Implementing District Energy Systems: Municipal Approaches To Overcoming Barriers

By

Kevin George Simpson

B.A., Bishop's University, 1991
Dipl., BCIT, 1996

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We accept this thesis as conforming
to the required standard

.....
Dr. Charles Krusekopf, Thesis Supervisor
Royal Roads University

.....
Dr. Chris Ling, Thesis Coordinator
School of Environment and Sustainability

.....
Michael-Anne Noble, Director
School of Environment and Sustainability

ROYAL ROADS UNIVERSITY

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Abstract

Climate change and energy security are issues facing municipalities throughout the world. Efficient, resilient, sustainable, community-based energy systems, such as district energy systems (DES), fuelled mostly by renewables, are an important tool for addressing both climate change and energy security at the municipal level. In spite of their benefits, DES are not widely adopted in Canada (CDEA, 2011). This is due to the complex nature of the barriers which project proponents face. This thesis examines the experience of the City of Prince George in adopting and implementing the Downtown DES. Using a case study methodology, data was collected through a review of relevant municipal documents and a series of semi-structured, open-ended interviews. A thematic analysis revealed unexpected barriers related to lack of adequate public consultation and negative perceptions regarding biomass as a fuel for the DES. These ‘lessons learned' were then developed into recommendations for other municipalities considering DES.

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Table of Contents

List of Tables

List of Figures

Chapter 1 - Research Introduction

Introduction

Climate change and energy security are two global-scale challenges currently facing all levels of government in Canada (Province of British Columbia, 2007a; "Energy Security: A Canadian Perspective", 2011). However, the community or municipal scale is typically where those challenges manifest themselves, and is where the response to them is applied (Burch, 2010a). Efficient, resilient, sustainable, community-based energy systems, fuelled mostly by renewables, are an important tool for addressing both climate change and energy security at the municipal level. District energy systems (DES) are one example of such a system. Climate change responses such as these face many barriers to their successful establishment.

Recent research by the Canadian District Energy Association (CDEA) has identified the municipal or community level as the location for most challenges associated with district energy system uptake (2011). The City of Prince George has recently completed construction of the Downtown DES, after first discussing the project over a decade ago. Therefore, by identifying the strategies and tools employed by the Prince George project proponents, my research can increase the chance of successful uptake of district energy systems in other communities. This case study: examines the recently constructed city of Prince George Downtown DES; investigates how the project proponents overcame barriers to implement the system; and makes recommendations regarding the implementation of municipal DES.

The Intergovernmental Panel on Climate Change (IPCC) released its fourth assessment report on climate change in 2007, in which they state that "warming of the climate system is unequivocal" and, anthropogenic GHG emissions are the driver behind the warming of the

climate: “there is *very high confidence* that the global average net effect of human activities since 1750 has been one of warming” (IPCC, 2007, p. 37). The consequences for ecosystems as a result of climate change will be extensive and profound. Energy security issues, such as increasing competition for scarce energy resources and the accompanying rise in prices can be seen as a significant threat to economic growth (Hughes, 2009). Either of these challenges alone would be difficult to solve, taken together the task becomes that much harder.

Reducing energy demand through both efficiency and conservation will require a new, de-centralised approach to the energy system (Dusyk, Berkhout, Burch, Coleman & Robinson, 2009). A renewable-resource based, smaller scale, more integrated energy system is one solution. The term Integrated Community Energy System (ICES) is used to describe such a system (Bataille et al., 2010). District energy systems are one example of ICES. They are recognized for their effectiveness in achieving improved energy efficiency, increased energy system resilience and lower GHG emissions. DES are an approach to meeting the thermal heating requirements of residential, commercial and industrial buildings through an integrated system of pipes connected to a central heat source (Gilmour & Warren, 2008).

However, their acceptance has not been widespread in Canada. Municipal responses to climate change, including supporting the uptake of DES, face many barriers. There are inter-twined social, economic and environmental factors at play in both the development and operation of the urban environment and its energy system. These factors lead to organizational, institutional and behavioral barriers, create market failures and combine to create a situation of path dependency, where resistance to change comes from many sources (Burch, 2010a; Weber, 1997). Kenworthy sees changing the forms and patterns of urban development as an especially difficult process, a sentiment that applies to the urban thermal heating sector (2006).

The purpose of this case study is to examine the barriers to implementation faced by the Prince George Downtown DES, and the strategies and tools used by Prince George staff and council to identify and overcome these barriers. When implementing green initiatives, municipalities face barriers related to capacity, but also face systemic barriers. Human factors and systems which affect the implementation of DES, rather than the technical aspects, are the focus of this research project. Although technical aspects, such as energy source, energy demand and distribution networks are important considerations, they are less of an implemental challenge than those associated with "human factors" (Thollander, Svensson, Trygg, 2010, p. 3651).

Climate Change and Energy Security

Canadian energy use and GHG emissions are growing. From 1990 to 2008, energy use increased approximately 26%, and GHG emissions increased approximately 17% (Government of Canada, 2011a; Government of Canada, 2011b). Climate change is the result of accumulating amounts of greenhouse gases (GHGs) in the atmosphere, mostly from the combustion of fossil fuels for transportation, thermal needs and electricity generation. It is widely acknowledged as a significant threat to ecosystems and the social and economic systems that depend on them (See for example, (Orr, 2009; Simpson, Jaccard & Rivers 2007; Weaver, 2008). Energy security refers to the resilience of the energy system and its ability to ensure "access to adequate, reliable, affordable and cleaner energy" supplies ("Energy Security: A Canadian Perspective", 2011, para #6). Threats to energy security include increasing demand from consumers, reliance on a mostly finite fossil fuel resource and an ageing energy distribution network. Because of the inter-connected nature of climate change and energy security, often a solution that addresses one of them can effectively address both (Hughes, 2009).

Current Policy Framework in British Columbia

In spite of withdrawing from the Kyoto Accord, the Canadian government signed the Copenhagen Accord in December 2009, setting a GHG emissions reduction target of seventeen percent below 2005 levels by 2020 (“Canada's Action on Climate Change”, 2011). British Columbia, through the Greenhouse Gas Reduction Targets Act of 2007, has a legislated provincial GHG emissions reduction target of at least thirty-three percent below 2007 levels by 2020. Recognizing the key role played by municipalities in achieving this reduction, the government passed Bill 27 — 2008: Local Government (Green Communities) Statutes Amendment Act, requiring local governments to set GHG emission reduction targets, as well as implement strategies and policies to support those targets in their Official Community Plans (OCP). The Act also amends the Local Government Act to require the establishment of objectives and strategies for reducing energy, water use, and GHG emissions in regional growth strategies.

Additionally, the provincial government, the Union of British Columbia Municipalities and most municipal governments in BC (including Prince George) have signed the British Columbia Climate Action Charter, a non-binding, but public, commitment to carbon neutral operations and GHG emissions reduction targets. The Climate Action Charter reinforces the leadership role played by municipalities in achieving GHG emissions reductions, acknowledges the interdependent relationship between the province and municipalities in achieving GHG emissions reductions, and seeks to build on ongoing efforts to create more sustainable communities (Province of British Columbia, 2007b).

Municipal Energy Challenges and Opportunities

For many municipalities in British Columbia, including Prince George, meeting their emissions reduction targets will be difficult, as they are experiencing population growth and corresponding increases in energy demand. Urban GHG emissions from the transport, residential and commercial / institutional sectors account for forty percent of Canada's total emissions (Bataille et al., 2010). In 2008, approximately eighty percent of residential energy use and GHG emissions resulted from space and water heating (Government of Canada, 2011a). That same year, energy use and GHG emissions from space and water heating accounted for approximately fifty-five percent of total energy use and GHG emissions in the commercial/institutional sector (Government of Canada, 2011a). Waste heat accounts for approximately fifty percent of the energy from these two sectors (Bataille et al, 2010). This presents a significant opportunity for improved energy efficiency and reduced GHG emissions in the thermal heating sector.

Adding to the complexity of these challenges are many barriers to community sustainability, including: infrastructure replacement, brownfield re-development, urban renewal and energy planning, where, "…there is a long history of centralised control of energy policy and planning" (Rogers, Simmons, Convery & Weatherall, 2008, p.4225). These challenges also provide opportunities to move communities onto a more sustainable path. Municipalities in British Columbia have begun to engage in energy and emissions planning as a way to address the challenge of escalating GHG emissions. Municipal policy shapes the urban form, which in turn creates the environment for households and businesses to make energy and emissions decisions (Bataille et al., 2010). Therefore, municipal governments have a leadership role in creating an environment where households and businesses can make sustainable energy decisions. This role will require implementing a variety of new policy measures, as well as building new

partnerships. One strategy municipalities can employ is encouraging and supporting the use of DES in their communities.

District Energy Systems

Physically, district energy systems are centralized systems that supply heat and hot water to commercial and residential buildings through a network of pipes (Ghafghazi, Sowlati, Sokhansanj & Melin, 2009). DES can also be thought of as community level energy management systems, where energy is converted, distributed and consumed locally (Church, 2007). They have the potential to lower municipal emissions through several means, including: reductions in fossil fuel use through enhanced efficiency (optimized boiler use); fuel switching from non-renewable sources to renewable; and smoothing out energy demand loads by balancing commercial, industrial and residential use (Gilmour & Warren, 2008). DES promotes energy cascading through more efficient use of energy. Energy cascading is the matching of energy use with energy quality (Bataille et al., 2010). In the case of the Prince George Downtown DES, waste energy from industrial processes at Lakelands' mill site can be used to replace the energy from electricity or natural gas required for commercial and residential heating. This allows the electricity to then be used for better purposes, such as operating electronic devices, while at the same time reducing GHG emissions by displacing fossil fuels.

DES help to address energy security issues as they are more resilient than individual building systems, in that they can accommodate many fuel types, including renewables, from multiple and diverse sources (Harvey, 2006). This makes them less susceptible to supply interruptions that accompany traditional energy distribution networks. In addition to reduced energy use and GHG emissions, district energy systems create local economic and social benefits. Because DES can use locally sourced energy supplies, such as waste heat from nearby

industrial processes, as opposed to, for example, natural gas produced in a remote location and transmitted to the community, local jobs are created. District energy supplied by municipal utilities has the potential to provide new revenue streams to local government without raising property taxes. The social benefits that accrue from district energy include raising community awareness of sustainability issues, and in the case of the Prince George Downtown DES, a reduction in fine particulate matter emissions, which is expected to lead to improved health outcomes.

An Unexpected Turn of Events

An energy supply agreement with Lakeland Mills Ltd. is in place to guarantee the energy source for the Downtown DES for 10 years (City of Prince George, 2010b). In early 2012, the City finished building an energy transfer station at the site of the Lakeland Mills sawmill, which was to be the main energy supply for the system. The city also contributed to the optimizing of the existing boiler system, which Lakeland used for process heat. The fuel source for the system is hog fuel – essentially sawdust and bark from the saw mill ("hog fuel", 2012) that was previously both hauled away to other customers and burnt on site to heat the companies' kilns. The energy transfer station was to be operated by staff from Lakelands Mills. However, on April 23rd, 2012, the saw mill at Lakelands' Prince George site was destroyed when it exploded and caught fire (Hoekstra & Carman, 2012). The loss of the saw mill building resulted in a decrease in on-site mill residue being produced to feed the Downtown DES. In spite of this, Lakeland Mills remained committed to maintaining its agreements with both the city and UNBC (K. Brown, personal communication, May17, 2012). These commitments will be met through an agreement with Canfor Pulp. The agreement will see Lakeland supply chips and logs to Canfor in exchange for hog fuel, which will be used to feed the energy plant (Peebles, 2012).

Research Objectives and Questions

In order to understand how the experiences of jurisdictions that have installed DES may be applied to current and future district energy system projects, these experiences must be collected, compiled and analysed. While avoiding the mistakes of others is a worthwhile goal on its own, creating an environment where DES and other community energy solutions can thrive is required to increase its market penetration and contribute to the process of reducing municipal emissions. It is important to understand both the unique and universal barriers to the Prince George Downtown DES, and also examine key factors that allowed for the project to move forward. By identifying the complex social, environmental and economic trade-offs associated with the Prince George system, and establishing how that information was used to guide the thought process of Prince George decision makers, a real-world example of DES uptake will unfold. Therefore, the objective of this paper is:

1. To identify the perceptions of Prince George politicians, executives and managers with respect to district energy systems and their benefits.
2. To identify the barriers that inhibited the uptake of the Downtown DES.
3. To identify the approach taken by Prince George city council to overcome those barriers.
4. To develop recommendations for municipal governments on how they might implement DES in their community.

Based on the research objectives, the research questions are:

1. Why did the Prince George city council pursue the Downtown DES?
2. What were the main barriers to DES uptake in Prince George?

3. How was the city of Prince George able to overcome barriers and implement the Downtown DES?
4. What was the role of Prince George in increasing DES uptake in relation to its other partners?

Significance of Research

The municipal level is seen as the location with the most influence over uptake of district energy systems and as a location for implementing sustainable energy policies. New local partnerships between government, businesses and the community will be required to align the goal of reduced emissions with competing economic and social objectives. This research supports municipalities in their attempts to implement district energy systems by sharing the experiences of other jurisdictions. Previous studies have identified a number of areas where challenges and opportunities for district energy system implementation including: the regulatory environment, governance structures, ownership models and the encouragement of participation by both potential suppliers and customers (Bataille et al., 2010). This case study focuses on these challenges and opportunities in the context of the Prince George Downtown DES and provides new information to help guide municipalities and other stakeholders with regard to the development of DES.

Chapter 2 - Research Methodology and Case Description

Introduction

This chapter provides details regarding the Prince George Downtown DES case study, including case selection and description; research methodology and design; interview subject identification and selection; data collection, storage and analysis; and ethical considerations are outlined below. The types and sources of data collected and the rationale for their selection has been summarized in Table 1.

Table 1 *Data Selection*

Data Type	Source of Data	Rationale
Primary and secondary municipal documents	City of Prince George website and staff.	Provides evidence of project scope, timeline, and key parties. '*The public record*'.
Interview	Respondent 1 – Dan Rogers. Former councilor and mayor of Prince George	Provides evidence of: historical perspective, project timeline, 'political' context, commitment of leadership, and links to strategic objectives.
Interview	Respondent 2 – Bob Radloff. Former general manager of development for the City of Prince George? and former Downtown DES project manager	Provides evidence of: historical timeline, project details, and 'political' context.
Interview	Respondent 3 – Kristy Brown. Current utilities department supervisor for the City of Prince George, and Downtown DES project manager.	Provides evidence of: operational issues, operational perspective and project details.
Interview	Respondent 4 – Gina Leyte Liston. Current City of Prince George utilities department supervisor. Former environmental coordinator.	Provides evidence of: historical perspective, project timeline, 'political' context, and project details.
Interview	Respondent 5 – Greg Anderson. Current City of Prince George civic facilities manager.	Provides evidence of: Downtown DES customer perspective, and linkages to other aspects of Prince George operations.

Data Type	Source of Data	Rationale
Interview	Respondent 6 – Kristiina Watt. Current City of prince George community planning department supervisor.	Provides evidence of: linkages to other aspects of Prince George operations and strategic plans.
Interview	Respondent 7 – Chris Bone. Current manager of communications and citizen engagement for the City of Prince George.	Provides evidence of: City of Prince George approach to communications and public engagement.
Interview	Respondent 8 – Garth Frizzell. Current Prince George city councilor.	Provides evidence of: 'political' context, commitment of leadership, and links to strategic objectives.

Research Conduct

This research project was conducted in accordance with Royal Roads University ethical guidelines and policies and procedures, including: Royal Roads University Research Ethics Policy (2011); Royal Roads University (RRU) Policy and Procedures on Academic Integrity and Misconduct in Research and Scholarship (2010); and Royal Roads University Request for Ethical Review For Research Involving Humans (2011).

Case Study Selection

Like other communities in British Columbia that are signatories to the Climate Action Charter, Prince George is required to reduce corporate GHG emissions and has also set a target for community-wide emissions reductions. The citizens of Prince George have firsthand experience with climate change related issues, where the mountain pine beetle outbreak, exacerbated by mild winters, has devastated local forests. Their approach to these issues consists of mitigative and adaptive measures. On the mitigative side, the city has joined the Partners for Climate Protection, an initiative of the Federation of Canadian Municipalities (FCM) which promotes greenhouse gas (GHG) reduction strategies; is a signatory to the BC Climate Action

Charter, which commits the city to carbon-neutral operations by 2012; and is switching to district energy for heating buildings in the downtown core. In support of these initiatives, the city has developed several strategies and plans, including an Energy and GHG management plan, which has the implementation of a DES as its first priority (The Sheltair Group, 2007).

The Prince George Downtown DES was initially selected as the location for this case study for two reasons: it has not been previously studied; and there are broad similarities between Prince George and other communities in British Columbia with respect to the availability of biomass as a fuel. Like Prince George, many B.C. communities have nearby sawmills producing wood waste that could be used to fuel a DES. This similarity allows the results and conclusion of the investigation to be applied to other jurisdictions. Once I began investigating the Downtown DES, I realized that Prince was George was an excellent site for examination due to the various iterations that the system has been through leading up to the existing configuration and implementation.

Case Study Description

The City of Prince George is located in Northern British Columbia, at the confluence of the Fraser and Nechako rivers in the traditional territory of Lheidli T'enneh First Nation. It is a major service hub for Northern British Columbia, with the economy rooted in both the private and public sectors (“Welcome to BC’s Northern Capital”, 2012). The original proposal included plans to build a biomass-fuelled combined heat and power (CHP) cogeneration plant (Federation of Canadian Municipalities, 2003). The plant configuration and location changed over the years, with a city-owned energy plant near a residential neighbourhood brought forward in the mid 2000s. This last iteration of the DES ran into significant public opposition from local citizens,

who were concerned with air quality, and the impact that a biomass energy plant would have on the local airshed (Hay, 2008; Hoekstra, 2008). This theme will be discussed later in the thesis.

The current Downtown DES configuration differs from the earlier plans in that it makes use of an existing facility, does not produce electricity and has new project partners. The source of thermal heat for the system comes from an existing energy plant located on the site of a local sawmill owned by the city's partner, Lakeland Mills Limited. This partnership is governed by an Energy Supply Agreement, a contract which will be explored in chapter four. Lakeland Mills is owned by the Sinclar Group, which owns eight sawmills in Northern British Columbia ("about Sinclar", 2012). Sinclar is a company that has been using the bioenergy market to diversify its customer base and products; reduce its carbon footprint; as well as reduce its exposure to volatile energy prices. For example, the company produces pellets for use in wood stoves and uses biomass to meet its own operational energy needs (Williams, September 17, 2011). Besides its partnership with the city in the Downtown DES, Lakeland supplies biomass to the University of Northern British Columbia (UNBC) for their biomass gasification system ("Local Sawmill to Provide Fuel to UNBC Bioenergy Facility", 2012). UNBC won a campus sustainability award from the Association for the Advancement of Sustainability in Higher Education (AASHE) for the installation of the gasification system ("Canada's Green University", 2012). The Sinclar Group sees the project as part of its commitment to community development and an opportunity to support education and research in the bioenergy sector ("Local Sawmill to Provide Fuel to UNBC Bioenergy Facility", 2012).

The city owns the main components of the DES, including the: energy transfer station on the Lakeland Mills site; distribution piping system; peaking backup energy centre and the energy transfer stations in the buildings that are connected to the system (City of Prince George, 2012).

The Downtown DES was developed by the utilities and environmental departments, and is currently operated by the utilities department, although Lakeland maintains and operates the facilities on its site. At the time of writing, a decision between governance models had not been made, with the options being an internal city department, similar to the current utilities department; or a city owned corporation, which would operate at arm's-length (K. Brown, personal communication, May 17, 2012).

The total budget for the system is $14,141,000, with funding coming from several different sources. Of that total, $13,846,000 goes to capital costs, with the remainder spent on pre-design and feasibility studies (City of Prince George, 2010a). The city received three one-time grants totaling $10,159,000 to assist in the funding of the DES. These came from the Municipal Rural Infrastructure Fund (MRIF) - a program of the Canadian and BC governments; the Green Municipal Fund (GMF) - a program of the Federation of Canadian Municipalities (FCM); and the Community Works Fund (CWF) - a program administered by the Union of BC Municipalities. The city is borrowing the remainder of the required funding from the FCM. The city also plans to apply $100,000 per year in ongoing funding from the CWF to the project for the first ten years (City of Prince George, 2010a). These grants allow the city to charge a relatively low rate for heat (80% of the price of natural gas) to its customers, and still pay off system related debts by 2022.

Table 2 *Ongoing Financials*

Item	Revenue or Expense	Source	Comment

Item	Revenue or Expense	Source	Comment
CWF Grant	Revenue	Union of BC Municipalities	$100,000 / year for first ten years of operation
Energy Sold	Revenue	Buildings connected to the Downtown DES (City itself / provincial government)	Includes capacity charge and energy charge
Operating expenses	Expense	City staff labour and fixed costs	Payment for city staff to operate Downtown DES
Payments to Lakeland Mills	Expense	City, from Downtown DES revenue	Bylaw 8296 – Lakeland Energy Supply Agreement
Debt re-payment	Expense	GMF repayment	Last payment in 2022

The city is taking a phased-in approach to the building of the Downtown DES. Construction in phases allows for construction related disruptions to be minimized and eases the up-front financial burden. At the same time, the system is being sized to accommodate a larger future load allows for easier expansion. Construction of the energy transfer stations and the peaking backup energy system was completed spring of 2012 (“Downtown District Energy System”, 2012). Phase one of piping construction began in the summer of 2011 and was completed at the same time. Phase two of the piping construction took place from August to September of 2012 (City of PG website, 2012). Two of the main challenges associated with the construction phase were: the crossing of the CN rail yard (which, along with requirements associated with federal grants, triggered a Federal Environmental Impact Assessment); and the disruption to downtown businesses caused by street and sidewalk excavation (K. Brown,

personal communication, July 24, 2012; Williams, October 20, 2011). Construction was completed on-budget and essentially on-time (K. Brown, personal communication, July 24, 2012).

The fuel source for the energy plant is biomass, consisting of hog fuel from Lakelands' sawmilling operations. Hog fuel is typically made up of bark, saw dust and other waste products associated with the sawmilling process ("hog fuel", 2012). Prior to construction of the energy plant, Lakelands either trucked their hog fuel to local pulp mills or used it to fuel their own boilers. As part of the construction of the energy transfer station at the Lakeland site, an electrostatic precipitator was added to optimize the existing Lakeland energy system. This made the operation more efficient and results in less particulate matter emissions. Estimates of Greenhouse gas emissions reductions are approximately 1900 tonnes per year of CO2e; and particulate matter reductions are expected to be reduced by approximately 100 tonnes per year (City of Prince George, 2010b). The reductions are from both the displacement of natural gas and reduced truck trips associated with Lakeland's hog fuel activities.

The plant produces approximately five megawatts of heat energy, which is transmitted through the piped distribution network. A city owned natural gas fired back-up energy centre ensures that peak demand requirements are met. There are four energy transfer stations where thermal energy from the main distribution network is transferred to the systems' customers ("Downtown District Energy System", 2012). At writing, there are currently four buildings connected to the system, two more coming on-line, and the opportunity to expand the system in the future to more downtown buildings. The city is the only customer for the first phase, with later phases to include private building owners and the provincial government (K. Brown, personal communication, May 17, 2012).

Methodological Approach

This thesis employs a case study methodology. Case study is a useful means of researching organizations and policy implementation and making recommendations (Majchrzak, 1984; Robson, 2002; Tellis, 1997). Burns suggests that a strength of case study methodology is it is real world research which has the ability to incorporate "…a full variety of evidence, including documents, artifacts, interviews, observations, and even participant observation" (1989, p. 157). A case study research strategy proved to be an appropriate choice for gathering the data I required, as it is distinguished by its, "…attempt to examine a contemporary phenomenon in its real-life context" (Yin, 1981, p. 59). The setting of the case is important to highlight, as it is not possible to separate the decision making process related to implementing the Downtown DES from the context (Tellis, 1997). Each community faces its own challenges, has its own goals and objectives, and has a diverse range of stakeholders, that is, they have different contexts. Therefore, they will each have a slightly different experience, which produces unique data.

The flexibility of case study design allowed for a robust understanding of the environmental, social and economic factors that affected the uptake of the Prince George Downtown DES. The case study approach mitigated the issue of multiple variables, as it didn't limit data collection methods or require the use of particular types of evidence, thus allowing for adaptation as new information arose (Robson, 2002; Yin, 1981). An example of the benefit of a flexible research design came during my initial review of the city documents. At that time, it became apparent that plans to implement a community energy system had been considered several times in the past, leading me to expand the scope of my document review to include relevant articles and letters to the editor from the local newspaper, *The Prince George Citizen*. This in turn led to further probing around the issue of air quality.

The reliability or trustworthiness of qualitative data is a factor which may affect the scope or outcome of the study (Weiss, 1994; Yin, 2009). For example, Weiss (1994) points to the interview process as a possible source of bias from the interviewer, the respondent or both. There is a risk the interviewer may pose leading questions or the respondent may provide a less than candid opinion. Interpretation of qualitative data is another potential source of bias. During this phase, there is a danger of the researcher emphasising evidence which supports their hypothesis, or understating data which does not (Weiss, 1994). Therefore, in order to meet the data integrity needs of the study, a data triangulation strategy was employed. Data triangulation reduces the threat of reactivity, researcher bias and respondent bias; and increases the robustness of the results and constructs (Robson, 2002; Yin, 2009). By utilizing different methods of qualitative data collection, from a variety of sources, potential biases were reduced, thus enhancing the validity of the study. By implementing the study in stages, and adapting to new themes as they emerged, for example the unpredictability of public reactions to new policies and how that affected decision making around the Downtown DES, I avoided conflicting results, helping to ensure internal validity (Yin, 2009).

Data Collection

Yin (2009) identifies six sources of evidence that are suitable for analysis in case studies: archival records; direct observation, documentation, interviews, participant observation and physical artifacts. I have collected two types of qualitative data – data from document reviews and interview data. Document data includes both primary sources, for example municipal plans and policies, and secondary sources, for example newspaper reports. Interview data was collected from key informants familiar with the Downtown DES. This has resulted in multiple

fields of data for analysis which has allowed for the identification of themes and development of explanations.

Document Review.

An examination of municipal documents related to the Prince George Downtown DES, such as council minutes, bylaws and planning documents, provided evidence of the scope of the project, its time scale, and key parties involved. All municipal documents from the City of Prince George district energy website page were reviewed to determine if they required further analysis, as were the Official Community Plan, the Integrated Community Sustainability Plan, the Energy and Greenhouse Gas Management Plan and the Energy Supply Agreement. These were further supported by a communications report completed as part of the federal environmental impact assessment process, and a 2011 report completed by KPMG for Prince George city council evaluating ownership and operating models.

Additionally, relevant local press reports were reviewed to provide an outside perspective. Newspaper reports were initially chosen at random through a *Google Scholar* search using combinations of the words ‘Prince George’, ‘district energy’, ‘district energy system’, ‘community energy’ and ‘sustainability’. This was followed by a purposive sampling of related and follow-up reports. News reports reviewed spanned the period 2002 to 2011, and included letters to the editor.

Interviews.

Qualitative interviews are an appropriate research technique when trying to integrate multiple perspectives and detailed descriptions of an event or process (Weiss, 1994). Interview questions sought to probe further into themes that emerged from the document review. Interview participants were selected to represent decision-makers, executives and managers from the city.

Interview participants met the criteria of being current or former employees of the City of Prince George who are or were involved in some way with the implementation or operation of the Downtown DES. Semi-structured interviews took place over two months and consisted of a series of open-ended questions. Interviews were recorded and transcribed to ensure accuracy. The full interview protocol is attached to this report as Appendix A, and the invitation to participate in the interview process is attached as Appendix B. Interviewing those charged with implementing the Downtown DES provided evidence of both their motivations for pursuing district energy and their decision making with respect to overcoming barriers.

Data Analysis and Presentation

Yin (2009) and Robson (2003) describe processes for developing analytic strategies and steps to follow when analyzing data. For example, both describe examining the data for patterns and themes, grouping or categorizing those patterns or themes and testing those patterns and themes. A thematic analysis of the literature served to guide the document review and interview processes. Document and interview data were analysed to determine meaningful patterns, identify themes and develop conclusions. Interview data was analysed using Dedoose qualitative analysis software downloaded from www.dedoose.com. The findings are summarized in Table 4, and Figures 1 and 2, which are incorporated into the discussion. A list of municipal documents is contained in Table 3 and a summary of the interviews is contained in Appendix D.

Chapter 3 - Literature Review

Introduction

The purpose of this chapter is to: examine barriers to municipal action around climate change; within that context, identify barriers to DES adoption; identify benefits associated with DES; and explore strategies and conditions that promote DES uptake. Research into the cause(s) of municipal inaction around climate change is based on earlier studies of barriers to government action around energy efficiency, energy conservation and climate change. This issue has been investigated by academic researchers since the 1990s (See Jaffe & Stavins, 1994; Weber, 1997), building on work examining market failures, the role of government and energy conservation from the 1980s (For example, Fisher & Rothkopf, 1989; Blumstein, Kreig, Schipper & York, 1980). Barriers associated with DES adoption is a topic that has been explored in the grey (for example, government manuals and material disseminated by non-governmental organisations and industry associations) and technical literature (engineering text books for example), but has not been widely examined in peer-reviewed academic literature. DES, as with other sustainability initiatives, are purported to have many benefits, such as lower greenhouse gas (GHG) emissions; energy cost stability; and increased local energy sector activity (Bloomquist, 2001; Porcher & Connolly, 2010). Realizing these benefits will require strategies that are efficient and have minimal impact "…on other…competing economic and social goals" (Bumstein at al, 1980, p. 368).

Municipal Barriers to Climate Change Action

Several models or typologies have been used to explain the barriers to the uptake of DES in particular; and energy conservation, energy efficiency and climate change action in general

(Burch, 2010a; Thollander, Svensson and Trygg, 2010; Weber, 1997). This section focuses on barriers to municipal response to climate change, energy efficiency and energy conservation, with an examination of barriers to DES uptake following later in the chapter. In these contexts, the term barrier is used to explain obstacles to more sustainable energy use, even when there is evidence that the benefits of taking action will outweigh the costs. In other words, barriers are essentially any factor which impedes "action to response" (Robinson & Gore, 2005, p.104). Although the models or typologies have their differences, the groupings of themes are similar, focused around human values and systems, and typically breaking-down into three or four broad categories.

Weber (1997), when examining barriers to energy conservation, identified four barriers: institutional, organizational, market failures and behavioural. Burch proposes three categories of barriers to municipal climate change action: cultural / behavioural, regulatory / legislative and structural / operational. She goes on to describe the social nature of these barriers as, "…familiar and established practices, institutional and social habits, and political cultures…" (2010a, p. 7576). Blumstein et al, start out dividing barriers into six classes: misplaced incentives, misinformation, ineffective regulation, market structure, financial and customary. Ultimately, they propose two categories of barrier, transient and stable, as a way to explain the significance of the barrier (1980). Transient barriers are those related to social inertia, and are typically removed by normal market functioning. Stable barriers are more difficult to remove due to the fact that they are deeply embedded in the "…social and institutional fabric" (Blumstein et al, 1980, p. 358). The barriers that Weber, Burch and Blumstein et al use to illustrate their models or typologies are very similar. For example, all three examine inter-jurisdictional barriers. For Weber (1997), they fall into the institutional category; Burch (2010a) puts them in the regulatory

/ legislative category, while Blumstein et al (1980) would categorize these barriers as stable or deeply embedded barriers. In spite of the different names given to the category of barrier, the qualities and descriptions are similar.

Discussions of barriers to municipal action with respect to climate change initially focused on the theme of capacity to mitigate and adapt to climate change (Burch, 2010b). Researchers who have examined municipal capacity to address climate change typically identify capacity related barriers concerned with a municipality's stock of human, social and financial capital (Betsill, 2001; Robinson & Gore, 2005; Yohe & Tol, 2002). For Robinson and Gore (2005), municipal capacity has financial, jurisdictional and organizational components. They also emphasize lack of knowledge or understanding, and failure to recognize the problem as additional key barriers to municipal response and suggest that in order for action to occur, it must be a, "…priority for both council members and residents" (2005, p. 108). Betsill (2001) sees budgetary constraints as a significant barrier, but emphasizes lack of administrative or organizational capacity as a key challenge. For example, she suggests that municipalities need to dedicate human resources specifically to the climate change portfolio and give those workers the technical skills they require to do the job. These capacity barriers were seen as the main impediments to municipal response to the threat of climate change.

More recently, Burch has identified socio-cultural and institutional barriers, along with path dependency, as key determinants of inaction by municipalities towards climate change (2010a). She suggests that the focus on municipal capacity as a barrier is inadequate, as it implies the potential for action, but does not explain why that potential is not being translated into action at the municipal level (2010a). To illustrate her theory, Burch examines the community of Delta, a municipality with ample financial and human resource capacity, where response to climate

change has not been significant. Her explanation builds on the problem identified by Robinson and Gore (2005), that in spite of municipalities having the potential to take action to reduce greenhouse gas (GHG) emissions, and some demonstrated success, the full potential is not realized and the success is not widespread. Betsill also recognizes the socio-cultural and institutional nature of barriers, arguing that climate change is an issue that cuts across departments and challenges the way "city governments organize themselves" (2001, p. 400). This view is supported by Dale (2001), who suggests that gridlock is inevitable in governments where there are no guiding principles or framework for inter-departmental interactions.

Path dependency results from the inertia associated with combined systemic barriers. In systems thinking, the term path dependency describes a systems' feedback mechanism that helps it to maintain the status quo (Doppelt, 2003). It refers to the way that the dominant approach to managing or thinking about a given system reinforces itself by limiting the development of competing alternative approaches, even if they have noticeable advantages. For example, Dale suggests that "vested interests" work to perpetuate the existing distribution of power and access to resources (2001, p. 95). Buckley and Betsill describe the situation of "entrenched policy coalitions" contributing to the gap between rhetoric and action (2005, p. 56). All of these examples point to a system that is complex and slow to change (Burch, 2010b). Changing paths usually requires either a significant shock or a cumulative recognition by a broad range of stakeholders of the necessity, feasibility and advantages of said change (Berkhout, 2002; Burch, 2010b).

Barriers to District Energy System Adoption

A municipal climate change mitigation strategy that reduces energy use and GHG emissions is the adoption of DES. This section builds on the previous by addressing the barriers

that are specifically associated with DES uptake, within the context of municipal climate change action. There are many technical requirements for DES to become established, such as heat-load density and distribution thresholds, proximity to heat source and amount of peak demand (Church, 2007; International District Heating Association, 1983). However, while limiting the feasibility of certain sites, these technical requirements do not typically act as the key barriers preventing system development. Many energy planning tools, based on the principles of multicriteria decision making, are available to decision makers for addressing technical details; yet unsatisfactory results are still possible during the implementation of DES (Ghafghazi, Sowlati, Sokhansanj & Melin, 2009). This is due to the non-technical barriers faced by both the projects and their proponents. Much like other sustainability initiatives, those barriers exist in the socio-political, organisational and financial realms (International District Heating Association, 1983).

Barriers to DES uptake is a theme found in technical literature, such as engineering text books, and in grey literature disseminated by governments, non-governmental organizations and business associations, but is not widely studied in academic literature. Although a theoretical explanation of those barriers is not usually brought forward in the grey literature, the few academic studies concerned specifically with DES barriers have developed theoretical explanations for their existence (For example Thollander, Svensson and Trygg, 2011; and Ghafghazi, Sowlati, Sokhansanj & Melin, 2009). The implementation of DES requires collaboration between many stakeholders, and necessitates information sharing throughout the process in order to overcome barriers (Thollander, Svensson and Trygg, 2010). Municipalities and their partners often lack the expertise or resources to assess different options. Often

stakeholders focus on the technical details, leaving “business and governance models” as an afterthought (City of Colwood, 2010, p.100).

In 2011, the Canadian District Energy Association (CDEA) completed a study of challenges or barriers associated with DES adoption. Like Thollander, Svensson and Trygg (2010), they found that the barriers associated with DES adoption are related to people and institutions, as opposed to technological barriers. The five key barriers identified are in the areas of knowledge, leadership, finance, human resources and sustainability. Often the barriers work in conjunction with one another. For example, a lack of experience designing and building DES (a human resources barrier), could lead to a wrong-sized system (a technical barrier), leading in turn to an unviable business model (a financial barrier). The CDEA concluded that the knowledge barrier underlies the rest of the barriers. The knowledge barrier is related to a lack of awareness and understanding of DES, and cuts across the public and private sectors, as well as the community at large (Canadian District Energy Association, 2011).

Thollander, Svensson and Trygg (2010) use systems theory to explain obstacles to DES, focusing on barriers between DES partners. Barriers to DES collaboration are divided into two levels, the technical and the technical/human. They found that technical barriers were rarely a significant factor between district energy partners; instead their research identified communications, socio-cultural issues and inertia as key barriers to DES partnerships. Examples of these barriers include: imperfect and asymmetric information; the approach of different stakeholders to risk; and conflicting values (Thollander, Svensson and Trygg, 2010). Additionally, they suggest there may be high transaction costs associated with multi-stakeholder bargaining and the creation of a new utility. Like other sustainability initiatives, DES face

barriers to their implementation that result from many partners with competing interests. Therefore the governance required for DES is one that actively engages all partners (Dale, 2001).

Benefits, Opportunities and, Strategies

The advantages of DES when compared to conventional thermal energy heating systems, is another theme that has been widely explored in the grey and technical literature. The advantages vary from economic to environmental to social, with environmental and social benefits gaining more weight as communities move towards sustainability. Elenchus Research Associates Inc. (2010) suggest that environmental and social benefits are the main drivers behind DES activity in British Columbia. Another important benefit of going through the DES deployment process relates to the establishment of new partnerships and the potential for future collaborations in community energy management (International District Heating Association, 1983). Below is a list of some of the purported benefits of DES (Bloomquist, 2001; Canadian District Energy Association, 2011; International District Heating Association, 1983):

- Increased energy efficiency.
- Reductions in atmospheric pollutants and GHG emissions.
- Improved energy system resiliency.
- Potential to use renewable fuel sources.
- Energy cost and supply stability.
- Local control of energy system.
- Local energy sector jobs and revenues.
- Increased community awareness with respect to sustainable energy issues.
- Catalyst for urban renewal.
- Free-up building space previously required for individual boilers.

The DES literature explores the conditions typically required for it to flourish and offers strategies for project proponents to establish those conditions. This is especially true for literature

produced by organizations that are actively trying to advance DES. For example, in a 2010 report produced by Elenchus Research Associates Inc. for the CDEA, the authors identify government support as the key driver of DES uptake and operation. This is echoed by Ostergaard who, in a report for the Pacific Institute for Climate Solutions (PICS), suggests that municipal governments are "instrumental" in advancing DES development (2012). This support can be delivered through legislative, regulatory or financial means and requires leadership, patient financing and a long-term view (Elenchus Research Associates Inc., 2010; Ostergaard, 2012).

Leadership at the municipal level is seen as a key determinant in advancing DES (Canadian District Energy Association, 2011). In order to establish favourable conditions for DES, realize their benefits and become more sustainable, cities need to make more efficient use of their resources. This is partly accomplished through urban planning, which guides the shape of the urban form, which in turn affects energy use and GHG emissions and is for the most part a public policy choice (Bataille et al., 2010). The fact that urban planning is a municipal government responsibility helps to explain the key role played by local government in creating the conditions for DES uptake. Municipal government influences the direction of local energy production, distribution and use through policy incentives and regulation, such as mandatory connection of all new buildings to the DES through the designation of district energy zones (Bataille et al., 2010). By designating and encouraging development in district energy zones, municipalities can create a critical mass of energy demand, thereby making district energy systems viable. Other strategies available to municipalities for encouraging DES adoption include: legislating mandatory connection to DES; building critical mass of customers by connecting government owned buildings to DES; and linking community revitalization strategies to DES (Elenchus Research Associates Inc., 2010; Gilmour & Warren 2008; Porcher & Connolly,

2010). However, municipalities do not operate without the support of senior levels of government. Support for DES at the provincial level in British Columbia includes: legislation requiring municipal governments to consider GHG emissions during development planning; the BC carbon tax - a tax on GHG emissions; and funding of feasibility studies (Bataille et al., 2010; Canadian District Energy Association, 2011). Additionally, the provincial government provides funding to groups such as the Community Energy Association to promote and advance the adoption of energy efficiency projects such as DES.

Conclusion

There are many barriers to DES uptake and many benefits that flow from their adoption. Although technical barriers exist, they rarely impede DES uptake in the same way that institutional or organizational barriers do. The barriers to district energy system uptake and other sustainability initiatives are similar in their complexity, location and ability to interact with one another. Together, these barriers lead to systemic inertia. Just because the capacity to address the problem exists, doesn't mean that effective action is forthcoming. Overcoming barriers to DES uptake requires an approach that recognizes the complex nature of the urban energy system and proposes solutions that address each component of the barrier. Creating the conditions in which district energy flourishes in British Columbia will take the efforts of all levels of Government and the ongoing support of organisations committed to its advancement.

Chapter 4 – Results

Introduction

In this chapter, the adoption and implementation of the Prince George Downtown DES is explored through a review of the strategic direction provided in higher level plans, such as the Official Community Plan (OCP) and Energy and GHG Management Plan; and through analysis of the responses from the interview participants. Documents were reviewed with the objective of identifying both the linkages to the Downtown DES and the strategies for supporting it. Policies, initiatives and objectives from four different documents were evaluated. Interview data was assessed based on the objective of identifying the perceptions of key project informants with respect to the research questions. Common or re-occurring positions are summarized in Table 4, with detailed thematic analysis, including differences in perspective, provided in the sections that follow.

Several common, over-arching themes or topics emerged during both the document review and the interviews. These themes are the ideas and events that shaped the development of the Downtown DES. These themes are hierarchical: both conceptual, such as perception of events or motivations; and applied, such as financing details or contractual obligations. These themes contained sub-themes, which served to provide more supporting detail. Those that came up the most often and across the broadest spectrum of data were typically assigned a higher importance. For example, the theme of benefits associated with the Downtown DES was identified in both the Energy and GHG Management Plan and by interview participants. However, not all sub-themes associated with those benefits were shared. For example, the Energy and GHG Management Plan focused primarily on the benefit of GHG emissions

reductions, while the interview participants provided a much wider range of benefits, including some not related to energy or emissions.

During the interview analyses, I found differences in themes identified by Prince George elected officials and Prince George staff. For example, both elected officials saw the Downtown DES as a tool for attracting new businesses to Prince George, while staff were generally more pragmatic, citing GHG emissions reductions and energy issues. Finally, not all of the themes identified during the interview process aligned directly with the literature review. For example, most of the district energy literature suggests mandatory connection bylaws as a method to ensure customers for the system. In Prince George, two of the project insiders identified this approach as problematic. They suggested that this would have overwhelmed the fixed capacity of the system, as well as being unpalatable to many downtown businesses.

Evaluation of Prince George Strategies Related to the Downtown DES

The documents and plans presented in Table 3 below link to and support the Downtown DES. The document selection process consisted of a search of the City of Prince George website, and consultation with Prince George staff. Documents were searched for key words, including district energy, energy, biomass and GHG emissions. The full text of the objectives, policies and initiatives with links to the Downtown DES is contained in Appendix C. A review of these documents was conducted, with the objectives of:

- evaluating the approach of Prince George to sustainability issues;
- providing a context for the Downtown DES adoption process;
- providing a location for the Downtown DES within the over-all vision for Prince George;
- developing an understanding of the partnership between the City and Lakeland Mills.

Table 3 *Documents Reviewed*

Document	Approach	Linkages to Downtown DES	Comments
Official Community Plan	Present guiding vision with supporting objectives and policies.	Objectives 5.1.1; 6.1.1; 6.5.1; 6.5.2; 6.5.3 Policies 5.1.1; 5.1.3; 5.1.11; 5.1.12; 6.5.6; 6.5.16	Downtown DES aligns with both energy reduction strategy and introduction of low-carbon energy strategy.
Energy and GHG Management Plan	Corporate and community level plans for GHG emissions reductions.	Subject area 1, Initiative 1	Implementation of phase 1 of Downtown DES is first priority of Energy and GHG Management Plan.
Integrated Community Sustainability Plan (MyPG)	Built on community engagement principles. Presents long-term vision for the community.	Sets goals in clean air, green energy, green practices, reduced GHG emissions, economic diversity and sustainable business.	Links to and supports other planning documents.
Energy Supply Agreement (Bylaw 8296)	Contractual agreement contained within a Prince George bylaw.	Energy supply agreement for the Downtown DES.	Ten year contract with option for renewal.

The Prince George OCP is a tool for staff, council and citizens to use in making decisions on community development. It lays the foundation for all other planning documents, and as the municipality's highest level plan, it guides virtually all activities associated with land and resource use in the City (City of Prince George, 2011). The adoption of the Downtown DES is connected to several OCP policy areas, including: the economy; clean air; and the promotion of green energy and reduction of GHG emissions. The Downtown DES links to the economic objective of a resilient, sustainable community, through several supporting policies. These policies include improved resource efficiency as a means of encouraging business competitiveness and capturing industrial efficiencies through system integration (2011). Objectives and policies that support clean air relate to reduction of fine particulates and other harmful pollutants, and are supported by the Downtown DES. It is an example of both a new

technology that results in improved air quality (Policy 6.1.1) and a program that achieves air quality benefits (Policy 6.1.6).

The City is pursuing two strategies in support of green energy and GHG emissions reduction goals - reducing energy use through demand side management and switching to low-carbon energy sources (City of Prince George, 2011). Recognizing the link between energy and GHG emissions, the OCP brings forward four objectives (Objectives 6.5.1 through 6.5.4) to address these interconnected challenges. The objectives are focused mostly on improved energy efficiency in buildings, both city owned and in the wider community. The objectives are supported by twenty-two policies, which include two district energy related policies. The first of these policies is to "…expand the customer base connected to the Downtown District Energy System (DDES) and look for opportunities to expand the DDES" and the second is aimed at promoting neighbourhood scale district energy (City of Prince George, 2011, p.63).

Energy use and GHG emissions are further addressed in both the City's Energy and GHG Management Plan and the Integrated Community Sustainability Plan (MyPG). The Energy and GHG Management Plan sets out a corporate action plan for achieving GHG emissions reductions by focusing on seven actions in four subject areas. The subject areas are related to aspects of energy and GHG emissions that are within the City's control – municipally owned buildings and the municipal fleet, as well as activities such as utility operations. The actions range from aspirational to applied. They include evaluating various energy efficiency and fuel-switching opportunities, with the first initiative being the implementation of phase one of the Downtown DES. Originally referred to as the Community Energy System, the Downtown DES was projected to reduce emissions by 950 tonnes per year, approximately two-thirds of the total reductions from all initiatives (The Sheltair Group, 2007, p. 16). The plan envisions

responsibility for the system residing within the City's Utilities Division and identifies "…appropriate financing" as a historic barrier to the project (The Sheltair Group, 2007, p. 18).

The Integrated Community Sustainability Plan (MyPG) was developed as a long-term, community wide planning tool. Its key outcomes are to support and align with other community plans and to set economic, social and environmental goals. The Downtown DES is supported by economic and environmental goals, and in turn helps to support those goals. For example, of the top ten goals identified by the community during public consultation prior to plan development, at least four are related to the Downtown DES. These include the economic goals of diversifying the economy and creating a more vibrant economy by focusing on, amongst other things, green energy; and the environmental goals of clean air and a city with green practices that leads in sustainability. Actions to support these goals include: target densities which helps support district energy; linking district energy to new biomass technologies; fostering the development of green buildings downtown; and accelerating renewable energy initiatives.

The energy supply agreement that the City entered into with Lakeland Mills is a key pillar of the Downtown DES, and is the final document reviewed in this section. The agreement is enabled through a bylaw, helping to ensure public accountability. It is a contractual agreement between the two parties, spelling out roles, responsibilities and to which party various benefits and liabilities accrue. An example of this final aspect is that GHG emissions reductions belong to the City and particulate reduction credits are the property of Lakeland. This is an example of a 'win-win', where each party has different environmental liabilities, and each party retains ownership of "environmental credits" which reduces that liability (City of Prince George, 2010b, p.13). Penalties and remedies for default by either party are described, with a dispute resolution process providing assurance. A price schedule for energy supplied by Lakeland escalates from

$20.35 / megawatt hour in the first year to $31.57 in year ten. Schedule ‘C’ of the agreement describes the process for setting energy prices beyond the first ten year period. At that time, energy prices will be linked to the market cost of one tonne of biomass, with prices escalating 5% per year after that.

Direct evidence of support for the Downtown DES is found in the documents that were reviewed. The energy and GHG Management Plan prescribes the adoption of the Downtown DES as the first action for the City to take in its efforts to reduce energy use and GHG emissions. The OCP and MyPG provide strategic support, for example, through the setting of green energy goals and objectives. The Energy Supply Agreement provides operational support, for example, spelling out energy prices for the next ten years. This evidence is supported by the responses of the interview participants.

Interview Results

Two elected officials, three managers and three supervisors were interviewed to provide in-depth perspectives on the Downtown DES, where it fits within the bigger sustainability picture in Prince George, and lessons learned from its adoption and implementation. Additionally, interview participants answered the question ‘What advice would you give to another community considering district energy’. Interviews took place over three months in mid-2012. They were conducted by phone, with the author taking notes and recording the conversations. A list of specific questions is contained in the interview protocol – Appendix A. Appendix D contains summaries of each interview. Participants were divided into three categories, elected officials, project insiders (those with a direct role in the Downtown DES project) and project outsiders (those with an indirect association with the Downtown DES).

Table 4 summarizes common or re-occurring answers to the interview questions, which are explored in depth, supported by notable quotes, in the following sections.

Table 4 *Common Interview Positions*

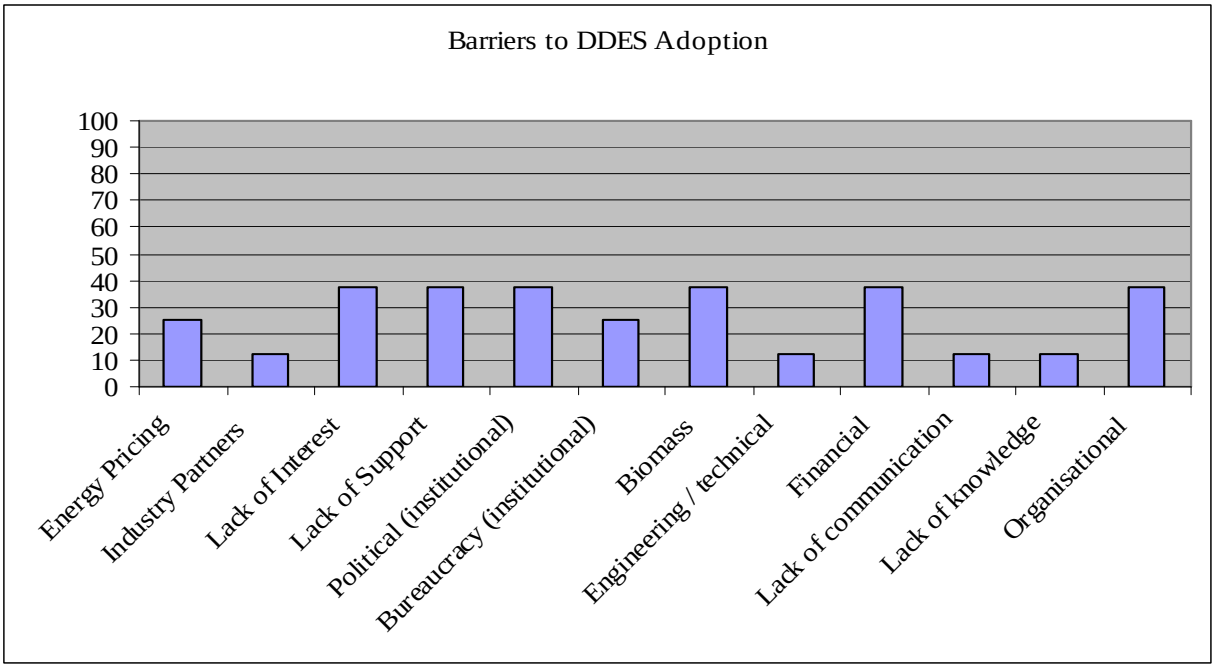
Category	Common Positions
Barriers to Downtown DES adoption	• Financial – Both capital costs and competition from cheaper conventional energy. • Lack of interest – From potential project partners (especially early on). • Prejudice against the use of biomass within the community (air quality).
Project Risks	• Community consultation / engagement. • Alternate approval process. • Project partners (different goals and objectives than the City).
Municipal Leadership	• The City was in the best position to lead the Downtown DES project. • Municipal leadership is required on sustainability and climate change issues.
Partnerships	• A private partner with a similar vision for the district energy system is key to success. • Downtown DES project required support from all levels of government. • Support from groups such as FCM and UBCM were also important, especially the Partners for Climate Protection program.
Community Engagement	• Lack of community engagement derailed early iterations of Downtown DES. • Input from community members resulted in improved Downtown DES design.
Motivations for Downtown DES adoption	• GHG emissions reductions. • Improved air quality. • Energy security and price certainty.

Category	Common Positions
Benefits of Downtown DES adoption	• Economic diversification. • Local energy economy activity. • Reduced particulate matter. • Reduced GHG emissions.
Lessons Learned	• Lack of community engagement derailed early iterations of Downtown DES. • Community input improved the Downtown DES project. • Phased-in approach is more manageable. • Grants and loans allowed financial barriers to be overcome.
Advice for other Communities	• Engage citizens in planning process. • Develop communications strategy early in process. • Link district energy to other plans, community goals and objectives. • Engage district energy experts during all phases.

Barriers and Project Risks.

A wide range of barriers to the adoption of the Downtown DES were identified by the interview participants. The combined responses are summarized in Figure 1 below. The scale on the left refers to the percentage of respondents who identified each specific barrier.

Figure 1 *Barriers to Downtown DES Adoption*



The barriers identified can be classified into three categories: institutional, organizational and economic. Institutional barriers include: constraints associated with the political system, such as partisanship and electoral cycles; barriers associated with a challenging regulatory environment and lack of support from agencies with project over-sight; and barriers associated with inadequate technical knowledge (educational). Organisational barriers include individual departments operating as silos; lack of communication between departments; and lack of public consultation. There are economic barriers associated with the capital cost of the system, as well as competition with the current low price of natural gas in North America, where prices are approximately half of what they were when planning first began for the Downtown DES. Risks to the project came in many forms and were often linked to the project barriers. Examples identified during interviews included: political, one respondent identifying the risk associated with changing council composition; financial, the risk that grants would expire; organizational

and technical. This final risk was exposed with the fire at the Lakeland Mills site, which jeopardized the energy supply for the Downtown DES. Although the fire was unforeseen, the energy supply agreement ensured an uninterrupted fibre supply to the system, demonstrating the ability of the City and its partner to manage risk through contractual means. The following two sections review key barriers identified by both the elected officials and staff.

Air quality.

A barrier in the form of opposition to burning biomass as fuel for the Downtown DES was particularly relevant to the project. Air quality in the city of Prince George is an ongoing concern due to geography - the City is located in a bowl, industrial activity - there are several large industrial emitters in the City, and temperature inversions which trap emissions. A committee, the Prince George Air Improvement Roundtable (PGAIR), made up of various stakeholders from the political, medical, and industrial communities, works to improve air quality in the City, focusing mostly on particulate matter. During the roll-out of one of the first iterations of the Downtown DES, two citizens groups concerned with air quality were formed to oppose it. Their campaign was successful, culminating with the 2008 rejection of the stand-alone energy plant version of the Downtown DES during an alternate approval process. This set-back came as a surprise to project insiders, who believed that the projected emissions reductions would be enough to win the day. As respondent four said, "…I assumed because I have been working on air quality for so long and I was an advocate that… people would believe me". The lessons learned from this set back were applied to the Downtown DES project, leading to the selection of an already existing energy source and an improved approach to communications. This was not simply an air quality issue; it was one of community engagement.

Community Engagement.

Community engagement was an area where the lack of a clear and strategic communications strategy, combined with other factors, such as public opposition to biomass combustion, served to derail the first iterations of the Downtown DES. The 'stand-alone' power plant option, located near a residential neighbourhood, was widely opposed in the community. Interview participants who had worked on the project from the beginning were keenly aware of the fact that the main factors in its demise were the lack of community consultation and an inability to communicate the benefits of the Downtown DES. This was also evident to respondent seven: "…when you think it's a good idea…you shouldn't make the assumption that others believe it as well".

However, through this experience, city staff and leaders were able to apply the lessons learned and the feedback they received from the public to the current Downtown DES project, helping to ensure its success. The federal portion of the project funding triggered an environmental assessment process that included a community consultation component. This took place in 2010 and resulted in mostly positive feedback, with letters of support coming from previously opposed groups. As respondent eight said: "…by the time it got to the final iteration, we'd had time to discuss the real concerns expressed by citizens".

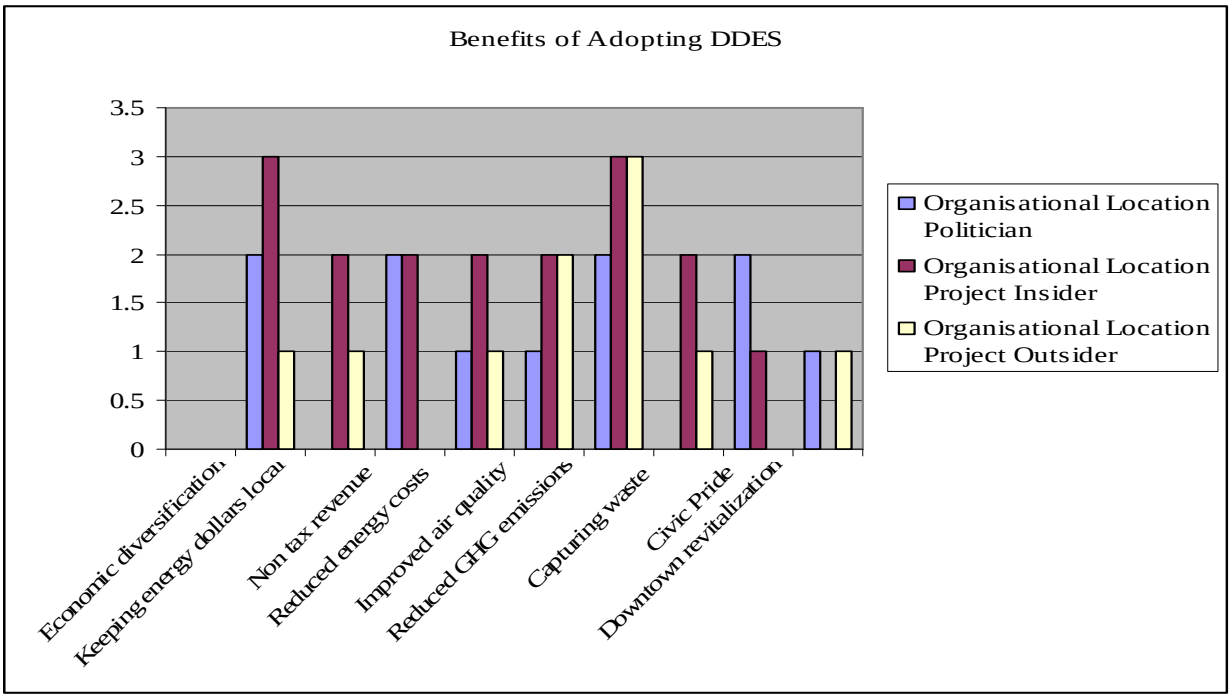
Motivations, Benefits and Opportunities.

The motivations for adopting the Downtown DES are closely tied to the benefits or perceived benefits that accompany district energy systems. The benefits and motivations for system adoption fell mostly into the economic and environmental categories, although several respondents identified civic pride and desire to innovate. The perceptions of the City's motivations for adopting the Downtown DES varied depending on the respondents'

organizational location. For example, both elected officials took a strategic view of the Downtown DES. They identified attracting new 'green' business to the City as a motivation, whereas that was only identified by one staff member. The elected officials also cited the desire to support Prince George's position as a bio-energy hub. City staff identified a less broad set of motivating factors, focusing mostly on the GHG emissions reductions and air quality improvements. For example, respondent six identified reduction of corporate GHG emissions as the only motivation behind the system.

On the benefit side, the following figure shows the range of benefits identified by the respondents, broken down by organizational location. We see that reduced GHG emissions and improved air quality are very important to respondents, but economic benefits are also significant. The scale on the left refers to the number of times a particular benefit was identified.

Figure 2 *Benefits of Adopting Downtown DES*



The successful implementation of the Downtown DES is partly due to the opportunity provided by circumstances outside of the control of the City. For example, respondent eight identified the 'aggressive' granting environment as a key driver to overcoming financial barriers, and respondent two identified a push from Natural Resources Canada (NRCan) to expand district energy uptake by supporting feasibility studies and providing expert advice. The Downtown DES was also seen to align with provincial climate change plans and priorities, which helped garner support in the form of provincial grants and expertise. The circumstances created by the mountain pine beetle epidemic, which served to greatly increase the fibre supply, was another opportunity that helped move the Downtown DES forward. Respondent eight noted: "the mountain pine beetle had devastated the forest … [which] provided an opportunity to take advantage of massive change in the landscape".

Municipal Leadership.

The theme of municipal leadership was found throughout the investigation and touched on almost all aspects of the adoption and implementation of the Downtown DES. 100% (8 out of 8) of respondents agreed that the community or municipal level is the appropriate location for sustainability initiatives. 100% (8 out of 8) of respondents agreed that it's important for municipalities to role model sustainable behaviour. Similarly, 83% (5 out of 6 – two respondents did not feel qualified to answer the question) agreed that the city of Prince George was in the best position to lead the Downtown DES project, although respondent four suggested that "…there's no question that a private corporation can absolutely do district energy", a sentiment echoed by respondent one.

In Prince George, municipal leadership took many forms. Two respondents pointed to support for the Downtown DES project from the city council, with respondent four saying "I

believe we always had that champion, even through…all the bumps in the road". Municipal leadership was also demonstrated through higher level plans, which set sustainability goals and objectives for Prince George. All interview participants thought that the Downtown DES supported and aligned with plans such as the OCP and MyPG, and that in turn, it was supported by them. For example, respondent one discussed the need to move towards a more sustainable community, asking: "What's a better example of that [sustainability] than the district energy system?" These results combine to show that all interview respondents saw local leadership as a key to Downtown DES adoption and to climate change response and sustainability issues in general.

Partnerships and Support.

All of the interview respondents attributed at least part of the success of the Downtown DES to the direct and indirect support of many project partners, including the federal and provincial governments, the Federation of Canadian Municipalities (FCM) and Union of BC Municipalities (UBCM) and the programs they administer, and the City's private partners (energy supplier and customers). All of the interview respondents spoke favourably of the financial support the system received in the form of grants and low interest loans. Respondent one noted that the project "…wasn't proceeding unless we got that money". Project insiders also acknowledged the technical support they received from their project partners, respondent three noting the support of the provincial government and respondent four pointing to the invaluable help provided by their consultants. This theme is echoed in the Energy and GHG Management Plan, which identifies many potential energy management partners. One important support in particular was singled-out by the elected officials and project insiders – The Partners for Climate Protection (PCP) program of the FCM. They pointed to the program as both a technical resource,

but also a catalyst for the Downtown DES. Both elected officials noted the fact that the City had recently achieved Milestone 5 of the program, meaning they were in the monitoring and reporting phase, after having implemented a set of GHG emissions reduction activities. Respondent eight saw the Downtown DES as "…aligned perfectly" with other PCP initiatives.

Lessons Learned and Advice for other Communities.

Many of the lessons learned by the interview participants centered on communications and community engagement. There was unanimous agreement that the lack of public consultation, especially early in the process, derailed the stand-alone power plant iteration of the Downtown DES. This was attributed to several factors, including late roll-out of the City communications plan, lack of meaningful engagement with stakeholders, and misjudging the negative public perception regarding burning biomass. Together, these factors led to the rejection of the Downtown DES in the first alternate approval process. Of the experience, respondent eight said: "Never underestimate the power of one night of Facebook campaigning to stop a project you've been planning for a decade". Out of that lesson, several respondents provided advice on how they would have done things differently, including from respondent seven: "…linking the [Downtown DES] to the goals that were established by community residents"; utilizing the full resources of the City, for example accessing the communications department; and engaging with the community early and often. Several respondents felt that the public consultation process ultimately improved the system configuration, citing the complete lack of opposition in the second alternate approval process.

Seeking advice from consultants and other experts was also recognized as important to moving the project through the different phases. For example, respondent one noted that "…we sought out advice of the experts from a business perspective, from a procurement perspective,

energy experts, government experts". Similarly, several respondents discussed the usefulness of examining the experience of other jurisdictions where district energy has already been implemented. Three City staff members described visiting other communities with DES. They spoke of applying what they learned from that experience to the Prince George context. Respondent four offered the advice to "…talk to other municipalities first, especially ones that are doing the same type of project". Most respondents spoke of the willingness of municipal staff and politicians from different jurisdictions to share information, and most said they would be willing to share their experiences with other municipalities.

Conclusion

Within this thesis, a review of Prince George planning documents and interviews with key Downtown DES informants provides detailed information of why and how the project was proposed, advanced and finally adopted. A link is identified between strategic objectives, such as reducing GHG emissions, reducing fossil fuel use and revitalizing downtown with the Downtown DES. The analysis of the planning documents and interviews revealed that both elected leaders and city staff see the Downtown DES as a means of creating a more sustainable community. The experience of Prince George staff and politicians during the adoption and implementation of the Downtown DES provided them several lessons, which they shared and transformed into advice for other communities. The next chapter will interpret the results of the document review and interviews, and attempt to link them back to the literature reviewed in this thesis.

Chapter 5 – Discussion

Introduction

Prince George is a place where both elected leaders and city staff are taking action on energy use and GHG emissions. They are using the Downtown DES as a vehicle to create a more sustainable space and water heating system in the City both by increasing energy efficiency and fuel switching. They are also using the Downtown DES to help create a more sustainable local economy by diversifying the customer base for nearby forest industry operators, and by introducing a new source of revenue for the city. In this chapter I will interpret the results from the analysis of the document review and interview data. This interpretation will link the results to the literature review and will provide an explanation of why and how the Downtown DES project was adopted, connecting strategic objectives with practical actions. This analysis will form the basis for the recommendations in the final chapter.

Several common themes and sub-themes emerged during both the document review and the interviews. One example of a higher-order theme was the benefits associated with the Downtown DES. This was identified in both the Energy and GHG Management Plan and by interview participants. However, the Energy and GHG Management Plan did not capture the range of benefits identified by the interview participants. It focused primarily on the benefit of GHG emissions reductions, while the interview participants provided a much wider range of benefits, including some not related to energy or emissions.

The organizational location of the interview subjects appears to have shaped their responses. There were differences in themes identified by Prince George politicians and Prince George staff. For example, elected officials saw the Downtown DES as a tool for attracting new

businesses to Prince George, while staff were generally more pragmatic, citing GHG emissions reductions and energy issues. Finally, not all of the themes identified during the interview process aligned with the literature review. For example, most of the district energy literature suggests adoption of mandatory connection bylaws as a method to ensure customers for the system. In Prince George there was concern that this would have overwhelmed the fixed capacity of the system, as well as being unpalatable to some downtown businesses.

Public Perception and the Combustion of Biomass

The issue of biomass as a fuel for the Downtown DES emerged as a key barrier to the adoption of early system iterations, particularly the 'stand-alone' energy plant option, advanced in the mid 2000's. Due to ongoing air quality issues, the combustion of biomass within the City is anathema to many in the public. The seriousness of the issue of poor air quality in Prince George led the city to partner with other levels of government and local stakeholders to implement recommendations from the Prince George Air Quality Management Plan (1998). The Plan goes so far as to make acceptable air quality a right, and its protection a responsibility of all (1998). Air quality is something at the front of mind for many city residents. Although the City tried to address this issue by tying the new emissions from the stand-alone energy plant to reductions elsewhere, the public did not accept this solution.

Negative public perception of burning biomass as fuel has been shown to affect renewable energy projects in other communities (Ghafghazi et al, 2010; Rosch and Kaltschmitt, 1999). In Vancouver, researchers showed that community and environmental groups opposed the use of biomass to fuel a DES because their "…concerns were not addressed properly during the feasibility study phase" (Ghafghazi et al, 2010, p.1140). During a fuel preference experiment, the researchers found that members of the community and environmental groups would have

selected biomass as their first choice to fuel the DES had information about the use of biomass been properly communicated (Ghafghazi et al, 2010).

Rosch and Kaltschmitt characterize the public's perception of biomass energy as skeptical of the technology involved, equating modern energy plants with inefficient wood stoves (1999). There was a similar perception at play in Prince George. In spite of a plan by the city to reduce emissions elsewhere in order to offset emissions from the stand-alone energy plant, public opposition was strong. Opposition to a biomass fueled DES was further solidified by an inadequate community engagement process. This failure was the result of several small contributing factors, which will be explored in the next section.

Community Engagement

Closely tied to the issues around public perception of biomass as a fuel, the need for proper community engagement was another dominant theme to emerge from the interview process. All participants recognized the necessity of a more timely and robust process, with the consensus being that citizen engagement should have taken place early in the planning phase. This was especially true with the sensitivities of burning biomass to fuel the system in what the public perceived to be an already compromised airshed. Although other communities may not face similar air quality challenges as Prince George, the community engagement process can be used as an opportunity for planners to address the key issues in their community. Another consensus position brought forward by the interview participants was that public input, especially following the rejection of the 'stand alone' iteration of the Downtown DES, improved the final product. Suggestions received during its review were taken into account during the planning of the final system configuration, helping to convert opposition into support.

Planning for sustainability initiatives such as DES needs to be guided by an open and inclusive process, where stakeholder input is incorporated into the system design. Rosch and Kaltschmitt suggest that from a strategic point of view, “the timing and targeting of the provision of information” must come early in the process and involve local and regional stakeholders (1999, p. 354). The Victoria Transport Policy Institute has identified seven principles to be incorporated into planning methodology in order to achieve optimal solutions. The planning process needs to be: comprehensive, efficient, inclusive, informative, integrated, logical and transparent (Litman, 2011). These principles are that much more important in planning a district energy system due to the complexity of urban systems and the complex interactions between various aspects of the system, the long term impact of infrastructure and building design, the higher short-term costs associated with changes in policy direction compared to business as usual, and the local context, which prevents simply applying best practices from other jurisdictions (Bataille et al., 2010; Kenworthy, 2006).

Some of the contributing factors that impeded the ‘stand alone’ public consultation process were within the control of city staff and elected officials, others were not. For example, the process was complicated by the agendas of other levels of government. Both the federal and provincial governments provided financial support for the Downtown DES and had funding announcement requirements that interfered with the City’s ability to make the project public in a timely manner. The effectiveness of the public consultation process was weakened by the inability to make a strong link between the system and strategic community goals and objectives; and by a failure to recognize the public’s perceptions with regard to burning biomass. Prince George staff and elected officials recognized that the planning process for the Downtown DES could have been more inclusive and informative. This leads to the conclusion that when

proposing a complex sustainability project, proponents must follow best practices for public consultation. This includes engaging early, linking the project to strategic objectives, and sharing information in a transparent way. Prince George has recently taken important steps in this direction, with the Integrated Community Sustainability Plan (MyPG) working to ensure that these principles are considered during land and resource use planning.

The Business Case

There were several economic factors that served to motivate the adoption of the Downtown DES and several financial factors that enabled its adoption. On the motivation side, the desire for a revenue stream that was not tied to property taxes was identified in both the literature (for example, Porcher & Connolly, 2010) and by the interviewees as an important driver. The desire to use the system as a vehicle for local economic development translated into support for the local sawmilling industry through the purchase of biomass energy. This aligns well with Prince George positioning itself as a bioenergy hub with research and development activities, combined with innovative projects (Frizzell, 2012). The mountain pine beetle (MPB) epidemic and the resulting increase in fibre supply led to commercial opportunities such as wood pellet plants and electricity generation from bioenergy (Frizzell, 2012). It has also resulted in new biomass related research projects at the University of Northern British Columbia and the creation of the BC Bioenergy Network, based in Prince George. The Downtown DES helps to further build on this foundation.

With approximately 70% of the capital costs covered by grants, and the remaining 30% coming from a low interest FCM loan (KPMG, 2011), financing was not a barrier for the Downtown DES. This level of financial support is allowing Prince George to build capacity and momentum over time, without pressure from the revenue side. The cost-recovery model results

in positive cash flow by the second year of operation and a discharging of loan obligations by the end of the 13th year. The flexibility that comes from not being burdened with high debt servicing costs is a critical foundation for the system and its ability to grow in the future. It also allows the City, as a customer, to realize low and stable energy costs into the future. While it may be difficult for other jurisdictions to realize similar levels of grant funding, for example the Municipal Rural Infrastructure Fund is no longer available, there are still funds such as the Green Municipal Fund and Community Works Fund available to local governments.

Governance and District Energy

DES are complex, multi-stakeholder systems that require governance structures that are empowered with the authority to make decisions while still being accountable to the community. Fortunately, governance related to the Prince George Downtown DES did not prove to be a difficult issue for the City to manage. They are considering two ownership and operating models; a city department and a wholly owned corporation. Both options will allow the City to control the decision-making process, while still being accountable to the electorate. In addition to those two considerations, Prince George is retaining ownership of the Downtown DES for several more reasons. Perhaps the most important reason is that funding through both the Municipal Rural Infrastructure Fund and the Community Works Fund stipulates that the grant recipient retain ownership of the infrastructure for at least ten years. Other reasons include creating an alternative revenue stream for the City, maintaining ownership of GHG emissions reductions, and excluding the BC Utilities Commission from having oversight of the project (KPMG, 2011). Combined, these reasons convinced Prince George staff and elected officials that retaining ownership and operating control of the Downtown DES was important to its success and important to realizing the benefits of the system. By retaining control of the system, the City is

able to realize the benefits, while lending its expertise, experience and resources to the project, helping to ensure its success. This model may not be suitable in municipalities where there is a lack of either financial or human resource capacity. In those cases, partnership with a private entity, either as owner, operator or owner/operator, may be preferable (Canadian District Energy Association, 2011; Ostergaard, 2012).

Strategies, Partnerships and Opportunities

The Prince George Downtown DES could not have come to fruition without the vision provided by City plans; the support of its partners and customers; and the unintended impact of events beyond their control. The importance of linking projects such as the Downtown DES to higher level plans was evident through the document review process. Along with MyPG, the Official Community Plan sets the vision for how the community will develop over time. Its economic and environmental objectives and policies created an environment where the system was a key part of the City's agenda. These planning documents were also critical to Prince George's grant and loan applications. Respondent one noted that without the background and support demonstrated by them, the funding process would not have been so successful.

At the time of writing, the city was the sole customer of the Downtown DES, with others coming on line later. This was a deliberate strategy to build a critical mass of demand through a ready-made customer base. In its 2011 study, the Canadian District Energy Association identified the municipal sector and its building stock as a prime area for growth in district energy. This captive customer base contributes to initial system viability, and also helps provide a consistent revenue stream from the beginning. Another similar strategy used by Prince George was to build the project in phases. This minimized disruption from construction, allows any

issues to be worked out on a smaller scale, and compliments the strategy of building demand from the ground up.

Circumstances outside the control of the system proponents helped to create an environment where the project could take hold. The abundance of biomass in the interior of British Columbia, due to the accelerated harvesting of MPB infested timber helped to make fuel switching a viable option. Several respondents identified the opportunities that existed due to the funding environment at the time of initial project development. Both the federal and provincial governments were eager to support clean energy projects, and Prince George was ready with a suitable project. The experience of Prince George shows that good planning can help to seize opportunities as they arise.

Conclusion

Understanding barriers to DES adoption and the socio-economic response required to overcome those barriers is a complex systems problem, where leverage points, for example structure of information flows (Meadows, 1999), are key to creating a more sustainable energy system. The Prince George Downtown DES is an integration of social, economic and environmental systems, and therefore is a complex community-based system, not a simple energy distribution system. Engaging with the community, linking DES to municipal objectives and partnering with other levels of government are just some of the keys to successful project implementation. Underlying all of these actions is municipal leadership. District energy requires the support and direction of government to flourish (Elenchus Research Associates Inc., 2010). Without the leadership shown by the city of Prince George throughout the process, the Downtown DES would not have become a reality.

Chapter 6 – Conclusion and recommendations

Summary

The need for action on GHG emissions and energy security is well established (Government of Canada, 2011; Province of BC, 2007), with the Intergovernmental Panel on Climate Change (IPCC) clearly linking anthropogenic GHG emissions with warming of the climate (2007). The consequences of this warming have the potential to be disruptive to both ecosystems and the human systems that depend on them. Similarly, energy security issues have the potential to negatively impact human systems through competition for dwindling fossil fuel supplies (Hughes, 2009). The community or municipal level is an important location in the response to those issues (Burch, 2010a). Efficient, biomass fuelled, community-based energy systems, are a tool available to municipalities for addressing both GHG emissions and energy security. In Prince George, the Downtown DES is one such tool, helping the City meet their GHG emissions reduction targets, while supporting a variety of other community goals and objectives.

The total capital cost of the system was approximately $14 million, with virtually all of funding coming in the form of grants and low interest loans. Construction of the first phase of the Downtown DES was completed in the spring of 2012 and buildings were connected later that summer, a second phase was ongoing at time of writing with two more buildings to be brought on line. The first customers for the system were all buildings owned by the City, a deliberate strategy to help create a solid foundation from which to build. In spite of an explosion and fire at the Lakeland Mills sawmill, the energy transfer station was not damaged and Lakeland Mills was able to continue supplying the system with heat.

The implementation of the Downtown DES was not without challenges. Previous research has identified the municipal level as the location for most barriers associated with district energy uptake (for example Bataille et al, 2010; Canadian District Energy Association, 2011). Complex social and economic systems, such as the energy system, naturally resist change through ingrained feed-back mechanisms. Early iterations of the Downtown DES faced many barriers, especially resulting from lack of public engagement and negative perceptions regarding biomass combustion. Although other barriers were present throughout the process, for example competition from low cost natural gas, most were removed over time. This was due to the ability of Prince George staff and council to identify and overcome them.

This thesis set out to answer questions about the motivations behind the adoption of the Downtown DES, barriers to its adoption and implementation; strategies employed by Prince George staff and elected officials to overcome those barriers; and the importance of partnerships to the system. Using a case study methodology, and a variety of data sources, helped to ensure data triangulation, leading to more robust findings. A review of research related to district energy revealed some common motivations for implementing DES as well as common barriers to DES adoption. These findings were supported by research into municipal response to climate change, which showed the complex nature of barriers to sustainable behaviour.

The results from the interviews revealed that Prince George politicians and staff were aware of the benefits of DES and had similar motivations for adopting DES as those identified in the literature. The interviews also revealed that project proponents faced barriers similar to those identified in the literature, especially with respect to using biomass to fuel the system. Finally, the successful strategies employed by staff to overcome those barriers were shared, providing lessons for other jurisdictions. The results of the document review showed a city committed to

reducing energy use and GHG emissions, including through the adoption of the Downtown DES. There were many enabling factors contained in the Official Community Plan and the Integrated Community Sustainability Plan that resulted in the adoption and implementation of the Downtown DES. Taken together, the results reinforce the importance of municipal leadership in sustainable community development and provide the basis for the following recommendations.

Recommendations

Due to the difficult nature of decision making associated with implementing new technologies and systems, such as district energy, a pragmatic approach by the stakeholders charged with its implementation is required. Johnson and Onwuegbuzie (2004) identify the promotion of incremental change and practical results that result from research based on pragmatism as a weakness. I see it as strength when dealing with risk-averse municipalities trying to implement new technologies that must incorporate the values of diverse stakeholders (Burch, 2010b). The experience of the parties involved in bringing the Prince George Downtown DES to life provides insight into the unique circumstances they faced, while at the same time showing the universal issues at play. Therefore, to provide support to community decision makers and their partners in other jurisdictions, the transferable factors that influenced the adoption and implementation process need to be assembled. By sharing information, power and decision making, adapting to feedback and considering all aspects and impacts of the system, project proponents can ensure the success of district energy systems, and help move communities to a more sustainable path.

Plans and Linkages.

The importance of linking sustainability projects like the Downtown DES to community-driven goals and objectives was identified by several interview respondents. The value of higher

level plans in moving the project forward was also noted during the interview process. Because higher level plans such as official community plans and sustainability plans guide virtually all municipal activities, especially with respect to land use, they have the ability to impact DES in both positive and negative ways. Options to positively influence DES adoption and implementation through higher level plans include:

- Establishing goals and objectives, with measurable targets, in energy use and GHG emissions.
- Explicit recognition of DES as a tool for achieving those goals and objectives.
- Implementing policies that support DES. These include policies, such as mandatory connection bylaws and district energy zoning.

All of this needs to be done in a way that incorporates the values and input of the community at large. When linked to this community input, DES uptake is more likely to receive community support.

Community Engagement.

The importance of community engagement in municipal planning was evident in analyzing the Downtown DES adoption and implementation experience. The lack of early consultation, combined with a public wary of biomass as a fuel source resulted in the rejection of the Downtown DES during the alternative approval process. The benefits to the final product from an improved community consultation process came in the form of improvements to system design and 100% acceptance during a subsequent 2010 alternative approval process. Best practices in community engagement rely on early, transparent and fulsome communication. They also require planners to combine this consultation with other ways for the community to

participate in the planning process (Arnstein, 1969). Depending on the ownership model, public participation can be accomplished through several means. In the case of a municipally owned DES, public participation on the board of directors would result in shared responsibility for planning and decision-making (Arnstein, 1969). In cases where the DES resides within a city department, citizen participation can be accomplished through governance structures such as advisory panels. Community engagement and citizen participation are keys to successful district energy system adoption. One method for ensuring this outcome is through the adoption of sound governance measures.

Governance.

The value of good governance structures was reinforced when an unexpected threat to the whole system resulted from the catastrophic fire at Lakeland Mills. The Energy Supply Agreement ensured a continuous supply of energy to the Downtown DES, resulting in little disruption. Contracts such as the Energy Supply Agreement are one example of tools that can protect project partners from risk and ensure system viability. For many communities, a municipally owned DES, whether a wholly owned corporation or an internal department, is the most effective model for advancing goals around energy use and GHG emissions. Additionally, there are often benefits that a municipality can gain through system ownership, which may not be available to private developers. Where conditions permit, municipalities should consider taking an ownership role in DES, especially in the early phases, when barriers are most pronounced. With public ownership, comes a higher level of public accountability. Public participation in planning and decision-making of municipal DES will help ensure accountability and can be accomplished through governance structures which are inclusive, adaptive and “whole-systems-based” (Doppelt, 2003, p.81).

Adaptive Management.

Adaptive management is a management system or process designed to incorporate feedback into decision making (Meffe, Nielsen, Knight & Schenborn, 2002). It requires managers and planners to learn how to be flexible, which requires organizations and institutions to foster an environment where that is possible (Fazey & Schultz, 2009). Adaptive management is well suited to sustainability planning, especially as a tool to help manage the risk associated with the uncertain nature of complex systems. By incorporating uncertainty into the planning process, a resilient energy system that meets the needs of future generations can be realised. This can be done through the development of contingencies and mitigation strategies, in addition to taking an adaptive management approach (Kenworthy, 2006: Litman, 2011). In the case of the Prince George Downtown DES, incorporating feedback from the community regarding early plans led to an improved final plan. To further ensure the growth and success of DES, an adaptive management framework, including broad objectives and the steps towards achieving them needs to be included in the planning phase. A DES monitoring plan should be integrated with the rest of the community's corporate performance management and monitoring initiatives. This would involve developing outcomes, targets and measurable indicators, along with methods for data collection, and would be reported annually. This feedback would then be incorporated into relevant plans, policies and procedures.

Conclusion

DES is one tool available to municipalities for reducing energy use and GHG emissions. In Prince George, the Downtown DES is being used to further both those objectives, while at the same time meeting other goals such as diversifying the local economy and improving community health through reduced particulate matter emissions. Their experience in implementing the

system, from its inception over ten years ago, to present day operation, provides several lessons for other communities wishing to adopt DES. The importance of early and transparent community engagement; accessing project funding from other levels of government; sound community sustainability planning; and adapting to changes in the plan was shown in both the document review and interview processes. The ability of the Downtown DES project proponents to adapt to community feedback, engage partners and access funding; combined with strong political leadership led to a final product that was able to overcome barriers and garner full public support. In Prince George, they are taking steps to create a more sustainable energy system and therefore a more sustainable community, through the successful adoption and implementation of the Downtown DES.

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Appendix A - City of Prince George Downtown DES Interview Protocol

Interview Participants

Name	Position	Relation to Downtown DES
Gina Layte Liston	Former Environmental Coordinator – City of Prince George	Project Champion of Downtown DES from early stages
Kristy Brown	Supervisor Utilities Engineering – City of Prince George	Manager Downtown DES
Greg Anderson	Civic Facilities Manager – City of Prince George	Customer of Downtown DES
Tina Watt	Long Range Planning – City of Prince George	Links to OCP and Energy and GHG Management Plan
Chris Bone	Communications and Citizen Engagement – City of Prince George	Links to outside stakeholders
Garth Frizzell	Municipal Councillor – City of Prince George	Political perspective
Bob Radloff	Various positions with City of Prince George - retired	Project Manager Downtown DES
Dan Rogers	Former mayor and councillor – City of Prince George	Project Champion of Downtown DES from early stages

Interview Objectives

The objectives of my research project are:

- To identify the perceptions of Prince George politicians, executives and managers with respect to district energy systems and their benefits.
- To identify the barriers that inhibited the uptake of the DDES.
- To identify the approach taken by Prince George to overcome those barriers.
- To develop recommendations for municipal governments on how they might implement district energy systems in their community.

Questions

<u>Research Question 1 – Links to Objective 1, 3 & 5:</u>

Why did the City of Prince George pursue the DDES?

- Why do you think your municipality chose to pursue district energy?
- Where did the idea for the DDES come from and when?
- Do you feel that district energy supports/aligns with your Official Community Plan and Energy and GHG Management Plan?
- Many benefits are reported to flow from district energy systems. Please discuss the benefits that have or are anticipated to accrue to Prince George.
- Please explain how the risks associated with taking an ownership role in the district energy system are outweighed by the benefits.

Research Question 2 – Links to objective 2 & 5:

What were the main barriers to DDES uptake in Prince George?

- Please discuss the barriers to district energy uptake in your community.
- Did you feel that it was within the jurisdiction/control of the municipality to address these barriers? Why or why not?

Research Question 3 – Links to objective 3, 4 & 5:

How was the city of Prince George able to overcome barriers and implement the DDES?

- Please discuss the main lessons learned from the earlier attempts to implement a district energy system in Prince George.
- Please discuss the factors which allowed the city to overcome barriers related to the DDES?
- How did you identify potential project partners?
- What criteria did you use to evaluate potential project partners?
- What strategies did you employ to engage other district energy stakeholders, for example customers or the public?

Research Question 4 – Links to objective 1, 3 & 5:

What was the role of Prince George in increasing district energy system uptake in relation to its other partners?

- Do you believe the municipal or community level is the most effective location for implementing sustainability policy?
- Do you believe that municipal government has a role in encouraging or role-modeling sustainable behaviour within the community?
- Do you feel that the city of Prince George was in the best position to lead the district energy project?
- Describe the support for the DDES received from other levels of government, the Federation of Canadian Municipalities and the Union of BC Municipalities.
- Do you have any advice for other communities considering DES?

Appendix B – Letter of Invitation and Consent Form

LETTER OF INVITATION & RESEARCH CONSENT FORM - INTERVIEWS

Date

Re: Implementing District Energy Systems: Municipal Approaches to Overcoming Barriers

Dear ___,

You are being asked to participate in a research project. Before you give your consent to be a volunteer, it is important you read the following information, take time to think about it and ask as many questions as necessary to be sure you understand what you will be asked to do.

My name is Kevin Simpson and this research project is part of the requirement for a Master's of Arts degree in Environment and Management at Royal Roads University. My credentials with Royal Roads University can be established by contacting Dr. Chris Ling, Program Head – School of Environment and Sustainability or my thesis supervisor, Dr. Charles Krusekopf.

The objective of my research project is to determine what approaches would be most suited to increasing district energy system uptake at the municipal level and particularly, the role of the municipality in the city of Prince George district energy system. Furthermore, this project will look at whether policies applied by a municipality can enable action to reduce Canada's overall GHG emissions, and to understand how local-level policies and approaches will work in accordance with other governance systems in British Columbia and Canada.

This portion of the research phase will consist of an interview and is foreseen to last approximately 60 minutes. The questions will refer to current and future approaches and initiatives to increase uptake of district energy systems at the municipal level. Information will be recorded in hand-written format and on an audio recorder and, where appropriate, summarized in the body of the final report. As a participant, you may also decline the use of an audio recorder and participate in interview through discussion format only.

A copy of the final report and research findings will be published. A copy will be housed at Royal Roads University, available online through UMI/Proquest and the Theses Canada portal and will be publicly accessible. Access and distribution will be unrestricted. In addition to submitting my final report to Royal Roads University in partial fulfillment for a Master's Degree, I will also be sharing my research findings with my sponsor, BC Hydro.

As the Researcher, I will endeavour to ensure no harm will come to you through participation in this project. You understand that benefits to participating in this study may include deeper understanding of initiatives and policies for overcoming barriers to district energy systems at the municipal level. You also understand that, other than the cost of your time in participating, there may be few, if any, potential liabilities in participating in this study. You are not compelled to participate in this research project. If you do choose to participate, you are free to withdraw at

any time without prejudice. Similarly, if you choose not to participate in this research project, this information is maintained in confidence.

In addition to being an invitation, this letter also acts as a Research Consent Form requesting your agreement to participate in the interview process. By signing this letter below or responding to it via email, you give free and informed consent to participate in this project.

Name: (Please Print): _____

Signed: _____

Date: _____

Please feel free to contact me at any time should you have additional questions regarding the project and its outcomes. My project sponsor, Travis Streb of BC Hydro can also be contacted for questions.

Sincerely,

Kevin Simpson

Appendix C - Full text of the City of Prince George objectives, policies and initiatives with links to the Downtown DES

Official Community Plan

Objectives

- 5.1.1 Support land use and planning that enhances Prince George as a sustainable, resilient, knowledge based, resource economy which is connected to the world.
- 6.1.1 Improve air quality by reducing fine particulate matter levels, odour and other harmful pollutants.
- 6.5.1 Reduce energy use and GHG emissions generated by existing buildings through retrofits or redevelopment and the introduction of renewable energy technologies.
- 6.5.2 Improve energy efficiency, use of renewable energy, and reduce GHG emissions for new buildings.
- 6.5.3 Improve energy efficiency, use of renewable energy, and reduce GHG emissions for City owned buildings and facilities.

Policies

- 5.1.1 Protect and enhance transportation networks, transit, service corridors and Utilities (water, sanitary, storm, and other public and private utilities) for the efficient movement of people and materials, as well as the transmission of energy, and communications.
- 5.1.3 Encourage business competitiveness through the efficient use of resources and energy (e.g., water conservation and GHG emission reductions).

- 5.1.11 Protect the environment (air, water and soil quality) through the strategic location of industry and the application of prudent regulations to reduce harm from industrial discharges and emissions.
- 5.1.12 Encourage eco-industrial projects that link processes, sectors, and buildings to share efficiencies in material, waste and energy production and distribution.
- 6.5.6 The City should work to expand the customer base connected to the Downtown District Energy System (DDES) and look for opportunities to expand the DDES infrastructure (underground piping) in conjunction with other works.
- 6.5.16 The City encourages energy efficiency for new residential development throughout the city. Examples of this include:
  - high efficiency housing (e.g., 70 kWh/m2/year for space and water heating) and/or housing that uses at least 10% renewable energy resources; and,
  - housing to connect and utilize a shared heating and/or power plant (e.g., neighbourhood sized district heating or geo-exchange heating systems).

Energy and GHG Management Plan

Subject area 1, Initiative 1

- **Community Energy System**

A Community Energy System that would provide heat to buildings in the downtown has been under development for several years.21 This system would use biomass fibre to generate hot water and distribute it to municipal buildings in the downtown area. This renewable energy source would offset the consumption of natural gas in these buildings. The CES is really a

building initiative since all the savings it achieves are in the reduced fossil fuel requirements of the connected buildings. The plan components include:

• Initiative 1: Implement Phase 1 of the Community Energy System (Municipal buildings)

Integrated Community sustainability Plan

Goals

- **Clean Air**

  Citizens enjoy clean air.

- **Green City, Green Practices**

  Prince George is a green city with healthy habitat and forests, and a strong environmental consciousness, led by government and local organizations that demonstrate sustainable practices.

- **Green Energy**

  Prince George is a leader in green energy.

- **Reduce Carbon Emissions and Adapt for Climate Change**

  Prince George has reduced carbon emissions and dependence on fossil fuels, and is prepared for climate change.

- **Diverse Economy**

  A diverse economy augments our forestry base, responds well to changing global trends, and offers a good local return on investment through a focus on local food, service, green energy, and a knowledge-based resource economy connected to the world.

- **Sustainable Business**

Prince George is a model for Northern cities in green and local business, and bio-energy.

Appendix D – Summary of Individual Interview Perspectives

Respondent one

Background

- City Councilor, Mayor, former Chair of the Board of Directors at the Community Energy Association.

Perspective

- Involved with DDES project from early stages.
- Funding from partners was integral to business case.
- Competitive partner selection process led to positive result for PG taxpayers / citizens.
- Positive policy environment in BC.
- Municipalities support each other – share information.

Barriers

- Lack of community consultation in advance of energy plant location announcement.
- Early stages there was a lack of suitable partners – business community wasn't interested.
- Financial / capital funding.
- BC Utilities Commission oversight (regulation and bureaucracy).

Motivations / Benefits

- Support local companies and local economic development and diversification.
- Climate Action Charter obligations.
- Energy security – price and supply.
- Competitive advantage for attracting new business.
- Local energy economy activity.
- Reduced particulate matter emissions due to electrostatic precipitator and eliminated truck trips.
- Source of non-tax revenue for the City.

Lessons learned / advice

- Importance of community consultation, especially where biomass as a fuel is concerned.
- Seek expertise / seek project partners.

Respondent two

Background

- DDES project manager.

Perspective

- Involved with DDES project from early stages.
- Difficult to be a leader (early adopter).

- Positive policy environment in BC.
- Municipalities can be the catalyst for DE system development.

Barriers

- Alternate approval process / politics.
- Initial project scope was too large.
- During early stages there was a lack of suitable partners – business community wasn't interested (high return expectations).
- Historic low cost of natural gas.

Motivations / Benefits

- Support local economic activity through the energy economy.
- Climate Action Charter / Partners for Climate Protection obligations.

Lessons learned / advice

- Importance of community consultation.
- Seek advice.
- Customers or potential customers are comfortable with municipality owned system.

Respondent three

Background

- DDES project supervisor.

Perspective

- Involved with DDES project from later (post-design) stages.
- Funding from partners was integral to business case.

Barriers

- Lack of community consultation and education.
- Lack of inter-departmental communication.

Motivations / Benefits

- Support local economic activity through the energy economy.
- Source of non-tax revenue for the City.
- Partners for Climate Protection obligations.
- Reduced particulate matter emissions.

Lessons learned / advice

- Importance of consulting regulatory agencies (BC Safety Authority).
- Transparent community consultation / engage community support.
- Move project process quickly.

Respondent four

Background

- Utilities department supervisor, former environmental coordinator.

Perspective

- Involved with DDES project from early stages.

- Funding and technical support from partners was integral to business case.
- DDES is one piece of the energy system / sustainability puzzle.

Barriers

- Lack of community consultation in advance of energy plant location announcement.
- Negative public perception towards biomass combustion.
- During early stages there was a lack of suitable partners – business community wasn't interested.
- Political / resistance to change (new technology).
- Internal organisational silos / lack of inter-departmental support.

Motivations / Benefits

- Capitalize on favourable granting / funding environment.
- Reduce particulate matter emissions.
- Natural gas prices were high during initial project planning stages.
- Support 'greening' of local businesses.

Lessons learned / advice

- Examined experience of other communities with DE as project was developed.
- Could have done more public consultation / more timely (expected by public).
- Seek advice of experts and other communities.

Respondent five

Background

- Civic facilities manager.

Perspective

- DDES customer.
- Familiar with DDES project from early stages.
- Grants make energy price cost competitive with natural gas.

Barriers

- Capital cost of system.
- Competition from natural gas (easier).

Motivations / Benefits

- DDES links to local forestry-based economy.
- Innovation.
- Saves boiler maintenance and replacement.
- Energy security – price and supply.
- Reduced particulate matter emissions.

Lessons learned / advice

- Make sure design estimates and costing figures are accurate.
- Phase-in the project.
- Seek advice and partners.

Respondent six

Background

- Planning department supervisor.

Perspective

- Project outsider.
- Recent link to DDES through educational activities and phase two customer recruitment.
- Municipalities can be the catalyst for sustainable development projects.

Barriers

- Negative public perception towards biomass combustion.
- Lack of effective communication.
    - Didn't link DDES to other community goals and objectives.

Motivations / Benefits

- Climate Action Charter / Partners for Climate Protection obligations.
- Municipal leadership.
- Downtown revitalization.
- Improved air quality.

Lessons learned / advice

- Need a good communications plan (plain language).
- Communicate with public throughout the process.

Respondent seven

Background

- Communications and citizen engagement Manger.

Perspective

- Indirect link to DDES.
- DDES aligns well with community goals.

Barriers

- Lack of inter-departmental communication / support.
- Didn't access communications department resources in early stages.

Motivations / Benefits

- Municipal leadership.
- Supports community sustainability goals.

Lessons learned / advice

- Transparent community consultation / engage community support.
- Build partnerships early in process.

Respondent eight

Background

- City Councilor, Board Member at the Federation of Canadian Municipalities, Board Member Partners for Climate Protection.

Perspective

- Approved DDES project while on council.
- DDES links to and supports other community plans, goals and objectives.
- Funding from partners was integral to business case.
- Municipalities lead energy use and GHG emissions reduction projects.

Barriers

- Lack of community consultation, especially where biomass as a fuel is concerned.
- Competition from low cost natural gas.

Motivations / Benefits

- Capitalize on favourable granting / funding environment.
- Take advantage of favourable biomass availability conditions.
- Meet GHG emissions reduction targets.
- Energy security – reduce fossil fuel reliance.
- Support leadership position in bioenergy.
- Competitive advantage for attracting new business.
- Source of non-tax revenue for the City.

Lessons learned / advice

- Communications plan was initiated too late.
- Need to keep public communications simple.
- Ensure DE fits in with community vision.