well-established, it does not necessary mean it can withstand legal challenge. Third, there may be latent enabling power in the provincial statutes that no local government has discovered, not was discovered through the research conducted for this thesis. So while this thesis attempts to be comprehensive, it is possible that there are policies and opportunities that remain undiscovered.

Five criteria are established to evaluate each of the policies. The criteria are for the purposes of framing a discussion of the pros and cons of each policy. I do not conduct a formal evaluation, which would require a formal survey aimed at planners. The reason I do not conduct a formal survey is because the purpose of this thesis is to identify policies that advance energy efficiency in buildings, not formally evaluate them. That is something further research could carry out. My evaluation discussion is informed by input received during the aforementioned consulting projects on energy efficiency and local government policy (ibid).

From the policy case study I derive recommendations for all local governments and explore the policy implications of the findings.

1.5. Scope

This thesis focuses on the governance aspect of advancing energy efficiency within the built environment. The primary focus is on policies rather than specific measures. Thus, it is a strategic analysis versus one that focuses on the technical or economic viability of specific energy efficiency measures. The technical and economic viability of any given energy technology needs to be assessed in detail while considering a broad range of economic, technological and site specific variables[2]. The findings of this thesis will provide the foundation for further, more detailed, analysis of specific measures in site specific contexts.

The scope is limited to energy use associated with building operations and does not include embodied energy (e.g. the energy used in rendering the construction materials). I also do not consider transportation energy use and related emissions; the reason for this is the extensive amount of research already available in the literature[3].

1.6. Significance of Thesis

Being a planning thesis, this investigation aims to work from the literature toward practical solutions. The operational-level significance of this thesis is two-fold. First it will give local

[2] As noted in Jaffe et al (1999) there are numerous important variables to consider during an economic-engineering analysis of the financial viability of a technology, including: purchaser's discount rate, investment lifetime, energy prices, and capital costs. Heterogeneity in any one or all of these factors leads consumers to derive different expectations of energy technologies, and this informs their investment decision.

[3] For example, see Newman and Kenworthy 1989, Frank and Pivo 1995, Frank et al 2000, Cooper et al 2001, Tong and Wong 1997.

governments a coarse indicator of whether threshold conditions currently exist for a range of energy technologies and design practices. Secondly, where threshold conditions do not exist, this thesis will inform policy decisions to hopefully achieve those conditions. The growing interest around energy and emissions management among all local governments makes this thesis timely.

2. Community Energy Management: A Conceptual Framework

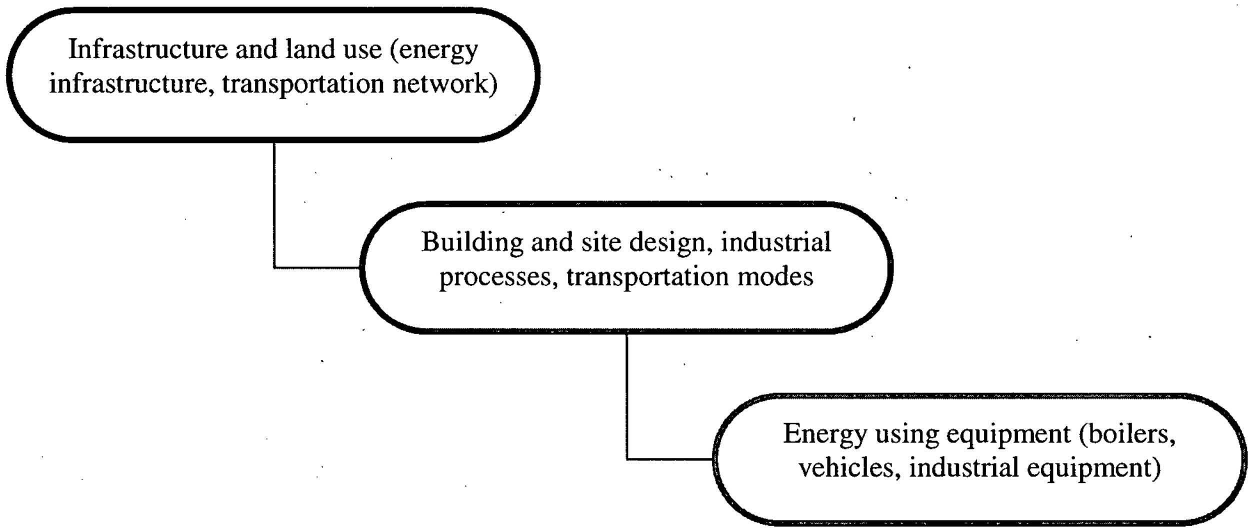
In the article "From equipment to infrastructure: community energy management and greenhouse gas emission reduction," Jaccard et al (1997) explore the concept of community energy management (CEM). Community energy management combines planning concepts with energy management concepts to optimize the overall energy performance of an urban system. For example, combining the concept of mixed land use and energy cascading[4] can create the urban conditions for capturing the waste heat from an industrial operation in order to provide heat for nearby commercial or residential needs (ibid).

Community energy management is regarded as "consistent with and in many ways a synthesis of a variety of planning initiatives such as *neo-traditional urban design, complete communities* and *green cities*" (ibid, 1066). These schools of urban planning tend to be motivated more by a concern for air quality, public amenities, green space and livability than energy throughput of the urban system. Yet the synergies are relevant factors because they align many of the objectives of community energy management with more mainstream and widely accepted planning concepts. Typical planning objectives such as higher density and mixed use are often pursued under the rubric of livability and Smart Growth, yet can establish the foundation for energy-related co-benefits.

As demonstrated in Figure 1, energy related decisions exist within a decision-making hierarchy, where higher level decisions have the potential to influence decisions made further down the hierarchy.

[4] Capturing the waste energy (i.e. heat) of an upstream process to provide an energy service elsewhere. An example is co-generation. Thermal electricity generation produces heat, which can be input into a district heating system to provide space conditioning for nearby buildings.

Figure 1: Energy Related Decision-making Hierarchy



Adapted from Jaccard et al, 1997.

Land use and infrastructure decisions are at the top of the hierarchy because they have long-term impacts and influence the energy decisions in the two lower levels. Building and site design decisions often directly influence the choice of energy using equipment for buildings yet are often subject to previously-made land use decisions. Energy-using equipment is at the bottom of the hierarchy because these decisions have less impact and tend to be determined by decisions further up the hierarchy.

To illustrate, consider a district heating system, which is the result of land use and infrastructure decisions. A district heating system is a highly efficient heat and hot water system that connects the hydronic (hot water) or forced air heating systems of buildings to a central, shared boiler. The shared boiler serves as a mini power plant, displacing the need for individual furnaces or boilers. District heating systems require distribution infrastructure to deliver the thermal energy to buildings as well as minimum building density and heat demand in order for the energy system to be cost effective. Ensuring new buildings are compatible with the district system (i.e. system-ready) requires appropriate building and site design controls. The building's heat supply system determines the mechanical and architectural design of the building, which in turn effects equipment decisions at the bottom of the energy decision hierarchy.

As shown in Table 1 there are also three dimensions of the energy-related decision hierarchy: the spatial, temporal and decision-making dimensions (ibid).

Table 1: The Three Dimensions of Energy-related Decisions

Energy-related decision	The Three Dimensions Time	Space	Private/public
Land use and infrastructure	Years to decades	A lot	Public
Building and site design	One to three years	Moderate	Public/private
Energy using equipment	Less than one year	Little	private

Land use planning decisions can have a greater influence but take longer to implement, require more space, yet are within the realm of local government influence. Building and site design decisions can be quick wins, require less space and are often the result of a combination of public and private decision decision-making. Energy using equipment decisions require relatively little space and time to implement, yet are not usually within the realm of local governments' influence.

This thesis will focus on land use and site level decisions. Due the greater impact of land use and infrastructure decisions, and the public nature of such decisions, this is the preferred focus area for local governments. Building and site design decisions are also highly effective because of the partial public dimension and the propensity for such decisions to determine energy-using equipment. As well, site level decisions are realized in shorter time frames, so they provide an opportunity for near-immediate results. In Canada, energy using equipment is typically subject to federal and provincial performance standards, so this will not be a focus area for this thesis.

The CEM framework provides a useful conceptual model for thinking about energy-related policies and their effect on energy consumption.

3. Buildings' Secondary Energy Use and Emissions

Secondary energy consumption is "energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes" (Natural Resources Canada, 2006b). Natural Resources Canada's Office of Energy Efficiency publishes a secondary energy end use data handbook, an inventory of energy use by sector and end use. Table 2 shows Canada's end use by sector.

Table 2: Canada's Secondary Energy Use by Sector, 2003 (Petajoules[5])

Secondary End Uses	2003 (PJ)	% of total	Total growth 1990-2003
Buildings			
Residential	**1,457.6**	**17.2%**	**13.0%**
Space Heating	873.4	10.3%	11.7%
Water Heating	311.8	3.7%	15.6%
Appliances	189.0	2.2%	7.1%
Lighting	65.6	0.8%	23.4%
Space Cooling	17.7	0.2%	112.8%
Commercial/Institutional	**1,180.9**	**14.0%**	**36.2%**
Space Heating	644.0	7.6%	44.0%
Water Heating	76.2	0.9%	49.0%
Auxiliary Equipment	106.1	1.3%	25.3%
Auxiliary Motors	114.1	1.3%	11.3%
Lighting	158.1	1.9%	17.6%
Space Cooling	73.4	0.9%	93.2%
Street Lighting	9.0	0.1%	0.6%
Other Secondary End Uses			
Transportation	**2,361.3**	**27.9%**	**25.7%**
Agricultural	**211.9**	**2.5%**	**6.4%**
Industrial	**3,245.7**	**38.4%**	**19.4%**
Total	8,457.3	100.0%	

Source: Natural Resources Canada (2006c).

[5] One petajoule is 10^{15} joules. A joule is a standard unit of energy. A petajoule is equivalent to 30 million kilowatt-hours. A typical house in BC requires about 30,000 kWh per year.

Residential and commercial buildings account for about 30% of Canada's total secondary energy use. The remainder is attributed to the transportation (28%), industrial (38%) and agricultural sectors (3%) (ibid).

Space heating in the residential and commercial sectors combined accounts for 18% of secondary energy end use, and should be a key focus area. Water heating in the residential sector also requires attention. One area of concern is the growth rate of space cooling from 1990 to 2003. Though relatively little secondary energy use is attributable to air conditioning, the significant growth rate between 1990 and 2003 in both sectors (112% and 93%) suggests this end use will require attention in the future.

Natural Resources Canada also provides data for the emissions associated with secondary energy end use. Table 3 provides a summary.

Table 3: Canada's GHG Emissions by Sector, 2004 (Megatons of CO2e)

Secondary End Use	2004 (Mt)	% of total emissions	Total growth 1990-2004
Buildings			
Residential	**76.7**	**15.2%**	**10.3%**
Space Heating	41.3	8.2%	3.4%
Water Heating	19.2	3.8%	13.8%
Appliances	11.5	2.3%	21.2%
Lighting	4.0	0.8%	40.2%
Space Cooling	0.8	0.2%	77.8%
Commercial/Institutional	**67.9**	**13.4%**	**42.0%**
Space Heating	34.1	6.7%	33.7%
Water Heating	5.7	1.1%	56.4%
Auxiliary Equipment	10.2	2.0%	124.3%
Auxiliary Motors	6.0	1.2%	14.3%
Lighting	7.1	1.4%	14.2%
Space Cooling	4.2	0.8%	101.3%
Street Lighting	0.5	0.1%	-2.0%
Other End Uses			
Transportation	**176.4**	**34.9%**	**30.6%**
Agricultural	**14.7**	**2.9%**	**7.1%**
Industrial	**169.7**	**33.6%**	**19.7%**
Total	505.4	100.0%	

Source: Natural Resources Canada (2006c).

Emissions from residential and commercial secondary energy end use accounts for 15% and 13% of Canada's end use emissions respectively, for a total of about 28%. Transportation (35%), Industrial (34%) and Agricultural (3%) emissions account for the remainder (ibid). Residential space and water heating require the greatest attention. Emissions related to commercial space heating also warrant attention. Not unlike the growth in energy consumption for space cooling, the growth rate of emissions related to cooling is significant but overall emissions are negligible.

The large growth of emissions related to commercial auxiliary equipment is notable, as is the total emissions of this end use. Auxiliary equipment includes devices such as computers, refrigerators and copiers, as well as appliances that are powered by natural gas, propane and other fuels. Referring to the community energy management framework outlined in section 2, energy using equipment is mostly the domain of private sector decision making. For this reason, I will not address these energy end uses or their related emissions because they are generally beyond the realm of municipal government influence.

Most of a building's energy consumption is linked to a need for heat, whether for water or space heating. These end uses also lead to the majority of emissions related to buildings.

4. Potential Energy Technologies and Site Design Practices

There are literally thousands of technologies and design practices that will reduce a building's energy consumption and associated emissions. Drawing on the community energy management framework, I chose to focus on technologies and site design practices at the land use/infrastructure level and building/site scale because they are higher up in the energy decision-making hierarchy. Based on the analysis of buildings' secondary energy end use and related emissions, I focus entirely on technologies and site design practices that reduce buildings' consumption of energy for heat. Where relevant, I identify a technology's potential for reducing energy use for cooling as a co-benefit.

Table 4 categorizes five potential energy-saving technologies or design practices according to where they fit in the energy-related decision-making hierarchy.

Table 4: Energy Technology or Design Practices

Level of energy-related decision	Energy technology or design practice
Land use and infrastructure	• Increased density • District energy
Building and site design	• Geo-exchange • Passive solar site and building design • Building performance standards

This thesis focuses on district heating, geo-exchange, passive solar site and building design, and building performance standards because they are well-established technologies or design practices. Surprisingly, little work has been done on the effect of density on buildings' energy use. For this reason, I also consider density a potential design practice and explore its potential to influence energy consumption in greater detail.

4.1. Increased Density

There is a vast body of literature on the causal relationship between urban development patterns and transportation energy-related impacts (Newman and Kenworthy 1989, Frank and Pivo 1995, Frank et al 2000, Cooper et al 2001, Tong and Wong 1997). However, there has been far less research conducted on the effects of alternative development patterns on energy use of buildings and infrastructure (Lantsberg 2005, Steemers 2003, Lariviere and Lafrance

1999). Examining the literature, it is evident that alternative development patterns can influence buildings' energy use, but not in the absence of some key considerations.

It is often assumed that higher density development is more energy efficient due to its lower exterior wall surface area. Shared walls, ceilings and floors result in less heat transfer between the indoors and outside (Norman et al 2006, McMullan 2002). Where there is less heat transfer, there is a lower heating load, and thus less demand for heating service derived from secondary energy.

Norman et al (2006) conducted an empirical analysis of the energy and greenhouse gas emission implications associated with high versus low density residential urban development. Two Toronto, Canada case studies were compared: a multi-story condominium project in the downtown core and a low-density residential subdivision in the suburban fringe[6]. Low-density residential development was found to use 1.8 times more energy per capita than its higher density counterpart. The same factor was true for greenhouse gas emissions. The authors' findings were "consistent with other studies that have shown single-family houses use approximately twice as much energy as multiunit buildings (Diamond, 1995)" (17). On a per capita basis, therefore, higher density residential is preferable to low density when considering a building's operating energy.

Norman et al's findings are different, however, if the functional unit of measurement is living area. When the two development patterns are compared according to energy use per square metre of floor space, the low density example uses less energy per square metre[7]. As shown in Table 5, if we isolate the energy intensity of space heating, we see that even if the functional unit of measurement is floor space area, lower density building types are more energy intensive.

[6] The multi-family building was 150 dwelling units per hectare and the residential subdivision was 19 dwelling units per hectare.

[7] The reason for this is best explained in Natural Resources Canada's Survey of Household Energy Use – 2003 (2006b). The survey demonstrates there is a negative relationship between heated area (m^2) of a dwelling and its energy intensity (GJ/m^2). So, as heated area increased, energy intensity decreases, and vice versa. This would suggest that larger dwellings are more energy efficient, though such a conclusion would be mistaken. The survey notes two potential reasons for this. First, residential dwellers are likely to own and operate the same amount of major energy-using equipment (e.g. fridge, stove, washing machine, dryer) regardless of dwelling type. Thus, an energy using product will have a greater impact on the energy intensity ratio in a smaller dwelling unit than it would in a larger unit. The second reason is the tendency in Canada for larger dwellings to be constructed more recently, benefiting from superior energy efficiency building designs.

Table 5: Heating Energy Intensity, by Building Type, 2003

Building Type	Space Heating Energy Use (GJ)	Floor Space by Building Type (million m2)	Space Heating Energy Intensity (GJ/m2)	SHEU 2003 Energy Intensity (GJ/m2)
Single Detached	641,197,035	1,016	0.63	1.00
Single Attached	71,598,460	158	0.45	0.95
Apartments	104,928,062	319	0.33	1.10

Sources: Natural Resources Canada (2006c) and Natural Resources Canada (2006b).

Table 5 shows how energy intensity of heating gradually increases as density decreases. Applying this to Norman et al's study, it would not be unreasonable to suggest that, in terms of energy use for space heating, higher density residential development is still preferable to lower density even when the functional unit is floor space. Considering majority of residential energy use is for space heating, this is something for future research to take into account.

Holden and Norland (2005) examined the household energy use of eight residential areas in Oslo, Norway. They distinguish between low density housing areas (single family houses and row housing) and high density areas (row housing and multi-family). The authors analyse survey and energy use data using multiple regression analysis to isolate the effect of single independent variables, one of which is housing type. They conclude that "per capita average energy consumption for single-family housing, row houses and multifamily housing is approximately 12,000; 9,000 and 8,000 kWh, respectively" (Holden and Norland 2005, 2160). Residents in single family housing use 50% more energy than those in multifamily housing. Size and age of the house are the second and third most important factors. The larger the house, the more energy each household member uses. As for house age, from 1980 onwards the difference in per capita energy consumption between single family and multifamily is reduced by 50%. This pattern should be carefully watched, as it may, over time, require those who promote higher density residential patterns by denouncing the energy profiles of lower density residential development to rethink their position (Holden and Norland 2005).

In their comparison of the electricity consumption per capita of the 45 most populous cities in Quebec, Lariviere and Lafrance (1999) find high density cities use less electricity per capita than low density cities, but by very little. They found that a three-fold increase in population density would reduce per capita electricity consumption by 7%. As well, if "all cities had been built like the most dense city, the net electricity savings for the total province of Quebec would correspond to about 5% of the total electricity use in the province" (ibid, 63). At first glance, it would appear density has little effect on reducing energy consumption.

Recall heating is the dominant residential and commercial energy end use in Canada. In Quebec, in 2004, only 38% of residential space heating and 12% of commercial space heating was sourced to electricity (Natural Resources Canada 2006c). In the commercial sector, the majority of heating was sourced to natural gas (55%) and light oil (21%). So while the authors' statistical analysis may indicate that density has little impact on electricity consumption, the study is shy of conclusive with regards to density and energy end use for heating, the largest building-related energy end use service and source of emissions.

Steemers (2003) examines the effect of urban form on building energy trends, paying close attention to the effect of varying densities for residential and office buildings in the United Kingdom. He notes there are three ways density can be increased: increasing building depth, increasing building height or reducing spacing between buildings, and/or increased compactness.

For residential buildings, he finds an increase in building depth will usually result in decreased daylight and sunlight (i.e. solar heat) and thus increased heating and lighting loads, though marginal increases are minimal at 5-10% (ibid, 6). Because most of a residential dwelling's energy use is for heating, building depth is not as much of a factor.

When looking at building height, because the heating contribution of solar energy in conventional dwellings' is so small (10-15%), obstruction is not a big issue. However, for passive solar dwellings[8], which draw around 40% of their heating energy from solar energy, obstruction is a major issue (ibid). There is a positive relationship between obstruction angle

[8] Defined as a dwelling with 75% of its glazing to the south and 25% to the north.

and the energy requirement for space heating in passive solar buildings. Steemers identifies a 30 degree obstruction as a threshold, at which point "the balance will begin to swing against densification" (6). Of course, Steemers' conclusions assume new residential buildings are designed as passive solar buildings (i.e. 40% heating contribution from solar) while in reality most are not.

For commercial buildings, Steemers' notes that deeper site depths reduce the potential for natural ventilation and day-lighting, so he recommends shallower building sites that can capitalize on natural ventilation. Though this would appear to result in lower densities, buildings that avoid air conditioning can save approximately 30% of building volume due to less mechanical and distribution equipment (ibid, 7).

There is, however, a major limitation for optimal natural ventilation of office buildings in high density urban areas. Automobile noise and pollution deter occupants from utilizing operable windows, which in turn induces greater use of air conditioning (Steemers 2003, Hui 2001). Designers can limit mechanical ventilation to the street-facing façade "allowing the rest of the building to be naturally ventilated from a [quieter] and cleaner courtyard, garden or atrium" (Steemers 2003, 8). This is referred to as a mixed-mode strategy. Referring back to the community energy management conceptual framework, this is an excellent example of land use level decisions (density) influencing site-level decisions (building form) which influence equipment level decisions (mechanical ventilation).

Steemers then focuses on the heating and lighting load of office buildings. Increased density, similar to residential dwellings, can obstruct solar radiation and day lighting. Heat losses would decrease with deeper site plan depths but lighting load would increase (ibid, 9). However, all things considered (heating, cooling, lighting), a deep plan, air conditioned building will consume twice as much energy as a mixed mode building that emphasizes natural ventilation and day-lighting (ibid, 10). From an energy management perspective, increasing density by increasing lot depth should be avoided unless mixed mode building designs are adopted.

The key lesson from Steemers' analysis is that for residential dwellings "the energy implications of compact densification are balanced between the benefits from reduced heat losses and the non-benefits of reduced solar and daylight availability" (ibid, 13). For office buildings, however, increased density results in increased energy use, but the energy benefits of switching from an air conditioned office to a naturally ventilated office are far greater (ibid, 13). Hui's (2001) analysis of the effect of density on building energy use supports many of Steemers' findings; but also notes the potential for varying building heights to address issues related to ventilation, natural lighting and solar heat gains.

It is not possible to determine a widely applicable threshold density that optimizes the energy performance of an urban area. Too many variables prevent a standard threshold: weather, latitude, existing density, building envelope requirements, and occupant use, to name only a few. However, it is evident there are some key considerations that could inform energy-sensitive local government planning. In addition to policies that encourage greater density, effective policies will empower municipalities to determine or influence:

1. Building depth, height and distance between adjacent buildings (compactness);
2. Building orientation;
3. Obstruction angles (passive solar gain and natural daylighting); and,
4. Building form in order to achieve 'mixed mode'; buildings that ensure natural ventilation.

I'll explore potential policies that encourage higher density yet take the above considerations into account in the next chapter of this thesis.

4.2. District Energy

District energy systems[9] have been in use for over 100 years, growing in popularity in Europe after the 1973 OPEC oil crises, a response to a fear of over-dependency on oil imports (Woodward et al 1994). In Canada, district energy systems are not used as extensively as in Europe due to our low natural gas and electricity prices, which often out-compete district energy systems on a levelized per energy unit cost[10] (Natural Resources

[9] Sometimes called district heating systems.

[10] To calculate a levelized cost, the NPV of all capital and operating costs is converted to an equal annual payment, taking into account the time value of money (i.e., discount rate or financing costs of consumers). A monthly mortgage payment is a common example of a levelized cost - a stream of interest and principal repayments are converted to a single (constant) monthly payment. In this way, the annualized cost of heating

Canada 1999). However, notable examples include the City of North Vancouver's district heating system and the City of Vancouver's proposed neighborhood energy utility at Southeast False Creek and the East Fraser Lands mega-developments. The City of North Vancouver's district heating system reduces nitrous oxide emissions and carbon dioxide emissions by 64% and 21% respectively compared to a conventional heating system (City of North Vancouver 2004). The City of Vancouver's proposed SEFC and EFL systems are expected to reduce emissions by 6,200 and 7,320 tons of greenhouse gases respectively (Compass Resource Management 2006, 2007).

A district energy system delivers thermal energy – in the form of hot water, steam or chilled water – via underground pipes to buildings from a central power plant. Such a system can meet the space heating, hot water and air conditioning needs of a building more efficiently than individual building energy production equipment (Natural Resources Canada 1999). The centralized plant displaces the need for individual furnaces, boilers, electric baseboard heating and/or air conditioners in each building.

One of the major advantages of a district system is the range of fuel sources that can be used to run the central boiler, including natural gas, wood waste, geothermal, or electrical cogeneration[11]. A related advantage is that these systems can use the most economically optimal fuel source at any given time, and switch to different sources as they become more economically and/or technically viable. Individual boilers or furnaces are not readily adaptable to alternative fuel sources such as biomass, heat from sewage effluents, or waste heat from a cogeneration unit (ibid). Greater efficiencies and less carbon-intensive fuel sources also lead to reduced energy-related emissions (ibid).

The viability of a DE system is marked by many factors, including: local climate, urban form, fuel source options, financing options, system design, construction, buildings' heating and cooling loads, and many other technological variables (Bloomster and Fassbender 1983).

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technologies can be divided by their average annual heat output to generate a levelized cost of heat (Compass Resource Management 2005).

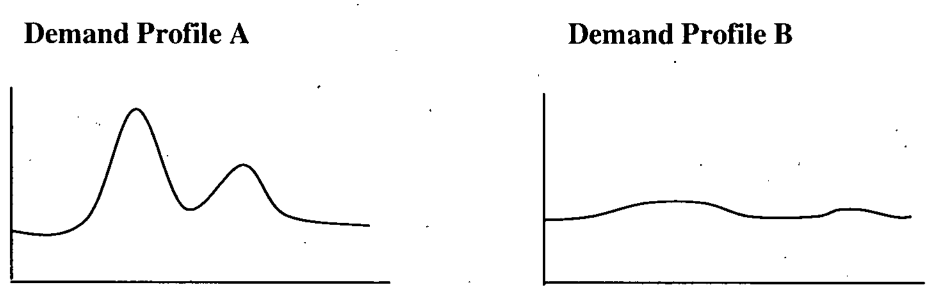
[11] The simultaneous generation of electricity and useful heat, also commonly referred to as combined heat and power (CHP). Many industrial facilities generate their own electricity. Often, the heat generated in the process is lost. The central boiler of a district heating system can use the 'waste heat' to generate hot water or steam.

By far, the largest factor is up front costs, which determines the levelized cost per unit of energy.

Approximately 75% of a district energy system's life cycle costs are attributed to capital costs (Natural Resources Canada 1999). These high up front costs "pose challenges for getting systems started, particularly since negative cash flows are inevitable in the early years…A few large initial heating and cooling loads are usually required" (Compass Resource Management 2002, 26). One of the foremost barriers facing district energy systems is an economic one, which is largely determined by competing fuel prices and end use demand. Where there is an abundance of reliable, low-cost fuels, district energy systems will not be as competitive (Natural Resources Canada 1999, Compass Resource Management 2002). The viability of a district energy system will depend on the amount of energy required over time (demand) and the minimum amount of heat required at any given moment in time (load), something local governments can exert some control over via development patterns and density.

As mentioned, a major determinant of the economic viability of a district energy system is related to buildings' energy demand and load. Load is the amount of energy a building or group of buildings requires at a given point in time. Demand is the total amount of energy required over a period of time. Energy supply and distribution systems are typically designed to meet the annual peak load of a service area (Natural Resources Canada, 2006a) and thus are often under-utilized. Figure 2 shows two demand profiles for two different buildings (or groups of buildings).

Figure 2: Two Possible Demand Profiles for a Group of Buildings



Adapted from Natural Resources Canada, 2006a.

The space below each line is the amount of energy the building or group of buildings require over a period of time (lets say one day). The energy required to meet the needs of the demand profile on the left requires a larger energy system that is often not utilized to full potential, due to the presence and variation of peak loads. The demand profile on the right has little variation and a smaller peak load, thus it requires a much smaller energy system that is more efficiently utilized.

As a general rule, "the unit cost of delivering district energy decreases with increasing size and density of demand" (ibid, 29). The lower the unit cost of energy, the more competitive district energy systems are with conventional building energy systems. Recall that capital costs dominate the life cycle cost of a district energy system and that capital costs are a function of the overall capacity of the system. A system designed to meet demand profile A will be larger but less utilized than a system to designed to meet demand profile B. Thus, a system designed to meet demand profile A will have greater capital costs and therefore higher unit costs of delivering energy. A system optimally sized to meet total demand will result in lower unit costs. A service area that has a high total demand (to guarantee competitive returns from energy revenue) and diverse (flat) load profile is well-suited to district energy systems. One of the simplest ways

> ...to level the overall energy demand profile is to aggregate the loads of multiple consumers. Adjacent building owners, when linked to a single system may mutually compensate the peaks and troughs of their individual profiles (ibid, 10).

A residential building with a high peak heating load during morning and early evening complements commercial activity where higher energy demand occurs during the day. Where new, large developments are about to occur, new buildings can be positioned to optimize the output of the district energy system. This is referred to as aggregation of loads and "calls for the integration of thinking at the development and municipal level, incorporating possibly residential, commercial and retail properties in the same development" (ibid, 10). Aggregation of loads speaks to the need for considering daily and seasonal variations in energy loads. Residential land use interspersed with commercial activity is a good way to optimize aggregation of loads.

As mentioned above, a high total energy demand within the service area is necessary for a district energy system to be viable. Analysts use thermal load density as a crude measure of whether a service area is well-suited to a district energy system (MacRae 1992). Table 6 shows the appropriate densities for a district heating system.

Table 6: Favourability of District Energy Systems

Thermal Load Density (MMBtu/hr/acre)[12]	kW/m^2	Typical type of land use	Suitability
0.97 or greater	0.070 or greater	Downtown; high rises	Very favourable
0.97 to 0.7	0.070 to 0.051	Downtown; multi-storied	Favourable
0.7 to 0.28	0.051 to 0.020	City core; commercial buildings and multi-family apartments	Possible
0.28 to 0.17	0.020 to 0.012	Two-family residential	Questionable
0.17 or less	0.012 or less	Single-family residential	Not possible

Source: Compass Resource Management (2002), adapted from MacRae (1992).

Thermal load density is the amount of energy required for one hour in one acre of built environment. For example, 0.97 or greater MMBtu/hr/acre corresponds to 0.0700 kW/m^2, which is the typical load of a downtown area with high rise buildings. Higher density residential and commercial areas are better suited to district energy systems due to their high thermal load density. Lower density development patterns may not be able to host a viable district energy system. Thermal heating density is the key measure. Typical use of land is a crude proxy for thermal heating density; crude because a predominantly low density residential development interspersed with a few commercial or institutional buildings and in conjunction with a cheap fuel source or heat supply can provide favorable conditions for a viable district energy system (Natural Resources Canada 2006a).

Retrofitting a district energy system to a service area with existing buildings presents unique challenges. Buildings with hydronic (hot water) heating systems or forced air systems are well-suited to connect to a district energy system due to the compatibility of buildings' mechanical systems. However, buildings with electric resistance baseboard heaters are not

[12] MMBtu is one million British Thermal Units, the equivalent of about 293 kilowatt-hours.

compatible due to the absence of pipes/duct work to distribute the hot water/warm air. Again, we see how land use and infrastructure energy-related decisions relate to decisions lower down in the decision-making hierarchy, in this case at the energy-using equipment level.

To summarize, policies that help create favourable conditions for district energy systems will help ensure:

- Aggregation of loads by encouraging mixed use neighborhoods, including situating residential and commercial/institutional buildings in close proximity;
- A threshold demand for the thermal energy. To achieve this, all or most buildings within a service area need to be connected to the district energy system. Another way to ensure threshold demand is to include a few large heating or cooling loads in a system (e.g. a school and a hospital);
- Buildings' compatibility with a district energy system. This means ensuring new buildings' mechanical heating systems are compatible with district energy systems, and avoiding non compatible heating systems like electric baseboard heaters. For existing buildings, this means the ability to retrofit the building's energy equipment to be compatible with the district energy system will bear on the system's costs. A district energy system will be compatible with buildings that use forced air or hydronic space conditioning systems but not buildings that depend on electric/baseboard heating; and,
- Proximity to waste heat sources, usually from industrial processes or electricity co-generation plants.

Policies available to local governments to achieve these conditions are explored in the next chapter of this thesis.

4.3. Geo-exchange

Geo-exchange[13] systems – sometimes referred to as ground source heat pump systems – are an efficient way of providing buildings with space heating and cooling, and hot water. A geoexchange system captures the heat from the earth, an aquifer, a nearby water source, an

[13] The Canadian Geoexchange™ Coalition is the owner and manager of the Canadian trademark rights for the term "geoexchange™". It is the preferred term for what is historically known as ground source heat pump systems.

adjacent sewer, or heat generated within buildings and delivers the heat for a required energy service (i.e. warm air). The systems can also work in reverse, removing the heat from a building and dispersing it in a thermal sink (i.e. the ground), thus cooling the building during hot summer days. Geo-exchange systems "use roughly 40-60% of the energy consumed by a conventional heating and cooling systems and therefore can offer significant reductions in the greenhouse gas emissions and Criteria Air Contaminant (CAC) emissions associated with fossil fuel combustion" (Compass Resource Management 2005, iii).

A typical geoexchange system has three components:

- A thermal source/sink heat exchanger, often referred to as the "loop" – a field of pipes that circulates fluid that collects low temperature heat from the ground or body of water that the loop rests in;
- A heat pump, a electrically driven mechanical device that extracts heat from the fluid that circulates through the loop and concentrates that heat energy into higher temperature air or water for use within the building. In cooling mode, the process works in reverse, drawing heat out of the air in the building and delivering it either to the heat sink or for another use in the building (i.e. for hot water); and,
- A building distribution system – compatible systems include conventional hydronic (hot water) systems, forced air ducting, or less conventional systems like radiant floor heat.

Relatively few new buildings install geoexchange systems when compared to the large uptake of conventional space heating and cooling systems, such as natural gas furnaces/boilers and electric baseboard heaters, usually due to higher capital costs of geo-exchange.

Though capital costs are high, the levelized cost per unit of energy (i.e. dollars per kilowatt-hour) can be quite competitive. In 2005 the Greater Vancouver Regional District commissioned a study to assess the technical and resource potential of several emerging alternative energy technologies, one of which was geo-exchange (ibid). The study analysed a range of geo-exchange configurations for single family dwellings, multi-family residential units, and small and large offices[14] by comparing the levelized cost per unit of energy delivered of geo-exchange with conventional heating systems. For single family dwellings, the cost of geo-exchange is always higher. For low rise and high rise multi-family units that use natural gas boilers for heating, geo-exchange generally has a lower cost. For low rise and high rise multi-family units that use electric heating, geo-exchange generally has a lower cost. In small and large offices, geo-exchange has a greater cost. The levelized cost of geo-exchange is a function of the earth loop configuration, ground conditions, the heat pump size, and utilization, thus these results are telling, but can vary significantly by geographic region and specific application.

Climate is a key factor when assessing the cost-effectiveness of a geoexchange system. In Canada, climates vary widely by region, which determines heating load and cooling load of the building. The most cost-effective scenario is when heating load and cooling load is balanced. The reason for this is that the system's full potential is optimized because it displaces the need for both conventional heat energy in winter (i.e. heat from a natural gas furnace) and energy required for cooling in summer (i.e. electricity for air conditioners). Operating cost savings over the entire year reduce the life cycle cost of the systems, which helps justify the initial incremental capital cost of a geoexchange system over a conventional system. Summer cooling also helps to re-charge the ground field with heat. High demand for both heating service and cooling service is one of the primary reasons that geoexchange systems are so cost-effective in climates like those in the British Columbia interior region and less cost-effective in the British Columbia Lower Mainland region.

In the district energy sub-section of this thesis (above), aggregation of loads was discussed. Aggregating loads is combining building uses (e.g. residential and commercial) so the energy use patterns of each building type compliment each other, resulting in a more efficiently utilized energy system. The example provided was residential building with a high peak heating load during morning and early evening complements commercial activity where higher energy demand occurs during the day. The principle of aggregation of loads also generally applied to geo-exchange. Often the economics of the geo-exchange system improves when the system is more fully utilized. That said, there are no rules of thumb: each

[14] The analysis was conducted using building archetypes for British Columbia. Construction practices, latitude, weather and equipment energy efficiency standards vary by region and thus would effect the results of the analysis.

system is unique and depends on a range of factors to determine economic viability. Mixed commercial/residential land use does however establish basic conditions for increasing the likelihood of an economically viable geo-exchange system.

To summarize, policies that help create favourable conditions for geo-exchange energy systems will:

- Favor multi-family residential units over single family dwellings. This also favors district energy systems; and
- Encourage land uses that allow for aggregation of loads; i.e. residential-commercial mixed use.

4.4. Passive Solar Site and Building Design

Passive solar site and building design optimizes the available heat from the sun and natural ventilation from the wind to reduce energy consumption for space heating, lighting and air conditioning. The effectiveness of passive solar and natural ventilation design is a function of building materials, site and building orientation and a range of natural factors, including: relation to the sun, weather conditions (specifically, cloud cover), topography, and local air pollution levels, which obstructs sunlight (Canadian Mortgage and Housing Corporation 1998). These are important considerations because it highlights the difficulty with establishing one-size-fits-all design principles and determining widely applicable energy saving and greenhouse gas emission abatement estimates. This section will therefore focus on general guidelines.

Recall Steemers' (2003) analysis of the effect of building and site design on energy use. Though his conclusions were in the context of increased density, they are directly applicable to this section, and thus worth summarizing:

- For office buildings, increased density can obstruct solar radiation and daylighting;
- Heat loss decreases with deeper site plan depths but lighting load would increase due to loss of natural day lighting;
- A deep plan, air conditioned office building will consume twice as much energy as a mixed mode building that emphasizes natural ventilation and day-lighting. A mixed

mode building is one that mechanically ventilates the street-facing zone and naturally ventilates the rest of the building. This would be achieved through design, using courtyards, gardens and/or atriums.

- A major limitation for optimal natural ventilation of office buildings is automobile noise and pollution, which deter occupants from utilizing operable windows, which in turn induces greater use of air conditioning (Steemers 2003, Hui 2001).
- Re-orienting a dwelling from due south to due west increases the buildings' space heating requirement by 9-15%, depending on the level of solar passivity of the design;

The Canadian Mortgage and Housing Corporation's "Tap the Sun: Passive Solar Techniques and Home Designs" (1998) outlines site and building design recommendations to maximize solar gain. Guidelines are grouped according to site design and landscaping, building siting, and building form. The CMHC publication notes that "passive solar design is the art of balancing a building's solar gains against its heat losses. Since solar gains and heat losses vary by geographic area, house designs will vary in different parts of [Canada]" (4).

The following are general guidelines[15] that focus on the building/site level in the community energy management decision making hierarchy. Decisions related to building envelope and mechanical devices are the domain of provincial and federal authorities, and addressed through provincial buildings codes and federal or provincial energy efficiency standards.

Site Design and Landscaping

The south side of the building should be unshaded in winter, and with large window areas (ibid 45). This allows solar radiation and natural daylighting. Windows should be oriented within 15 degrees of due south (ibid 45); note however that slightly east facing is preferred to slightly west facing because east facing captures morning sun and lessens overheating from afternoon sun. In row and stacked housing, blocks of units should run east-west. Avoid "L," "U" and "T" configurations as they create shading, which reduces passive solar gain (ibid 52).

[15] Maximizing passive solar heat gain, cooling, and natural ventilation at the site/building scale is complex. Professional architects and engineers should be engaged to conduct computer building energy simulation (for passive solar gain and/or managing cooling loads, and maximizing natural ventilation), and conduct day-lighting modeling in design stage (to maximize natural light).

The use of detached shading (trees and shrubs) is effective for managing cooling loads in summer. Trees provide shade, reduce a building's cooling needs by cooling the surrounding air through leaf evaporation and by shading adjacent hard surfaces that would otherwise give off heat. Trees that lose leaves in fall are best (ibid 24) and the best location for shade trees is to the east and west. Avoid locating trees so far south along the east and west sides of the site that they block the sunlight falling on the south-facing windows (ibid 24). Generally trees should not be located directly south of the house. Even a defoliated deciduous tree can cast enough shadow to impair the performance of south-facing glazing. While in winter, large deciduous trees can block more than 50% of the sun's rays (24). If there must be a tree to the south, it should be a single-trunked, tall-growing variety close to the house, and the lower branches should be removed as the tree grows (ibid 24). During the winter, most heat is collected between 9:00 a.m. and 3:00 p.m., therefore a 30° angle on either side of the north-south axis should be kept clear in front of all south-facing windows (ibid 24).

Building Siting

To manage cooling loads, strive for operable windows, across from other operable windows in the direction of prevailing summer winds. As well, try and orient the building on an east-west axis to maximize the use of day-lighting. Such building orientation also captures winter solar gain and avoids excessive summer sun that strikes the east and west facades.

Building Form

The effective use of overhangs and awnings can help manage heating and cooling loads. On south-facing windows, position awnings and overhangs to limit heat gain in spring, summer and fall. As well, overhangs and awnings are less effective on east or west facing windows because of the low angle of the sun from these directions (ibid 20). The best compromise between winter solar passage and summer solar blockage is to ensure that the window is completely unshaded at the winter solstice on December 21st and between fully and half-shaded at noon on the summer solstice on June 21st (ibid 21).

For stacked housing units, arrange upper level balconies to provide summer shading for the south facing glass in the units below. (ibid 52)

For windows and skylights, east and west facing facades should avoid excessive glass because this will induce higher cooling load requirements. South facing glass should be combined with over-hangs and balconies (solar shading) to deter solar heat in summer. Avoid north-facing windows and horizontal windows (ibid 2); they are less well suited to capturing solar radiation gain.

Lastly, to maintain solar-ready roofs (i.e. roofs that can easily accommodate domestic hot water solar unit or photovoltaic cells), use a compound-pitch roof with the south-facing side inclined at 45 degrees (ibid 38).

To summarize, effective policies that reduce energy use through passive solar site and building orientation will empower municipalities to determine or influence:

- Site plans (lot depth, street frontage)
- Building design and layout, including the use of mixed mode strategies
- Site orientation
- Building orientation
- Solar access
- Overhangs and awnings
- Site landscaping
- Building form (e.g. roof pitch)

Policies available to municipal governments to influence the above factors are explored in the next chapter.

4.5. Building Performance Standards

Buildings in Canada are categorized as either Part 9 or Part 3 buildings. These categories are embodied in the National Building Code, the standardized code for building construction on which provincial building codes are based. Table 7 shows the two building typologies and their characteristics:

Table 7: Dominant Building Typologies in Canada

Part 9 buildings	Part 3 buildings
• Housing and small buildings (i.e. low rise MURBs) • up to 3 stories high • footprint < 600 m2 • wood frame • for low-rise MURBs: shared heated areas, ventilation systems or heating systems between dwelling units	• all other buildings (high rise residential, commercial/office buildings, institutional, etc)

There are a range of high performance building standards for each typology. These are standards that are not code requirements, but encouraged otherwise, usually through utility and government incentives. Some examples include EnerGuide for New Houses and BuiltGreen for Part 9 buildings, and Leadership in Energy and Environmental Design and ASHRAE 90.1-2001 for Part 3 buildings.

EnerGuide for New Houses (EGNH) is a building certification program of the Canadian federal government. The plans of new homes are run through modeling software called HOT2000. The software produces a report, suggesting upgrades to reach a high performance level (generally this is EGNH 80). The builder then has the option of upgrading the building and/or its equipment to achieve the higher rating. After construction, the house is tested (called a blower-door test) to see what level of energy efficiency it achieves. In British Columbia, there are many provincial and utility incentives available to those builders that achieve EGNH 80.

BuiltGreen is a Part 9 building certification program that focuses on four separate and distinct target areas: energy efficiency, indoor air quality, resource use (including waste management), and overall environmental impact. Builders can achieve one of three potential ratings: gold, silver and bronze. Builders can choose from a suite of options, however a minimum level of energy performance must be attained. BuiltGreen relies on the EnerGuide for New Houses rating system for this aspect of its certification.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) develops performance standards for refrigeration and indoor environments. ASHRAE 90.1-2001 is a widely recognized standard for energy performance in new commercial buildings and residential buildings over three storeys. It is widely adopted in many jurisdictions, including the City of Vancouver and Ontario, and is the minimum energy code requirement in the United States. As well, ASHRAE 90.1 energy efficiency standard is the basis for credits provided by the Leadership in Energy and Environmental Design (LEED) building rating system.

The LEED rating system is a benchmark for the design, construction and operation of high performance buildings. Buildings are rated according to a scoring system, achieving one of Platinum, Gold, Silver or Certified. The five prerequisite and credit categories include: sustainable sites, water efficiency, energy and atmosphere, materials and resources and indoor environmental quality. As of January 22, 2007 there were 57 LEED certified projects in Canada. All LEED buildings must be at least 25% more energy efficient than the Model National Energy Code for Buildings, but tend to perform much better as the higher up the rating scale[16]. To provide context, the Province of British Columbia's Energy Efficiency Buildings: A Plan for BC (2005b) outlines targets for new and existing residential, commercial, institutional and industrial buildings, to be reached by 2010. The commercial/institutional building target is 25% better than the MNECB, which, if achieved, would reduce reducing the average energy consumption in new buildings by 20% (Province of British Columbia 2005a).

EnerGuide for New Houses, BuiltGreen, ASHRAE 90.1-2001 standard and LEED are third party[17] building labeling and/or certification programs that have an energy component. Meeting the energy standards within these programs ensures a higher level of energy performance. Because they each have independent, third party review processes, it takes the onus off of municipalities to check and verify whether the standards are met.

Each program/standard has pros and cons. The point is not to evaluate each program, but to demonstrate there are reputable, energy saving building performance programs and standards

[16] In general, LEED silver projects achieve energy savings of 30% to 40% (City of North Vancouver 2005).
[17] In this case, third party refers to a program or standard independent of the primary parties: the builder and the regulator.

that municipalities can reference when establishing policy that affects new buildings. I'll explore potential policies that require or encourage minimum standards (beyond those of provincial building codes) in the next chapter of this thesis.

4.6. Summary of Key Considerations for Effective Policies

If policies are to be effective at reducing energy consumption and corresponding emissions, they should speak to the key considerations outlined above. Table 8 is a summary of key considerations necessary for advancing or enabling the five technology/design practices identified in this section.

Table 8: Key Considerations for Technology or Design Practices

Technology/design practice	Considerations policy should address
Density	• Building depth, height and distance between adjacent buildings (compactness) • Building orientation • Obstruction angles • Building form in order to achieve 'mixed mode'
District heating	• Aggregation of loads (mixed use) • A threshold demand for the thermal energy • New buildings' compatibility with a DE system • Proximity to waste heat sources, usually from industrial processes or electricity co-generation plants
Geo-exchange	• Favor multi-family residential units over single family dwellings. • Aggregation of loads (mixed use)
Passive solar site and building design	• Site plans (lot depth, street frontage) • Building design and layout, including mixed mode strategies • Site orientation • Building orientation • Solar access • Overhangs and awnings • Site landscaping • Building form (e.g. roof pitch)
Building performance	• Ensures a high performance building label or certification

These considerations will guide the policy scoping exercise necessary to determine effective policies.

5. Policy Case Study: British Columbia

5.1. Energy Policy Context

In Canada, energy policy jurisdiction is shared between the federal and provincial governments, with electric and gas utilities operating under the legislative authority granted to them by their respective provinces (Natural Resources Canada 2000).

The federal government has responsibility for the inter-provincial or international movement of energy and energy using equipment. Energy efficiency standards of equipment which cross provincial or international borders, energy imports and exports and nuclear energy and transboundary environmental impacts are all under the purview of the federal government (ibid).

Provincial powers related to energy include responsibility for matters within provincial borders, including trade and commerce and environmental impacts (ibid). Energy using equipment that is manufactured and sold within BC is regulated under the Energy Efficiency Act whereas equipment made out of province and imported to BC is subject to federal regulations.

The electricity and gas market in British Columbia is regulated by the B.C. Utilities Commission under the legislation contained in the Utilities Commission Act. The Ministry of Attorney General has overall responsibility for the Act. However, the Ministry of Energy, Mines and Petroleum Resources has the overall responsibility for energy policy. There are six municipal electric utilities in British Columbia, all governed by the legislation contained in the Utilities Commission Act. Utilities report to the Ministry of Energy, Mines and Petroleum Resource.

Energy consumption related to buildings is regulated under the BC Building Code. The Office of Housing and Construction Standards – a branch of the Ministry of Forests and Range – is responsible for the BC Building Code. Municipalities have little authority to require energy efficiency building standards beyond those established in the BC Building Code. Local government exercise of authority in relation to building standards is limited to an exercise of authority "for the health, safety or protection of persons or property"

(Community Charter 2003, s.53). Since energy efficiency is not within this domain, energy efficiency requirements would not be considered an appropriate exercise of authority.

Local governments do have jurisdiction in the area of land use and development controls, provided polices, regulations and measures do not attempt to supersede the BC Building Code and/or are permitted within the local government enabling legislation. That said, there are several areas where local governments have the authority to exercise discretion (e.g. through a rezoning process) and can ask for just about anything they feel is deemed of value to the community.

5.2. Local Government Planning in British Columbia

In British Columbia, Canada local governments are considered creatures of the province, meaning all planning and administrative actions are directed by enabling, provincial legislation. With the exception of the City of Vancouver[18], all municipalities operate primarily within the limitations of two, dominant statutes: the Local Government Act and the Community Charter.

5.3. Legislative Mandate for Energy Management

A key document, the Official Community Plan is considered a blueprint for the direction for development in the community. The OCP "articulates the community's objectives and policies regarding land use, community development, and operations. All bylaws and works of the local government must be consistent with the plan" (Environmental Law Centre 2005, 19).

There is an existing mandate in the British Columbia Local Government Act for municipalities to include energy management provisions in their Official Community Plan (OCP):

- To the extent that it deals with these matters, an official community plan should work towards the purpose and goals referred to in section 849 *[regional growth strategy goals]* (Section 875 (2)), and

[18] The City of Vancouver operates under its own, unique enabling legislation known as the Vancouver Charter. Because this statute applies only to the City of Vancouver, planning actions with authority rooted in the Vancouver Charter will not be explored.

- Without limiting subsection (1), to the extent that a regional growth strategy deals with these matters, it should work towards but not be limited to the following [...] (m) planning for energy supply and promoting efficient use, conservation and alternative forms of energy (Section 849 (2)(m)).

In addition, the Local Government Act provides the mandate for the inclusion of policies related to the preservation and protection of the natural environment:

- An official community plan may include the following [...] (d) policies of the local government relating to the preservation, protection, restoration and enhancement of the natural environment, its ecosystems and biological diversity (Section 878 (1)).

Inclusion of energy management language in the OCP establishes an important policy foundation. Comprehensive energy management language can:

- Guide future policy development;
- Lend guidance during development-specific negotiations;
- Provide staff with a mandate to explore energy management options in civic and private development.

The energy-related language will guide staff and the community until the OCP is amended, typically between 5-10 years. As such, language in the plan should be general enough to accommodate an evolving energy technology sector, yet specific enough to give staff the confidence to pursue robust energy-related measures and planning from the outset.

5.4. Policies

The key considerations for energy technologies or design practices that were outlined in Table 8 guide the policy scoping exercise. It was important that policies address these key considerations so they will advance the technologies and design practices.

Following an exhaustive search of BC local governments' policy and planning documents, and personal contact with a large number of planners and local government decisions makers[19], a broad range of policies were identified that can create the threshold conditions necessary to reduce energy use in buildings.

[19] For a full list of local government contacts, see CAEE 2007.

5.4.1. Zoning

BC's local governments are empowered to regulate the use of land under section 903 of the Local Government Act,[20] which outlines the scope of zoning power. Local governments are delegated the authority to divide the municipality into zones and regulate land use on those parcels. Municipalities typically establish a zoning bylaw, the primary tool used to implement land use plans. Traditional zoning will outline allowable use and density of land, siting of buildings and structures, parking and sign requirements. Note that a local government is not empowered to require district heating or geo-exchange systems within its zoning bylaw.

Zoning is a practicable way to ensure a minimum density for thermal load density, encourage mixed use for aggregation of loads, and ensure residential and commercial development occurs in reasonably close proximity to waste heat sources (i.e. industrial processes). Thus, the zoning bylaw is also well suited to help local governments achieve the necessary conditions for a district heating system and geo-exchange systems. Zoning determines the land use and maximum density, so while it can create the conditions for a desired land use mix and density, it cannot guarantee the developer will build to the allowable maximum density.

5.4.2. Development Cost Charges Bylaw

Local governments levy Development Cost Charges (DCCs) on new development projects to cover the capital costs of infrastructure needed to service new development. Local governments acquire their legislative authority to charge DCCs from the Local Government Act, which allows local governments to impose DCCs to offset the capital burden imposed by new development for five types of infrastructure (see section 933): sewer, water, storm drainage, road and parkland needed to accommodate growth. The maintenance and operating costs associated with infrastructure are not eligible (WCEL 2003). DCCs cannot reflect other sustainability considerations such as air quality, energy consumption, support for transit use, or maintenance of water quality, despite their overall benefit to society (ibid). There is no legislative authority to reduce DCCs for energy efficiency alone (ibid).

[20] As noted in Buholzer (2006), this is not a simple delegation of power. See s. 903 of the Local Government Act.

Local governments are, however, empowered to vary DCCs by geographic area and building type so as to favour both Smart Growth and high-performance green building design. A report by West Coast Environmental Law (WCEL) suggests that significant infrastructure cost savings associated with smart growth planning principles and high performance building design features are possible (WCEL 2003). Note that building design features would include those that reduce the servicing requirements for water, sewer and storm; energy is not applicable to DCCs. The WCEL report surveyed 15 municipalities' DCC bylaw to assess whether any of them reflect differences in infrastructure costs related to location, land use, density and "green" design. The findings indicate:

> Every municipality sets different DCCs for different land uses (e.g., commercial, residential, industrial) and almost every municipality sets different charges for single family and multifamily residential units. Some municipalities vary the multifamily DCC based on a project's density. However, only a few municipalities vary the single family charge based on density and few vary commercial and industrial DCCs by density.
>
> Some municipalities set different charges for different geographic areas in the municipality, but many do not.
>
> None of the municipalities examined currently takes high performance building design into account in setting DCC rates.
>
> (WCEL 2003, iii)

The consequence of a DCC bylaw that doesn't determine the amount of the levy based on density, geographic area and/or building design is a missed opportunity to encourage higher density development and better buildings. A finer grained DCC bylaw can feature lower levies for developments that impose a lower capital burden on the municipality; in other words, higher density developments and higher performance building design would be levied lower DCCs, thus providing a financial incentive to pursue these kinds of developments. As the WCEL report notes, Smart Growth development can result in significant infrastructure cost savings, thus it is suitable for development occurring in 'Smart Growth' precincts to pay lower DCCs than developments occurring in areas with higher servicing costs (ibid).

The District of Maple Ridge is in communication with the Province to revise and/or clarify the legislation to grant local governments the authority to waive or reduce DCCs for innovative development with a lower economic, social and ecological cost over the long term. The Union of BC Municipalities has since endorsed a resolution to this effect. The Provincial government is currently reviewing how existing development finance tools including DCCs can be used to facilitate the development of sustainable infrastructure and buildings, and is looking at how enhanced development standards contribute to reducing infrastructure costs (Fraser Basin Council 2007).

The DCC bylaw is an effective way to encourage greater density, and, in the near future, may be a good way to encourage high performance buildings with lower life cycle costs. The latter option may depend on the outcome of the District of Maple Ridge's discussions with the Province. Due to its favorability towards higher density precincts (i.e. Smart Growth), this policy is well suited to increase density and create favorable conditions for district energy systems.

5.4.3. Revitalization Tax Exemption Bylaw

A tax exemption bylaw provides a financial incentive for developers to build in a specified area of the municipality and/or to a specified building standard. Environmental revitalization, including energy efficiency, is listed by the Province as being within the intent of the legislation. Section 226 of the Community Charter:

> ...provides authority to exempt property from municipal property value taxes. To use this authority, a Council must establish a revitalization program (with defined reasons for and objectives of the program), enter into agreements with property owners, and then exempt their property from taxation once all specified conditions of the program and the agreement have been met. Exemptions may apply to the value of land or improvements, or both. Councils are free to specify, within their revitalization programs, the amounts and extent of tax exemptions available. (Ministry of Community Services 2007, 2)

Revitalization tax exemptions are limited to municipal property value taxes (Section 197(1)(a) of the Community Charter only) and do not extend to school and other property taxes, such as parcel taxes. An exemption may be granted for up to 10 years.

The authority to provide a revitalization tax exemption is not subject to section 25 of the Community Charter (prohibition against assistance to business). Section 396E of the

Vancouver Charter also provides the City of Vancouver with authority to provide revitalization tax exemptions.

The District of Maple Ridge established a Revitalization Tax Exemption Bylaw to encourage residential high rise development in a pre-designated revitalization area[21] (District of Maple Ridge 2006). Buildings that are five stories or higher and 75% residential are eligible for a two year property tax exemption. Buildings that are LEED silver, gold or platinum qualify for a four year tax exemption. Table 9 summarizes the potential tax exemption available over four years for basic buildings and green buildings.

Table 9: Tax Exemption Rates for Eligible Buildings

Year	RTE – Basic Exemption	RTE – Green Exemption
1	100%	100%
2	50%	75%
3	0%	50%
4	0%	25%

In developing the policy, the District also provided a case study of the financial savings a hypothetical building would enjoy. Buildings qualifying for the RTE – Basic would be eligible for an exemption value of $127,562 while a RTE – Green building would enjoy an exemption of $218,368. Since residential buildings are likely to be condominiums, the appeal of this market-oriented policy is questionable because the developer will likely not enjoy the tax exemption but rather the owners of individual units will. However, it may be possible to market the property tax savings as a feature to future buyers, which may in turn command a higher unit sale price. The higher unit sales price may be enough to justify the initial capital outlay required for a higher performance building.

The Revitalization Tax Exemption Bylaw is unproven at this point, but appears to be a way local governments can encourage greater density, provide favorable conditions for district heating systems, and achieve minimum energy performance standards (i.e. LEED).

[21] To be eligible, buildings must be 75% residential and be five stories or more (i.e. a Part 3 residential building).

5.4.4. Comprehensive Development Zoning

Comprehensive development (CD) zones are a way to "package site-specific land use regulations adopted in response to the application of a landowner whose plans cannot be accommodated by using an existing zoning category" (Buholzer 2001, section 7.93). The use of CD zones are more often used to comprehensively plan large sites, and permit tailoring the development in ways the existing zoning bylaw does not specify (ibid). Because there is no zoning specifications assigned to the parcel, typically the landowner's development plan becomes a schedule in the zoning bylaw.

In the case of matters outside of the zoning power (e.g. green building guidelines), it is important to note that owners "cannot be obliged, as a matter of zoning, to comply with aspects of the incorporated plans" (ibid, 7-36). To avoid the possibility that what was agreed to and adopted in the zoning bylaw may not actually be implemented, local governments will use what is called a statutory covenant, an authority permitted under section 219 of the Land Title Act. This legal tool allows municipalities to "impose land use restrictions that are beyond the scope of public law devices like zoning regulations" (ibid, 12-3). More importantly, it ensures the required uses 'run with the land,' meaning the covenant binds the owner of the land (regardless of whether ownership changes) to the requirements outlined in the covenant.

A notable example of where CD zoning was used to advance energy efficiency objectives related to buildings is the City of Langford's Westhills Development. This large development proceeded under the terms of comprehensive development rezoning and was subject to numerous terms. The Westhills development is a mixed-use neighborhood with approximately 6,000 residential units and commercial and civic buildings. All commercial and multi-family residential buildings are required to be LEED certified. All residential buildings that do not fall within LEED certification are required to be built to a BuiltGreen standard. Westhills is officially registered as a LEED-ND (New Development) Pilot project under the US Green Building Council Pilot program. There are a large number of projects that are pilots, a small number of which are in Canada. Recall that all LEED buildings must be at least 25% more energy efficient than the Model National Energy Code for Buildings, but tend to perform better the higher up they are in the LEED rating scale[22] (Fraser Basin Council 2007).

It would appear that comprehensive development zoning is a good way to achieve higher density and mixed use land use, key conditions for a district heating system and geo-exchange, passive solar design and building orientation, and energy performance building standards.

5.4.5. Service Area Bylaw

The Service Area Bylaw can be used to establish designated service areas for particular types of energy services. Under Section 8(2) of the Community Charter, a municipality may provide any service that the council considers necessary or desirable, and may do this directly or through another public authority or another person or organization. Local area services are a subset of the general service authority outlined in Section 8(2). The authority for establishing local area services resides under Section 210. Under these provisions, a service area bylaw can be used to establish service areas for particular types of energy services (e.g., a hydronic district heating system) and to require buildings within the service area to connect to the energy service.

The City of North Vancouver established a bylaw to create a district heating service area for the Lower Lonsdale precinct, with a requirement that all new buildings over a certain size be connected to the district heating system (City of North Vancouver 2004). A wholly owned subsidiary, Lonsdale Energy Corporation (LEC), was incorporated in 2003 to operate the system. The council acts as the tariff setter, regulating the rates charged by LEC.

The advantage of this bylaw is that it helps create the necessary thermal load density for the district heating system to be viable. The potential disadvantage is that it requires a massive capital outlay associated with a district heating system, which may be unrealistic for many local governments. However, the local government can partner with a non-government partner that may be interested in buying into the project and recovering its investment through long term energy sales.

[22] In general, LEED silver projects achieve energy savings of 30% to 40% (City of North Vancouver 2005).

5.4.6. Local Improvement Charges

A local improvement charge (LIC) is a financing mechanism that allows municipalities to cover the capital costs of specific improvements to a site or neighbourhood, then recover those costs through the property taxes of the owner(s) that benefit from the improvement. The LIC shows up as an additional line item on the property owner's municipal taxes.

The Pembina Institute conducted a national scoping exercise of LICs in its report Using Local Improvement Charges to Finance Energy Efficiency Improvements: Applicability Across Canada (2005). The report features a section on legislative authority for LICs, including provisions under the Community Charter and the Vancouver Charter (see Appendix 2 of the report, Provincial Regulations Governing LICs, page 38). The report notes that the main advantage of the LIC is that it associates the repayment of the cost of efficiency improvements with the building property rather than with the current building owner. Owners who are unsure whether they will remain at the location long enough to enjoy the operational cost savings associated with the improvement may be hesitant to lay out the upfront costs associated with most energy efficiency upgrades.

With the exception of the Yukon, LICs have not been used to finance energy improvements on private property anywhere in Canada to date. However, a 2007 legal opinion obtained by Central Saanich has confirmed that BC municipalities do have the legislative authority to use LICs for such purposes (Lidstone, Young and Anderson 2007).

The LIC policy instrument gives local governments the ability to finance, build and operate a district heating system, and cover the incremental capital costs of higher energy performance buildings. The LIC policy can also be used to cover the capital costs of a geo-exchange system for a building or group of buildings.

5.4.7. Development Permit Area Guidelines

Section 919 and 920 of the Province of British Columbia's Local Government Act authorizes the establishment of Development Permit Areas, in which a development permit must be issued by Council prior to the subdivision of land, the construction or alternation of a structure, or the alteration of land.

As stated in section 919.1 (1) of the Local Government Act:

> An official community plan may designate development permit areas for one or more of the following purposes: [...] (e) establishment of objectives for the form and character of intensive residential development; (f) establishment of objectives for the form and character of commercial, industrial or multi-family residential development.

It would appear there is no difference between what local governments are empowered to require for intensive residential[23] versus commercial, industrial or multi-family residential. Yet section 920 (8) of the Act states that

> If land has been designated under section 919.1 (1)(d), (e) or (f), a development permit may include requirements respecting the character of the development, including landscaping, and the siting, form, exterior design and finish of buildings and other structures.

Yet much of that enabling power is dampened in section 920 (9) of the Act, which states that

> If land has been designated under section 919.1 (1) (f), a development permit may include requirements respecting the character of the development, as referred to in subsection (8) of this section, but only in relation to the general character of the development and not to particulars of the landscaping or of the exterior design and finish of buildings and other structures. (author's underlined emphasis)

This distinction is important within the context of what local governments are empowered to require with regards to energy efficiency. It would appear local governments have greater flexibility about what they can require for lands designated Intensive Residential Development (i.e. character, landscaping, siting, form, exterior design and finish of buildings) versus what they can require for commercial, insdustrial and multifamily buildings (limited explicitly to general character of the development).

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[23] As noted in Buholzer (2005), there is no statutory definition of intensive residential development, but rather is defined by the local government with the expectation it can reasonably be considered intensive. Higher density single family dwellings of higher densities (relative to other SFD densities in the municipality) would be considered reasonable (11-13).

In order for a local government to establish Development Permit areas, the objectives that justify the designation of Development Permit Areas and the guidelines that will enable the objectives to be achieved must be established in the Official Community Plan (Local Government Act section 919.1 (2)). The central question that remains is whether local governments can establish guidelines specific to energy efficiency under the auspices of what is permitted for intensive residential and/or what is permitted under commercial, industrial and multi-family. BC Ministry of Community Services staff suggested that because there is no specific clause enabling local governments to regulate for energy efficient development, that the parts of section 919.1 (1) (e) and (f) could be a practical way to go about achieving energy efficiency if there is strong political support at the local level (Fraser Basin Council 2006). However, Ministry of Community Services' staff also noted that the legislation was not drafted with energy conservation measures in mind, and that some types of measures may not be within the scope of the development permit requirements (ibid).

Research for this thesis revealed The City of Richmond provides the only current example of using Development Permit Guidelines to achieve energy efficiency provisions. There could be other examples that the research did not uncover. The City's multi-family building guidelines encourage:

- Sunlight access – a minimum of 75% of dwellings and open spaces are to receive direct sunlight every day of the year
- Minimum north-south spacing between buildings (to avoid shadows)
- Windows oriented to the south in order to maximize solar gain; and,
- Operable windows.

(City of Richmond 1999)

The Distirct of Saanich (2007) recently developed new "Community Design Principles and Guidelines." Part of the guidelines will be used for the District's new Development Permit Area guidelines. Although still in draft format, the guidelines directly address solar orientation, energy efficiency, views, and shadows. Having reviewed the draft guidelines, it would appear the District's revised guidelines are the most audacious attempt to interpret the statutory limitations with an energy efficiency lens. Almost every key passive solar design consideration outlined in Table 8 is directly addressed.

Development Permit Area guidelines are practicable tools to achieve passive solar design and building orientation design practices.

5.4.8. Rezoning Policy

Often a developer will want to build a structure that is of a larger density or different use that the zoning permits. In these situations, the developer will approach the municipality with an application to rezone their property. Council is not required to grant a zoning bylaw amendment, yet is empowered to permit rezoning and exercise its discretion for what land use and density are permitted on the site. Sometimes municipalities agree to accept additional amenities or community benefits, for example, energy efficient building features, in connection with rezoning.

Local government staff are permitted to require the rezoning applicant to prepare a development plan. However, the bargaining conducted by staff cannot contractually bind council to provide the rezoning. Council must maintain its right to exercise its discretion (i.e., have and make a choice) on whether or not a zoning bylaw amendment will be allowed.

Local government staff is permitted to require the rezoning proponent to prepare a development plan. Often the staff will suggest that the voluntary grant of a section 219 Land Title Act covenant from the developer, in order to secure community benefits or amenities, will assist in obtaining staff's favourable recommendation to council to grant a zoning bylaw amendment. (The Sheltair Group 2006). However,

> Such a "bargain" cannot contractually bind Council to provide the rezoning if the covenant is provided, but the court does apparently allow this bargaining by staff for developers to obtain the staff's blessing on a project. (ibid 27)

Bowen Island Municipality developed a Council policy whereby rezoning applicants are strongly encouraged to achieve Built Green™ "Gold", and EnerGuide for New Houses 80 for any new residential development (Bowen Island Municipality 2006). BuiltGreen is a third party building rating system targeted at single family houses and row houses. To achieve the

Gold rating, buildings must reach an EnerGuide rating of 77. Bowen Island Municipality to increase that requirement to 80 in order to support the Province of British Columbia's energy efficiency targets for residential buildings[24].

A council rezoning policy is a good way to go about ensuring passive solar building design and site orientation and energy performance building standards.

5.4.9. Density Bonusing

Density bonusing is a process whereby a local government permits additional density beyond the applicable zoning for the area in exchange for the provision of an amenity (e.g. affordable housing, civic facilities). Planning departments can promote energy efficiency by including high-performance "green" buildings as an amenity (linked to environmental/health benefit) and granting additional density for green building measures.

Section 904 of the Local Government Act allows the provision of additional density where specified amenities are provided. This must be set out in a zoning bylaw. The bylaw must describe the conditions that, if met, will entitle the developer to additional density (e.g., energy efficiency features). If developing a density bonus regime, due diligence is necessary to consider the impact greater density can have on services and the neighborhood, and how much density is required to entice developers to provide an amenity in exchange for more floorspace.

Another mechanism to secure amenities is Phased Development Agreements, brought into force by regulation in June 2007 as Section 905.1 in the Local Government Act. The concept of entering into agreements with developers to provide community "amenities" is made explicitly lawful in this legislation. Advisory materials are being prepared and will be posted on the website of the Ministry of Community Services. Note that the provisions complement those in Section 904; they do not replace them.

As a note of caution, local governments interested in using this tool ought to observe the outright density permitted for each zone. There may be cases where additional density could

[24] The provincial target aims to achieve an EnerGuide for New Houses rating of 80 for every new home by 2010, reducing the average energy consumption in new homes by 32% (Province of British Columbia 2005b).

require a taller structure, potentially resulting dramatic structural changes. There may be cases where a development is already at its threshold density/form for a Part 9 building (i.e. four stories or less) and going higher could mean having to build a Part 3 building (i.e. a concrete versus woodframe). The cost difference could offset the additional revenue derived from the additional density, dissuading the developer from pursuing additional density.

SFU UniverCity Trust (SFU CT) is a unique development situated in the City of Burnaby. They do not hold regulatory power, but work in collaboration with the City of Burnaby to developer policies and guidelines that meet the objectives of the SFU CT. Recently, they developed a green building bonus for features that exceed the minimum Green Building Requirements, mandatory building elements that must be met as a condition of (City of Burnaby) zoning, but as administered by SFU CT. The Green Building Bonus allows for an additional 10% density for green building features in excess of the requirements, as administered by SFU CT. The bonus is granted for:

- Enhanced Stormwater Management – 5% FAR Bonus for enhanced stormwater management systems;
- Enhanced energy efficiency – 5% FAR Bonus for buildings that are the equivalent to 23% better than ASHRAE 90.1 (for part 3 buildings) and meet or exceed EnerGuide 80 and/or R2000 (for part 9 buildings);
- Alternative energy systems – 10% FAR Bonus for installing a renewable or ultra-high efficiency energy system to meet a minimum of 50% of building energy loads, including space heating and domestic hot water.

(SFU Community Trust 2007)

In order to receive the bonus density, the applicant is required to have an approved green building consultant or SFU Community Trust approved alternate with LEED or other green building experience, submit verification.

Density bonusing is potential a way local governments can advance uptake of geo-exchange energy systems and encourage passive solar site design and energy performance building standards.

The next chapter of this thesis includes a discussion of some of the advantages and disadvantages of each policy.

6. Policy Findings Discussion

The focus of this section is to summarize the policy scoping exercise in the previous section and discuss some of the advantages and disadvantages of each policy. Each policy is discussed in terms of five areas:

1. Influence in the community energy management decision-making hierarchy: The CEM conceptual framework guides this thesis. A policy's position in the CEM decision-making framework determines its range of influence on energy use.

2. Applicability: A policy's ability to advance several energy efficiency technologies or design practices (versus just one) makes it multi-dimensional and appeal to a broader constituency.

3. Non-energy co-benefit: Energy management tends not to be local governments' primary focus, particularly in contrast with more immediate responsibilities such as housing choice, mobility, accessible services and citizen safety. Energy-related policies that can be packaged with co-benefits will likely enjoy greater uptake.

4. Political feasibility: Aspects of the policy that can arouse political opposition can make the policy less enticing for local government decision-makers. Some of the pros and cons of each policy are discussed.

5. Administrative feasibility: Policies that are easy for local government staff to administer will likely enjoy greater uptake whereas policies that are untested or come with complex administrative regimes may encounter resistance.

6.1. Position in the Community Energy Management Decision-making Hierarchy

Recall the community energy management decision-making hierarchy presented in chapter two. Policies aimed at altering land use and infrastructure change are at the top of the hierarchy because they influence decisions further down the hierarchy thus having a greater overall (domino) effect. Policies that are directed at the building or site-scale are in the middle. Policies that influence energy end-use decisions are at the bottom of the hierarchy because they do not influence subsequent decision-making. Recall this thesis is not exploring energy-related decisions at the energy using equipment scale because they tend to be private decisions outside the influence of local government policy. Table 10 summarizes where each of the policies identified and described in section five fit within the CEM framework.

Table 10: Policies' Position in the CEM Decision-making Hierarchy

Policy	Land use and infrastructure scale	Building and site scale
Zoning Bylaws	X	
Development Cost Charges Bylaw	X	
Revitalization Tax Exemption Bylaw		X
Comprehensive Development Zoning	X	
Service Area Bylaw	X	
Local Improvement Charge		X
Development Permit Area Guidelines		X
Rezoning Policy		X
Density bonusing		X

Four policies influence change at the land use and infrastructure level. These are preferred because these policies induce broad changes that influence decisions further down the decision-making hierarchy. It could be argued that zoning is at the building and site scale because its primary function is density and land use at the parcel scale; however it is the main policy instrument that determines the spatial structure of an urban area. For instance, clustering high density zones creates the conditions for a transit station or viable district heating system, whereas zoning a neighborhood single family residential and row houses creates low density residential neighborhoods where often even commercial activity is not viable. Developing a finer grain development cost charge bylaw encourages the development of the desired building type and density in a preferred district, thus shaping spatial structure but doing so one parcel at a time. Comprehensive development zoning often includes an assemblage of parcels, thus it is at the land use scale. The service area bylaw, by definition, applies to a precinct and is at the land use scale. The remainder of the policies apply only to the parcel or building scale.

6.2. Applicability

Policies that can be used to advance several or all of the energy efficiency technologies or design practices are more useful for energy management purposes. Table 11 summarizes the applicability of each policy tool to the energy efficiency technologies and design practices described in chapter three.

Table 11: Summary of Policies and Their Applications

Policy	Increased Density	District Energy	Geo-exchange	Passive solar site design and building orientation	Building Performance
Zoning Bylaws	X	X	X		
Development Cost Charges Bylaw	X	X			
Revitalization Tax Exemption Bylaw	X	X			X
Comprehensive Development Zoning	X	X	X	X	X
Service Area Bylaw		X			
Local Improvement Charge		X	X		X
Development Permit Area Guidelines				X	X
Rezoning Policy				X	X
Density bonusing			X	X	X

The Revitalization Tax Exemption Bylaw and Comprehensive Development Zoning encourage the broadest range of technologies and design practices. Almost all of the other policies address two categories. Only the Service Area Bylaw and Development Permit Area Guidelines can be used for just one technology/practice.

6.3. Non-energy co-benefit, Political and Administrative Feasibility

Each of the policies identified in chapter five are discussed in terms of:

- Non-energy related co-benefit;
- Political feasibility; and
- Administrative feasibility

These are important considerations because local governments typically do not have a mandate for energy management, so venturing into energy efficiency policy development may come with some potential pitfalls, but also some advantages.

6.3.1. Zoning

The increased density and mixed use achieved through zoning policy is the foundation for schools of planning such as Smart Growth and New Urbanism. Benefits include increased mobility, increased accessibility to services, minimum density and proximity for viable public transit, contained urban sprawl, and more socially vibrant spaces, to name only a few. Zoning is very multi-dimensional and the energy benefit is one of many.

The numerous benefits of using zoning for the purpose of increased density and greater mixed use is demonstrated above. However, not everyone supports Smart Growth objectives. Common concerns with increased density include crime, ill-health due to overpopulation, urban blight, excessive noise, few play areas for children, and over-crowded schools, to name just a few. Images of New York City's "projects" create mental barriers that prevent those unfamiliar with advances in smart growth and new urbanism from considering the numerous social, economic and environmental benefits of higher density and mixed land use. Overcoming this will take time. In the meanwhile, the real or perceived concerns are enough to weigh against some of the benefits of higher density, mixed use zoning regimes.

From an administrative perspective, observing what is outlined in the zoning bylaw and/or Official Community Plan results in no additional work for local government staff. This policy is practicable.

6.3.2. Development Cost Charges

The primary benefit of adjusting the Development Cost Charges bylaw so DCCs reflect the true capital cost of a development is equity-related. When the DCC bylaw is more 'fine grained', buildings in high density areas pay DCCs that better reflect the true capital burden imposed on the municipality to service those buildings. From a financial perspective, lower DCCs result in more favorable conditions for profitable development, which encourages development in higher density areas. From a societal perspective, a more equitable DCC structure ensures everyone pays for the municipal services their building will depend on, no more, no less. A finer grained DCC bylaw promotes equity and avoids cross-subsidization.

Refining the DCC bylaw so it is finer grained encourages Smart Growth and higher performance buildings. These types of development impose a lower capital burden on the municipality. Thus, DCCs that reflect the true capital burden of a development is equitable. This policy is attractive.

Adjusting the Development Cost Charges bylaw requires some upfront analysis and a proposal to change the bylaw. Public consultation may be required. However, once the bylaw is passed, no additional work is required, making this policy reasonable from an administrative perspective.

6.3.3. Revitalization Tax Exemption Bylaw

A Revitalization Tax Exemption Bylaw can be used to promote higher density development and LEED-rated buildings. Though LEED includes energy-related considerations, other benefits include water efficiency and conservation, indoor air quality, and sustainable materials section, to name just a few. This policy promises benefits beyond energy efficiency.

A bylaw that offers tax exemptions to developers who wish to pursue projects in a predetermined area encourages density and provides a financial incentive, making it a fairly non-oppositional policy.

A tax exemption bylaw requires some adjustments to the property tax regime for buildings that qualify for the incentive, but only for a pre-determined number of years. In the case of Maple Ridge, the Revitalization Tax Exemption bylaw applied for four years at the most. This policy is fairly practicable.

6.3.4. Comprehensive Development Zoning

Comprehensive Development Zoning, in most cases, leads to higher density, mixed use development. Recall how the all the buildings in the City of Langford's Westhills development are required to be LEED certified (Part 3 buildings) or Built Green (Part 9 buildings). As discussed previously, green buildings such as LEED and Built Green promise a range of benefits beyond energy efficiency. As well, higher density, mixed use developments are appealing for reasons similar to those explained in the zoning section (e.g. mobility, accessibility, transit, etc).

This type of zoning is a negotiation between the development proponent and the local government. Assuming the developer would not enter into a zoning regime that was not to their benefit, this is a policy where both parties get either exactly what they want or what they can live with. This policy is attractive.

Assuming the parcel or assemblage of parcels is/are undergoing a rezoning process anyway, using this policy to achieve energy-related objectives is a little more work and complexity but practicable.

6.3.5. Service Area Bylaw

The City of North Vancouver's Service Area Bylaw ensures all new development is conducive to the City's existing district heating system. Arguably, building occupants that are connected to a district heating system will enjoy lower operating costs, however, in the case of multi-family buildings this benefit may be offset by the higher capital costs imposed on the developer for installing forced air or a hydronic heating system (the default heating system in the Vancouver area is electric-resistance to due lower up front (capital) costs. The costs and benefits are debatable but the single, energy-related focus of this policy is clear. This policy does not promise a non-energy related co-benefit.

The City of North Vancouver has enjoyed considerable success in winning awards and drawing positive attention around its district heating system (City of North Vancouver 2004). From a political perspective, this policy is moderately attractive.

The Service Area Bylaw adds an additional layer to the building permit process plus an administrative layer to oversee the connection of buildings and ongoing monitoring to the district heating system, suggesting this policy comes with some administrative onus.

6.3.6. Local Improvement Charges

For the purposes of this thesis, the Local Improvement Charge policy was considered only within an energy-related context, despite being used often for improvements to things such as paths and roadways in specific neighborhoods. Similar to the Service Area Bylaw, one could argue that more efficient energy systems lead to lower operating costs for occupants. However, more efficient energy systems tend to come with higher up front capital costs, and, in the case of LICs, those up front costs are borne by the municipality (yet ultimately recovered through the LIC). Because this is not a financial or economic evaluation-oriented thesis, I will not delve into an exploration of financial or societal costs and benefits. Suffice to say that the energy benefits are clear but additional benefits are not as clear.

Using Local Improvement Charges to achieve energy-related objectives is deemed possible by professional legal opinion but remains untested in British Columbia. Though some decision-makers may want to be the first to use this policy tool for energy-related purposes, most probably want to avoid an untested option, and the lack of uptake in B.C. supports this claim.

Using Local Improvement Charges to achieve energy-related objectives puts the local government in the position of being a financier of energy systems. Also, if a landowner defaults on their LIC, the onus is on the local government to recover its initial investment through legal channels. There is also the added layer of adding the LIC to property owners' annual property tax. All of these factors make this policy administratively onerous, not to mention potentially political dangerous.

6.3.7. Development Permit Area Guidelines

Using Development Permit Area Guidelines to achieve energy-related objectives promises no net non-energy co-benefits. One could argue that passive solar and natural ventilation results in more comfortable living and working spaces. However, a similar comfort level can be achieved by turning up the heat, turning on the lights, or running the air conditioning. This policy is considered one dimensional.

Using Development Permit Area Guidelines to achieve energy-related objectives require architects and in some cases consulting engineers to give a little more thought to buildings and site layout at the design stage. But DPA guidelines cannot require additional mechanical equipment, just design requirements, so marginal costs are limited if not non-existent.

Development Permit Area Guidelines are a family policy instrument to local governments. Adding an energy-related design requirement would require planners to consider a broader range of design issues, but not much more. This policy is fairly practicable.

6.3.8. Rezoning Policy

In the example identified in the policy scoping exercise, the rezoning policy description included using a third-party building labeling program, Built Green. Similar to LEED, Built Green also requires builders to pursue water conservation and efficiency, indoor air quality and sustainable materials measures. When the policy incorporates a broad range of 'green' features, the benefits go beyond energy efficiency alone.

An energy-related rezoning policy imposes additional costs on developers in exchange for council granting a rezoning. Previous to the development of the Bowen Island Municipality rezoning policy, there was not an example of where energy efficiency features were sought. Developers not already pursuing energy efficient development would consider energy an extra 'ask'. This policy requires a little more political aggressiveness and may not suit those governments concerned with dissuading new development. However, it results in public benefit, and thus is appealing to the community at large. This policy is beneficial to some and imposing to developers. From a political perspective, I consider it moderately attractive.

An energy-related rezoning policy requires planners to consider a broader range of issues. However, as is the case with Bowen Island Municipality and the City of Langford's Westhills development, a third party building rating system is used. This takes the onus off of local government to ensure the building meets basic requirements. Instead, the local government relies on Built Green (in Bowen's case) and LEED (in Langford's case) for assurance. This policy is fairly practicable from an administrative standpoint.

6.3.9. Density Bonusing

Density bonusing awards additional density in exchange for building features or contributions that are perceived as being of benefit to the community. Energy can be one of those community benefits. When the policy is used for energy-related objectives, there are no other benefits.

Density bonusing grants additional density for an energy efficiency upgrade, quid pro quo. Being more of a negotiation than an imposed regulation or standard it is moderately attractive from a political perspective.

Density bonusing is common practice in local governments. Adding energy efficiency to the list of potential amenities local governments can bargain for would not impose additional administrative burden, making this policy practicable.

Table 12 summarizes the non-energy benefits of the identified policies.

Table 12: Summary of Policies' Dimensionality

Policy	Multi-dimensional	One-dimensional
Zoning Bylaws	X	
Development Cost Charges Bylaw	X	
Revitalization Tax Exemption Bylaw	X	
Comprehensive Development Zoning	X	
Service Area Bylaw		X
Local Improvement Charge		X
Development Permit Area Guidelines		X
Rezoning Policy	X	
Denisty bonusing		X

The summary table shows that five policies have non-energy co-benefits whereas four policies are strictly energy-focused, likely with less broad appeal.

Table 13 summarizes the political feasibility of the identified policies.

Table 13: Summary of Policies' Political Feasibility

Policy Instruments	Attractive	Moderately attractive	Not attractive
Zoning Bylaws		X	
Development Cost Charges Bylaw	X		
Revitalization Tax Exemption Bylaw	X		
Comprehensive Development Zoning	X		
Service Area Bylaw	X		
Local Improvement Charge			X
Development Permit Area Guidelines	X		
Rezoning Policy		X	
Density bonusing	X		

Each of the policy's political attractiveness is summarized in Table 13. Most are attractive. Only two are not attractive. Using Local Improvement Charges for energy-related purposes is untested and therefore would come with some potential political risk. A rezoning policy, though not regulatory in nature, establishes an expectation of builders to meet a minimum standard. Without the policy, that expectation would not otherwise exist. Decision-makers may encounter some opposition to the policy and possibly even encounter builders who refuse to meet the standard set out in the policy.

Table 14 summarizes the policies' administrative feasibility.

Table 14: Summary of Policies' Administrative Feasibility

Policy Instruments	Practicable	Moderate	Onerous
Zoning Bylaws	X		
Development Cost Charges Bylaw	X		
Revitalization Tax Exemption Bylaw	X		
Comprehensive Development Zoning	X		
Service Area Bylaw		X	
Local Improvement Charge		X	
Development Permit Area Guidelines	X		
Rezoning Policy	X		
Denisty bonusing	X		

Most of the policies shown in Table 14 are fairly practicable, promising low administrative burden. This bodes well for energy efficient policy development that tends to require a local government champion to shepherd the policy development through administrative, political and implementation channels.

Local governments have a wide range of policy instruments available to them to reduce energy use and emissions in buildings. Policies that are equitable and show a benefit to the developer – Development Cost Charges, Revitalization Tax Exemption Bylaw, Comprehensive Development Zoning, and Density Bonus – are the strongest. These policies are:

- Effective: they are high up in the community energy management decision-making hierarchy, and have the ability to exert their influence in lower strata of the hierarchy;
- Widely applicable: they either directly advance energy efficient buildings, or can play an integral role in creating the conditions for higher performance buildings;
- Appealing for their non-energy benefits: they promise benefits beyond energy efficiency and emission reductions. This is of great importance because local governments do not have a mandate for energy management and it is typically considered outside the purview of municipal level governance;
- Easy to administer: they do not require extraneous administrative systems or layers, or require staff to venture into areas where they have little knowledge; and,
- Politically-friendly: decision-makers do not need to fear political opposition to these policies, and in fact may enjoy broad recognition.

7. Policy Implications and Further Research

Local governments can use a number of policy instruments to reduce building-related energy use and emissions. This thesis used a community energy management decision-making hierarchy conceptual framework that demonstrates most of local governments' influence is at the land use and site-level scale. This bodes well for energy and emissions reduction strategies because decisions higher up the CEM framework affect larger areas, influence decisions further down the hierarchy and ultimately can lead to greater emission reductions.

Most of buildings energy consumption is for space heat or hot water. The five technologies and design practices examined – increased density, district energy, geo-exchange, passive solar and natural ventilation, and high performance building labeling – all directly address heat and hot water use. Knowing the threshold or necessary conditions to make these technologies viable allows local governments to tailor policies to advance them. The case study revealed many potentially effective policies, but it is important to note that these results are specific to British Columbia. Below are key lessons learned to help guide other jurisdictions interested in exploring the role of local governments in advancing energy efficiency.

- In Canada, provincial governments have authority over building codes, leaving local governments little power to advance energy efficiency for the building envelope (e.g. windows, insulation). However, there are areas where local governments have power to influence land use and building- and site-scale decisions, which ultimately influence energy use. Most notably are policy instruments that advance high density, mixed use development and, in particular, those instruments that provide financial benefit to developers. Examples of such policies are development cost charges, revitalization tax exemption bylaw, density bonus, and comprehensive development zoning.
- Due to the influence planners can have over on energy use through land use and site level decisions, they can make a difference in areas typically dominated by economists and engineers. It is important for planners to realize their full potential in energy management and, in particular, how their decisions influence decisions lower down in the energy management decision-making hierarchy.

- Local governments have greater authority to influence building practices in situations where they are empowered to exercise discretion. The best example of this is via the rezoning processes. Policies related to rezoning include comprehensive development zoning and site specific rezoning policy such as the one developed at Bowen Island Municipality. Local government councils are not obligated to grant a rezoning, so they are well positioned to ask a developer to contribute something of benefit to as part of the rezoning application. In the case of wanting to advance energy efficiency through the rezoning process, it should be clearly stated in the Official Community Plan that energy efficiency and/or sustainable energy is considered to be a benefit to the community.
- Local governments can drive change in policy at higher orders of government. Because local governments have the ability to impose much higher standards than what is in the provincial building code (for example, through rezoning), they are in a position to usher more stringent standards into the marketplace. In this sense, local governments can be the driver of increasingly progressive provincial and federal level energy codes. Indeed, we are seeing that in British Columbia where 17 local government councils recently passed resolutions requesting the province to either establish higher energy efficiency standards for buildings, or give local governments the authority to do so (UBCM 2007). Local governments' ability to expedite energy efficiency market transformation should not go unnoticed by advocacy groups wishing to advance energy efficiency and energy utilities, who are financially motivated to increase energy efficiency[25].
- Local governments in Canada do not have a mandate or responsibility for energy management, but do so for other reasons. These reasons include civic pride, environmental ethic, to encourage livable communities, manage for occupant affordability, and a desire to demonstrate political leadership. There is no revenue stream available to local governments to develop energy related policy, so developing policy will mean absorbing costs to develop policy and in some cases monitor compliance (e.g. rezoning). Local governments may be able to influence energy use if they had access to greater resources.

[25] Utilities are tasked with providing low-cost, reliable power to ratepayers. Energy efficiency is widely regarded as one of the more economical options. In this sense, energy efficiency can be thought of as a form of energy supply, similar to a hydro-electric dam or thermal electric generating plant: a unit of energy not used is one that does not have to be generated.

- Although the provincial government has overall responsibility for the BC Building Code, local governments have many policy-based tools available to help them advance energy efficiency in private-sector buildings. That said, there are statutory limits to what local governments can do, and more enabling legislative authority would allow local governments to optimize their role as a key point of contact in the development process.

The research for this thesis was limited in several ways. First, there is very little quantitative data that compares the overall energy consumption of urban areas at different densities. It would be very useful to conduct a study similar to the study that Lariviere and Lafrance (1999) conducted when examining the effect of density on electricity use in Quebec. Conducting a broader study that assessed the effect of density on all fuel types would be better because so much space heat (the largest energy consumer of buildings) is generated from burning natural gas. Ideally, a key objective of such a study would be to determine whether it is possible to calculate optimal density and land use mix for reducing buildings' energy consumption. The results of such research would help inform future zoning practices.

Secondly, there is very little survey work done to assess the attitudes of Canadian planners regarding community energy management. The survey conducted by the American Planning Institute would provide a useful foundation. It would be useful to see if there are differences in attitudes between American planners and Canadian planners. Knowing how Canadian planners feel about tackling energy management and their specific interest areas could help focus policy research in that specific area.

Thirdly, broadening the case study in this thesis to include several other Provinces would make the findings more widely applicable, screen for anomalies, and build a stronger case for realizing local governments' full potential to reduce buildings' energy use and emissions. Though this thesis demonstrates that British Columbia local governments have a strong role to play in energy and emissions management it would be good to validate the ability of other local governments to have as much or hopefully more influence. Reducing Canada's greenhouse gas emissions depends on it.

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