ENERGY RESILIENCE IN NORTHERN COMMUNITIES: CRITICAL SUCCESS FACTORS FOR SUSTAINABLE NORTHERN ENERGY

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Abstract

Energy Resilience in Northern Communities:
Critical Success Factors for Sustainable Northern Energy

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This project examines the factors for success of alternative energy initiatives in remote northern Indigenous communities, and the link between northern community energy and resilience. The case study, in the Gwich'in village of Fort McPherson, Northwest Territories, focuses upon a biomass boiler district heating project that provides renewable heat fuelled by local wood chips, and the willow harvesting initiative that supports it. Data was collected by interviews and participant observation in Fort McPherson and Yellowknife, and by analysis of resilience, community energy, and biomass literature. Success factors identified include the importance of aligning energy systems with local cultural identity, traditional values and connection to landscape, values often under-represented in financially-driven energy decisions. Autonomy and self-reliance are shown to be critical factors in northern community energy decisions, related to well-being, pride in place and enhanced resilience. Community resilience is revealed as a key component of northern community energy success.

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Chapter 1 Introduction

1.1 Research question and objectives

There exists a need to identify and thoroughly understand success factors for northern community energy projects, so that this understanding may be applied to help northern communities attempting the transition into more locally-sourced, clean, autonomous and resilient energy scenarios. Using a single case study, this research therefore attempts to answer the following research question and achieve the following objectives.

Research Question:

What factors contribute to the success of alternative energy initiatives in remote northern Indigenous communities?

Objectives:

a) To understand factors that advance an alternative energy initiative at the community level in a remote northern community.
b) To explore how a community energy initiative can affect the resilience its energy system.

1.2 Background and Rationale

Many of Canada's northern communities share characteristics of isolation, rugged terrain, seasonal extremes in climate, permafrost, limited infrastructure, and dependence upon imported fossil fuel energy sources, all of which provide challenges regarding the

affordable and sustainable provision of energy (Fournier, 2012). In most remote northern settings (other than some communities in the northwest served by hydro) electricity is produced by diesel generating stations (Polar Knowledge Canada, 2015) situated in or close to the community. These plants emit polluting nitrogen oxides, sulphur oxides, carbon dioxide and particulate (soot) into the air, degrading local air quality and contributing to climate change (Li, 2005). Space heating in most communities is provided largely by oil combustion, with a minority of buildings using diesel electric heat, propane, natural gas, or liquefied natural gas (Polar Knowledge Canada, 2015). All of these fossil fuels involve various challenges such as depleting global resources, environmental degradation, greenhouse gas emissions, local pollution and affordability of energy.

With a population of approximately 120,000 spread over a region of 4 million square kilometers (Statistics Canada, 2011b)[1], transportation and distribution of fossil fuel in the North is a significant challenge. Economies of scale are also difficult to realize in the North, resulting in higher energy costs compared to southern Canada, almost twice the national average (National Energy Board, 2015) even when subsidies from territorial and regional governments are taken into account. The cold climate also increases relative demand, with per capita energy use in the North being almost twice the national average (National Energy Board, 2015).

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[1] For the purposes of population and area, the North is taken here to include Canada's three northern territories, as well as Nunavik (northern Quebec) and Nunatsiavut (northern Labrador).

An example of the disparity in heating costs in northern communities is shown in Figure 1 below, where space heating costs in Sachs Harbour, NWT are shown to be seven times the cost of natural gas for heating in Edmonton. In addition, Sachs Harbour has twice the heating degree days of Edmonton GNWT, 2013).

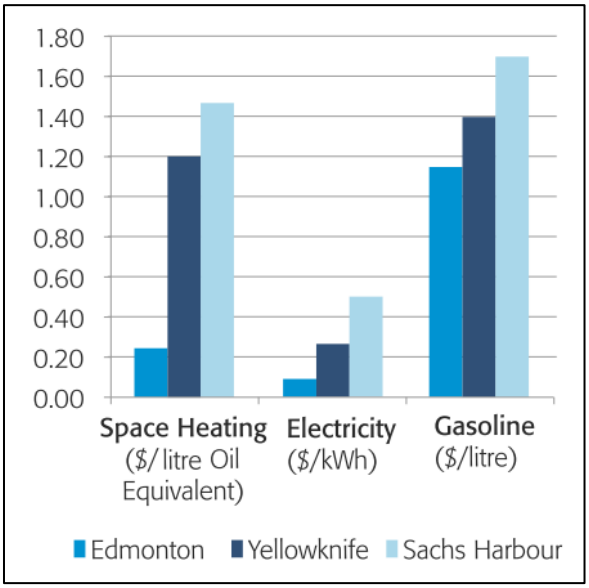

Figure 1: Comparison of northern energy costs (GNWT, 2013)

High energy costs contribute to existing poverty for many northern households. These costs force many people to choose between heating their homes and feeding themselves adequately (Ellery & Garces, 2011), which can have detrimental effects on residents' health (Hodbod & Adger, 2014). Health effects from inadequately heated homes may include premature deaths due to cold, increases in cardio-vascular and respiratory disease, mental health problems, and poorer educational outcomes and emotional well-being in children (Marmot Review Team, 2011).

Added to these concerns are issues of vulnerability in the North to social-economic challenges such as unemployment and poverty. Lack of community autonomy, self-reliance and sustainable employment opportunities associated with fossil fuel

dependence all augment this vulnerability. Fossil fuel energy systems, apart from relying upon depleting, finite resources (Li, 2005) typically build very little capacity in northern communities (Hodbod & Adger, 2014). Most of the money and expertise associated with energy supply and provision remains with the southern fuel provider.

This characterization of northern energy systems is in contrast to smaller community alternative energy systems, which are more likely to a) build local capacity, b) increase sense of ownership and self-reliance, c) keep energy dollars in the community and stimulate local economic development, and d) collectively benefit the community, being more secure, diversified, clean, resilient and sustainable systems (Hoffman & High-Pippert, 2005; Li, 2005; Lovins, 1977; Molyneaux et al, 2012; St. Denis & Parker, 2009; Walker et al, 2010; Walker & Devine-Wright, 2008). As a result of these benefits, social cohesion and well-being is enhanced by these smaller and less centralized community energy systems (Walker, 2008). Higher local control of cleaner energy, as well as energy security and costs concerns, is therefore an urgent priority for many communities in the North (GNWT 2013b; Weis, 2008).

In response to global climate change, which is increasingly impacting the North (Emakovich et al, 2014; Ruhland et al, 2013), policy efforts are underway at various levels of government to reduce greenhouse gas emissions and reliance on fossil fuels. Renewable energy systems are an effective means of achieving emission reduction targets, while lowering community dependence on imported fossil fuels (Jagoda, Lonseth, Lonseth & Jackman, 2011). Prioritizing these clean forms of energy over polluting sources at the national, regional and local levels is key to responsible environmental stewardship (Whitford, 2006).

In summary, dependence on fossil fuels in the North brings with it problems of high cost, low capacity building, lack of local economic development, and polluting greenhouse gas emissions, all of which may increase vulnerability and decrease resilience in remote northern communities. This project therefore proposes to examine the energy provision in one northern community through the lens of energy resilience. Resilience, considered a critical factor in any sustainable system (Lebel et al, 2006; Walker & Salt, 2006), deserves specific consideration when making decisions around northern energy. Resilience can be described as the capacity of a system to absorb and adapt to unexpected rapid transformation, disruption or crisis, in a way that retains healthy functions while not compromising future options (Molyneaux et al, 2012; Price, 2003). Resilience, as it applies specifically to communities, is defined by Amundsen (2012) as "the ability of a community to cope and adjust to stresses caused by social, political and environmental change, and to engage community resources to overcome adversity and take advantage of opportunities in response to change" (p.1).

This research explores the idea that community resilience is an integral part of energy system resilience in the North, where community capacity, adaptability and ability to self-organize and from partnerships all factor into the success of community energy initiatives. For the purposes of this research, "success" is considered to mean that an alternative energy project is operational, functioning well and offsetting fossil fuel, and that there is community acceptance of the project.

This project uses a case study approach to explore success factors that affect community alternative energy development in the North, and examines the relationship between northern community alternative energy, energy system resilience and

community resilience. It examines how resilience can be enhanced in northern communities to allow more affordable, autonomous, sustainable and clean energy futures for communities. It is argued that the research is timely, given the concurrence of desires for autonomy in northern communities (Billson, 2001), depleting global fossil fuel reserves, oil price volatility, global warming concerns, and the decreasing cost of renewable energy technologies. While much has been written about the lack of social acceptance of certain alternative energy initiatives and technologies, (Mallett, 2007; Shaw et al, 2015; Wüstenhagen et al, 2007), it is hoped that this research will lead to a better understanding of the factors that lead to *success* in northern sustainable energy efforts, and that lessons learned from this research can be applied to energy challenges facing communities throughout the Canadian North.

1.3 Case location and overview

This project examines the central research question through a single case study. The case is that of the Fort McPherson, NWT biomass heat project.

Fort McPherson, Northwest Territories is a Gwich'in First Nation community with a population of 808, of which 93% are Indigenous, and a total of 205 family dwellings (Statistics Canada, 2012). The population has remained relatively stable over the past ten years, with an annual growth rate of -0.2% (Statistics Canada, 2012). It lies north of the Arctic Circle at latitude 67˚N, and is situated on the Peel River approximately 120 km southwest of Inuvik, NWT (Figure 2 and Figure 3).

Figure 2: Fort McPherson shown on map of Northwest Territories
(http://wwp.greenwichmeantime.com/time-zone/north-america/canada/northwest-territories/map/)

Figure 3: Fort McPherson seen from a northern polar perspective
(http://en.wikipedia.org/wiki/Arctic#/media/File:Arctica_surface.jpg)

The case study focuses on the Fort McPherson biomass boiler and the local harvesting initiative that supports it. The boiler (85 kW) was installed in December 2013, and produces heat for two community buildings (Figure 4). The initiative is focused on providing this heat by burning local wood chips, sourced from the fast-growing willows that surround the community. To date it has provided part-time local forestry employment to approximately 50 residents at various times since harvesting began in 2013.

Figure 4: Fort McPherson biomass boiler, foreground, providing heat to the health centre and Band office in background (L. Keyte)

1.4 Positioning the Researcher

Two previous work experiences significantly impacted my perspectives on northern issues, and therefore influenced my position regarding this project. For 20 years I worked in and with northern communities, first as a pilot, flying Twin Otter seaplanes

in Canada's northwest and Alaska, and second as a wilderness guide, where I spent many summers leading sea kayaking and hiking trips in the eastern Arctic. The time I spent on the land, and working with the northern communities I lived in and travelled through, left an indelible impression upon me, of both the beauty and the fragility of our northern ecosystems. I was also influenced by the pervasive desire I heard from northerners to have a greater stake in the decisions that affect their communities, and a general frustration with their current level of dependence on imported oil for their energy needs.

I believe that addressing climate change is of vital importance, and I feel strongly that climate change mitigation has to include decarbonization at all levels, from consolidated international efforts down to the community and individual level.

I deeply respect and honour the beliefs, laws, rights, traditional knowledge and cultural values of North America's Indigenous peoples. I respect the Indigenous philosophy that decisions we make today must take into account their effect upon our descendants seven generations hence. My advocacy for clean, alternative energy provision in the North is therefore informed by a long-standing relationship with the North and its people, by my environmental beliefs, and by a firm support for the rights of northern Indigenous communities to determine their energy futures in a way that is in harmony with their cultural beliefs and with the Earth. I selected the Fort McPherson biomass heat project as a case study because it resonates with the above values, providing potential long-term community benefit in the form of clean heat and local jobs, while giving the community a greater stake in its own energy future.

Chapter 2 Literature Review

2.1 Overview

This literature review is grounded in the resilience literature. It also incorporates literature on community alternative energy systems and biomass energy.

The resilience literature provides a framework for examining and understanding northern energy as it relates to the resilience of the community and its energy system. Special emphasis is given to social and environmental aspects of resilience as these concepts are often under-represented in discussions and decision paths regarding northern energy, which tend to focus more on financial and technological considerations (Hodbod & Adger, 2014).

Following the review of the resilience literature and its pertinence for an exploration of northern community energy systems, the concept of community energy is reviewed, focusing upon the social elements that play key roles in the success of community energy projects.

Finally, academic literature on biomass implementation is discussed, encompassing techno-economic, environmental and social aspects of biomass energy development and use, and exploring how harvesting local biomass for energy can benefit northern communities.

2.2 Resilience

The concept of resilience arose originally out of the field of ecology, notably from seminal work and writing by C.S. Holling in 1973, who described resilience as the ability of a system to absorb change and disturbance without changing its basic structure and function or shifting into a qualitatively different state (Holling, 1973). More recently, resilience has been described as the capacity of a system to experience shocks while retaining function, structure, feedback capabilities, and therefore identity (Walker et al 2010, Walker & Salt, 2006).

Although written years apart, a common thread can be noted in the previous two definitions of resilience, namely, that maintaining the integrity of system structure and function are considered paramount to achieving resilience. However, recent resilience theory embraces the idea that system *change* is considered normal, with multiple stable states arising out of dynamic, adaptive cycles (Redman, 2014). The world is dynamic, and change is ubiquitous, so maintaining system *dynamics* becomes the focus, rather than guarding system stasis (Wu & Wu, 2013). This dynamic nature of most systems makes the idea of resilience a process, rather than an outcome (Berkes & Ross, 2012).

When developing strategies to thrive in dynamic systems, *transformative* approaches that increase long-term flexibility and resilience are favoured over mere *adaptive* strategies that, while they might respond to a crisis, do not necessarily improve a system's flexibility to thrive in subsequent periods of upheaval (Amundsen, 2012; Pelling 2011). In a resilient system, the creation of alternative open-ended futures takes precedence over purely adaptive approaches (O'Brian 2012; Redman, 2014), something

Walker et al (2004) refer to as "creating untried beginnings from which to evolve a new way of living." (p. 7).

The ability to self-organize when faced with change is a key element of resilient systems. Since change is ever-present, and change breeds the capacity to learn, self-organize and be innovative (thus increasing reliance), some argue that all sustainable systems must be resilient, but not necessary stable (Wu & Wu, 2013). Resilience is seen as the key to the sustainability of social-ecological systems (Walker & Salt, 2006). This is in contrast to the often-held belief that maximizing system *efficiency* leads ultimately to system *sustainability*. Redman (2014), states that the pursuit of efficiency (in the name of sustainability) can have the unintended negative consequence of reducing a system's resilience, as efficiency can compromise a system's ability to respond to change. This is corroborated by Lietaer et al (2010), whose research of resilience versus efficiency is summarized in Figure 5, showing peak sustainability as a *non*-bell-shaped curve, with optimal system sustainability skewed towards greater system resilience rather than greater system efficiency.

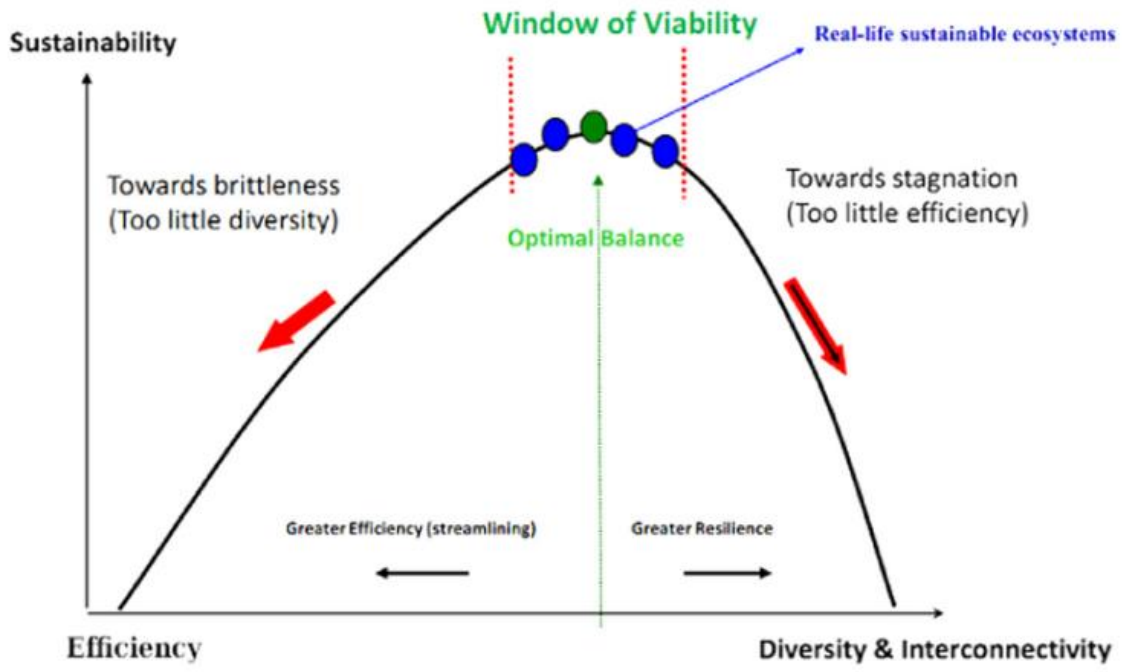

Figure 5: System sustainability as it varies with efficiency (increasing to left) vs. resilience (increasing to right) (Lietaer et al, 2010)

One particular type of, or application of the concept of resilience described in the literature that directly applies to the issue of northern community energy systems is that of "community resilience". Amundsen (2012) describes community resilience as "the ability of a community to cope and adjust to stresses caused by social, political and environmental change, and to engage community resources to overcome adversity and take advantage of opportunities in response to change" (p.1). The response required by a community might be local, but the need for the response often comes from being connected to the global system, which produces the change that drives the response (Amundsen, 2012). It is argued that when a community can respond to these changes by developing a diverse and innovative economy that includes a measure of livelihood

flexibility, it will reduce its vulnerability, while improving its economic and social resilience (Hovelsrud et al, 2010, Ross et al, 2010). This can also happen at the individual and household level. Individual resilience will enhance community resilience, while households with resilient livelihoods will likewise contribute to the resilience of the community (Berkes & Ross, 2012).

Responding to opportunities presented by change or adversity through innovation is essential to resilience. This includes a readiness to embrace change through experimentation, and to develop local rules (Wu & Wu, 2013). As change occurs, reflexive learning (to understand one's own role in the response) is a crucial aspect of community resilience (Amundsen, 2012).

Although burdened by stresses common in isolated northern regions (e.g., food insecurity, energy insecurity, substance abuse, poverty, unemployment, suicide), there is nonetheless an inherent or underlying resilience in northern communities, built through centuries of surviving in a changing northern environment where food and resources can be scarce and unpredictable (Fournier, 2012; Robards & Alessa, 2004). Historically, northern populations had to develop resilient qualities such as flexibility, the ability to self-organize while undergoing change, and the ability to quickly and effectively harness local resources, knowledge and experience in dynamic environments (Fournier, 2011; Robards & Alessa, 2004). Thriving in the North has required other resilient qualities such as the capacity for learning and adaptation, and the ability to absorb the shock of external disruptions (Hodbod & Adger, 2014; Molyneaux et al, 2012). It is believed that maintaining the inherent resilience of northern communities will require the continued

incorporation of the local cultural values and decision-making processes that aided historic community resilience (Robards & Alessa, 2004).

The resilience of a community depends not only on its historic resilience as described above, but is also affected by current factors. These include the physical and psychological health of the population; social and economic well-being; individual, family and community knowledge and attitudes regarding self-reliance and self-help; effective risk communication; level of social integration of government and non-governmental organizations in planning, response, and recovery; and the social connectedness of community members (Chandra et al, 2012).

Health and well-being in northern communities (which contributes to resilience) is also often closely connected with spending time out on the land (Todd, 2010). Connection to place, sense of belonging and connection with local values and beliefs, are also seen as important facets of community resilience (Berkes & Ross, 2012; Kulig et al, 2008; Ross et al, 2010; Stephenson, 2008)).

In addition to these concepts of connectedness, the idea of social capital is seen as vital to resilience, where healthy levels of trust within a community encourage the development of social networks and effective, overlapping governance frameworks. This trust and willingness to form partnerships allows a more flexible response to disturbances (Dale, 2010; Wu & Wu, 2013). Social capital also encompasses accountable leadership, which in a resilient community will ensure the just distribution of benefits and involuntary risks by accountable authorities (Lebel et al, 2006; Norris et al, 2008).

In addition to these *internal* community qualities, and in spite of the connection between resilience and *self*-reliance, a resilient community must nonetheless be effective

at drawing upon outside assistance and guidance if needed (Fournier, 2012). Trust and cooperation must exist between public and private sector actors and community members, in order to make the most of outside expertise when required by the community (Fournier, 2011). These relationships must be nurtured and understood through ongoing interaction, engagement and analysis. This helps to build positive communication channels, which are vital to resilience (Roege, 2014).

A diverse and innovative economy further promotes community resilience (Buikstra et al, 2010; Burkes & Ross, 2012; Fournier, 2012; Ross et al, 2010). Diversity of economy can buffer communities from the boom and bust cycles associated with unsustainable development. Decentralized, modular capabilities make it easier to adapt to change quickly and with flexibility, and are therefore preferred to system over-connectedness (Roege, 2014; Wu & Wu, 2013).

As resilience is enhanced, it will drive a feedback mechanism where well-being, job creation, and numbers of residents who choose to stay are enhanced, all of which strengthen identity of place and pride *in* place (Amundsen, 2012). This in turn creates an environment more appealing to private sector investment, and increases the likelihood that government funding, when accessed, may benefit residents (Fournier, 2012). Resilience is therefore seen as more than simply a response to change, but rather a proactive approach that seeks to counter vulnerability, increase well-being and foster sustainable growth. (Molyneaux et al, 2012; Roege, 2014).

2.3 Community Alternative Energy

The term "community energy" can have several meanings. A community energy project may be one led by the community, or by an organization within the community without commercial interests. In a physical sense, it might be situated in (or provide energy to) public buildings in a community. Regarding ownership, a community energy project may be shared through a cooperative, or may simply involve community members in its development (Walker & Devine-Wright, 2008). A community energy project in the ideal sense is one that is driven and carried out by community members, and collectively benefits the local community; it is "both by and for local people" (Walker & Devine-Wright, 2008, p. 498). Lovins (1977) states that by incorporating small-scale local renewable technologies (such as those referred to in this review as community alternative energy projects), more people can get involved without the encumbrance of centralized bureaucracies, and that local energy markets can compete "through ingenuity and local adaptation" (p. 50)

Diversification into multiple, decentralized renewable energy sources, and localization of energy sources, can lead to more secure, resilient and sustainable energy systems (Li, 2005; Molyneaux et al, 2012). By diversifying energy sources and moving away from traditional static single-source systems, a community energy system can perform and thrive in dynamic environments and across multiple time frames, helping a population respond to change flexibly and in a timely manner (Roege, 2014). Smaller remote communities may be the most willing to implement community renewable energy systems, as shown by St. Denis and Parker (2009), who found that a higher percentage of

small or remote communities in Canada supported renewable energy implementation than large communities. Their research showed that for remote communities, dependence on high-cost, carbon-intensive energy is a significant driver toward implementing renewable energy (St. Denis & Parker, 2009).

The literature reports that the benefits of community alternative energy are many. Firstly, community energy allows a clear link between local production and local consumption. The smaller scale of community energy systems allow them to better adjust to local needs, values and resources (Hoffman & High-Pippert, 2005). The small scale also allows more flexible response to threats to the energy system (St. Denis & Parker, 2009). They generate local income, stimulate the local economy, allow for local control and management, and result in lower energy costs and a clean supply of energy (Walker, 2008).

Moreover, there is a sense of community ownership and autonomy when a local population has a stake in their own energy (Walker et al, 2010). Lovins (1977) stated that people want to understand their own energy systems, to "feel responsible for their own destinies, not mere economic cogs" (p.91). Public understanding and support can also be greater for smaller community energy systems, bringing greater social cohesion around energy development and use (Walker, 2008). From the community perspective, the greatest benefits to community energy are seen to be the development of strong, self-reliant communities, and the increased security of the energy supply (Hoffman & High-Pippert, 2005; St. Denis & Parker, 2009).

Two key social factors leading to optimizing the outcome of community energy projects are communication and trust. While some projects have grassroots origins, there

is nonetheless a need for knowledge sharing and inviting outside expertise (St. Denis & Parker, 2009). This trust and sharing of knowledge from different sources is not only applicable to community energy; it is also seen as an important component of enhancing community resilience in general (Armitage et al, 2011; Fournier, 2011; Lebel et al, 2006; Walker et al, 2010; Wu & Wu, 2013). When outcomes are seen to collectively benefit the community, with local peoples actively involved at different levels, then acceptance and support for community energy projects are greatly enhanced (Walker et al, 2010).

2.4 Biomass

A short review of the recent biomass literature is presented here, as many of the success factors under study in this research are linked not only with the idea of implementing renewable energy in the North, but specifically with the use of biomass for local heat (also referred to as bioenergy). The following review summarizes research on bioenergy's advantages and challenges, then focuses specifically on social factors associated with bioenergy that may help northern communities achieve greater energy resilience.

The earth's renewable energy sources have the potential to supply more than 3000 times the current energy demand of the planet's population (Ellabban, Abu-Rub & Blaabjerg, 2014). Biomass alone could provide 20 times the current global energy needs (Figure 6). Renewable resources presently make up 19% of global energy consumption, half of which is supplied by biomass (Hauk, Knoke & Wittkopf, 2014).

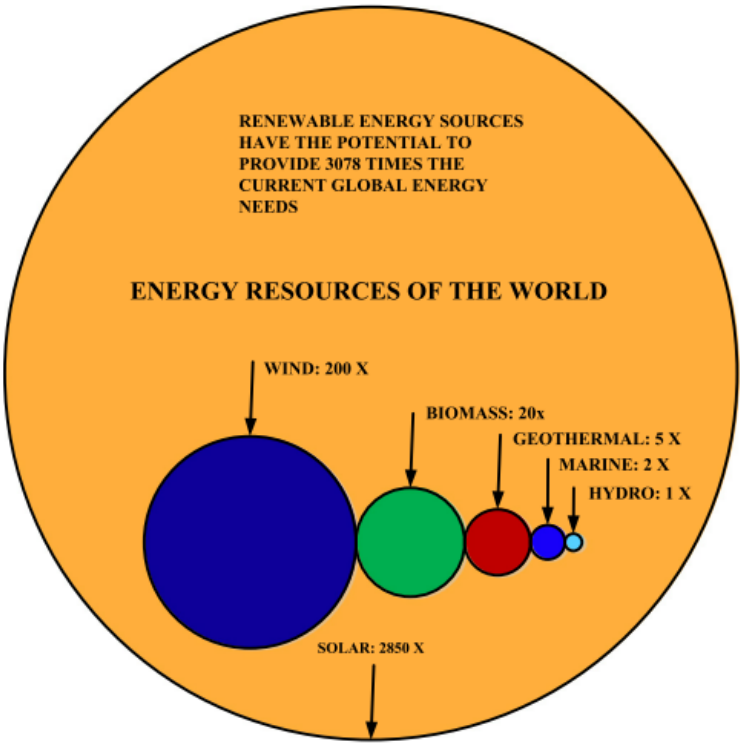

Figure 6: Energy resources of the world (Ellabban, Abu-Rub & Blaabjerg, 2014)

What makes biomass attractive as an energy source? Besides being abundantly available and renewable, biomass can easily be stored for later use long after harvesting, unlike other renewable energy sources such as solar and wind. It is available year-round from various sources, so provides a reliable feedstock, not subject to the seasonal variations of wind, sun and water (Akhtari, Sowlati & Day, 2014). Biomass energy reduces carbon emissions compared to fossil fuels (Eero et al, 2014), and in the case of locally-harvested biomass systems, it may help communities achieve energy independence and strengthen their local economy through local job creation and heat sales (Cambero & Sowlati, 2014). In particular the creation of local, sustainable harvesting jobs and the stimulation of a local forestry industry sets it apart from other

renewable forms of energy (Keyte, 2015). Incorporating bioenergy allows a community to both diversify its energy sources and increase sustainability (Cambero & Sowlati, 2014).

Being locally sourced and non-extractive, biomass fuel prices are not greatly affected by world markets, foreign policy or long-distance transportation costs. Prices for biomass fuel and bioenergy production are therefore considerably more stable than fossil fuels (Keyte, 2015). For this reason, and the fact that biomass fuel is an abundantly available local resource in many regions, biomass energy has the potential to increase energy security of communities (Sovacool & Mukherjee, 2011).

Environmentally, energy produced by biomass combustion is considered carbon-neutral, since carbon released during combustion is re-absorbed over time by forest re-growth. Bioenergy systems typically result in greenhouse gas emission reduction of 93 to 98% when compared to fossil fuel combustion (Eero et al, 2014). Furthermore, most biomass fuel (e.g. wood chips, wood pellets) is made from forest residues or waste materials. Burning waste materials in carbon-neutral district energy systems to produce heat and/or power has very low environmental impact (Akhtari, Sowlati & Day, 2014).

Challenges to bioenergy include limited availability of forest biomass in some regions, high production costs and fuel supply logistics. Handling and storage systems must be larger than those required for fossil fuels, due to biomass having higher bulk density, higher moisture content and lower calorific value than fossil fuels (Akhtari, Sowlati & Day, 2014). Pellets have more energy (and less moisture) per unit volume than wood chips, so are less expensive than wood chips to transport over distance. Even greater energy density is achieved through torrefaction, a roasting process where pellets

are heated without air or oxygen at 200 - 300˚C. This reduces weight by 30%, increases heating value by 20%, and increasing hydrophobicity, allowing for cheaper transportation, smaller storage system size and reduced water contamination issues (Peng, 2012).

One aspect of biomass often under-represented in the literature is the social benefits and impacts that arise from its use for energy (Akhtari, Sowlati & Day, 2014; Cambero & Sowlati, 2014). Social objectives, when researched, should be measured by more than just the numbers of jobs created, ideally including human rights, labourers' rights and corporate governance (Meyer et al, 2014). Also important to understand are development opportunities associated with bioenergy for rural or isolated communities, which could result in improved well-being within the population. Increased local biomass harvest and bioenergy use may also affect social elements of a community such as way of life, culture, community cohesion, political systems, local environment, health and personal rights (Cambero & Sowlati, 2014).

In summary, the key issues identified in the literature review relevant to this case study include the idea of resilience as it applies to northern alternative energy systems and northern communities, namely what defines this resilience, and how it can be enhanced by community alternative energy. This is complemented by the characteristics of community alternative energy in the literature, which include resilience characteristics such as diversification, localization, flexibility, local economic stimulation, community self-reliance, and adaptation to local needs, values and resources. The biomass literature underlines the potential of bioenergy to fit within this resilient local energy framework, highlighting its advantages of sustainable harvest (where an abundant resource exists),

local forestry jobs, carbon-neutral emissions, and the long-term social benefits associated with local bioenergy versus imported oil.

Chapter 3 Methods and Approach

Case Study Approach

The research was conducted using an exploratory and explanatory single case study of the biomass heat project in Fort McPherson, NWT, where several methods for data collection were utilized within the case.

Case studies are a suitable research approach when the investigator has little control over events (as is the case here), and when a contemporary social phenomenon is being studied, with some attempt to explain the boundaries between the phenomenon (in this case the community's success in increasing energy resilience) and the context (in this case the social, cultural, governance, environmental and economic factors behind the success) (Yin, 2014).

This study falls under the categories of both explanatory and exploratory research. *Explanatory* research often begins with "how" and "why" questions, and deals with operational links traced over time (Yin, 2014). This study's examination of "how Fort McPherson has made headway in pursuing its sustainable energy vision while others have not" fits well into this category. *Exploratory* research, on the other hand, is more often linked with "what, who, where, how much, how many" questions. While these questions do not always lend themselves to the case study approach (Yin, 2014), if the "what" question is exploratory in nature, such as our research question, "What are the critical success factors for energy resilience in remote northern communities?", then a case study approach is likewise appropriate.

In researching potential case study sites, a total or five remote northern communities were initially identified who were moving forward with sustainable energy initiatives, and who welcomed the research. These were the NWT communities of Fort McPherson, Aklavik, Fort Providence, and Kakisa, and the Yukon community of Burwash Landing. There was willingness in both territorial capitals, Yellowknife and Whitehorse, to provide jurisdictional context for the communities' energy projects. Fort McPherson was chosen over the other communities due to the high number of energy professionals who recommended it as a case study, because the biomass boiler pilot project had recently become operational and was producing heat from locally-sourced biomass and offsetting oil, and because of the enthusiastic and welcoming nature of the biomass project manager, Johnny Kay.

There was still however a choice between doing multiple case studies with two or three communities, and doing a single case study. Multiple cases can often make results more robust, and are thus sometime preferred over "putting all your eggs in one basket" in a single case study (Yin, 2014). Opportunities for external validity and generalizability are often maximized when multiple cases are involved.

However, a single case study approach was chosen over multiple case studies because of a number of factors. One was that limited time resources were available for the scope of this Master's project, and multiple case studies involve considerably more time. Another is that generalizability is challenging in any qualitative research regardless of approach, and qualitative researchers are often hesitant to generalize from one case to another, because the contexts of cases differ (Creswell, 2013). A single case study can therefore be justified because it tends to provide a more in-depth understanding of a

research question, with one specific case used to illustrate the issue being studied (Creswell, 2013). Furthermore, Yin (2014) argues that a single case study is an appropriate design if the case falls into one or more of the following five categories: Critical case, unique case, representative case, revelatory case, or longitudinal case. The Fort McPherson single case study can be viewed as a unique case, in that a) it is the only community in the territory with a 100% Indigenous community-owned biomass district heating system, and b) it is developing a sustainable local industry to provide fuel (wood chips) for the boiler. It can also be viewed as a representative case, in that the community faces many of the energy challenges (as outlined in the Introduction chapter) common to remote northern communities.

A single case study of the Fort McPherson biomass boiler project was therefore chosen as the research approach, with jurisdictional context provided by energy professionals in Yellowknife. Interviews were conducted in Fort McPherson to provide local context for the project, while interviews in Yellowknife were conducted to provide understanding of the territorial support, energy policies and strategies that affect NWT communities such as Fort McPherson. Both were supported by participant observation and document analysis, providing multiple sources of information as recommended by Yin (2014) and Creswell (2014).

Lines of inquiry were developed and explored by means of triangulation between these multiple sources of evidence in the data interpretation phase. Yin (2014) asserts that triangulation generally leads to more convincing and credible results than following single lines of inquiry.

3.1 Field Work

This section summarizes the timing and outline of the field work component of the research, which comprised of an initial research trip, a data validation trip, and a final data validation trip where results were presented in Fort McPherson and Yellowknife. Table 1 describes the components, timing and data collection methods within each research trip. The methods listed in the table are further elaborated upon in Section 3.2.

Table 1: Timing and components of field work

Research trip	Location	Dates	Research Methods
Initial research	Fort McPherson	Feb 16 - 27, 2014	1. Interviews 2. Document search 3. Participant observation
	Yellowknife	Mar 2 - 13, 2014	
Data Validation	Fort McPherson (included 2-day biomass project stakeholders meeting)	May 27 - 30, 2014	1. Data validation meetings 2. Document search 3. Participant observation 4. Presentation of initial results
	Yellowknife	May 31 - June 5, 2014	
Final data validation and results presentation	Fort McPherson	Mar 25 – 28, 2015	1. Data validation meetings 2. Presentation of results
	Yellowknife	Mar 28 – 30, 2015	

While in Fort McPherson, the main base for research was the Tetlit Gwich'in Council Band Office. In Yellowknife, headquarters were at the Arctic Energy Alliance, where office and desk space was kindly provided to facilitate the research.

3.2 Data collection methods

The main data collection methods used in this case study were document collection and analysis, semi-structured key informant interviews, and participant observation.

3.2.1 Document collection

Literature reviews help to provide rationale for pursuing a project, and aid in positioning the study within the existing scope of literature (Creswell, 2013). Furthermore, a document review and analysis allows the researcher to develop more informed and insightful questions about the research subject (Yin, 2014). An initial literature review and document analysis was therefore conducted for this research prior to commencing the research trip, and then re-visited and adapted after the results were compiled. This review helped refine the lens through which the results were interpreted, particularly with respect to exploring links to the resilience literature, and situating it within the northern community alternative energy literature.

The concept of resilience and its role in the project, although partially explored in initial interviews and considered during participant observation by the researcher, was further developed and refined as the project unfolded. A review of the resilience literature provided context for incorporating the concept of resilience with the primary research findings of this study. For details of the literature review, see Chapter 2.

Every effort was made to retrieve relevant documents for data analysis from Fort McPherson and Yellowknife, both before and during the research trips. These included studies and reports on engagement, feasibility, project development, policy documents,

energy audits, GHG emissions studies, biomass business plans, energy strategies, case studies, technological studies and funding documents. Documents were sourced from Tetlit Gwich'in Tribal Council, Hamlet of Fort McPherson, Government of the Northwest Territories, Government of Canada, Pembina Institute, Ecology North, Arctic Energy Alliance, industry, utility companies and consultants.

3.2.2 Key informant interviews

A "gatekeeper" was recruited in each community before the field work, to help identify and contact appropriate interviewees prior to the first research trip. The research objectives and interviewee selection criteria were sent to each gatekeeper. Ongoing communication took place over the months prior to and subsequent to each trip, both with the gatekeepers and with various potential participants, to prepare for and follow up on the research trip interviews.

Johnny Kay, past Chief of the Tetlit Gwich'in Council and project manager for the biomass initiative, was recruited as the gatekeeper for the Fort McPherson component, based upon his being the driving force behind the biomass project, and being the main point of contact by those supporting the project from Yellowknife. Leanne Robinson, Energy Management Specialist with the Arctic Energy Alliance, was recruited for Yellowknife, based on her role within the agency that connects her to many energy stakeholders, her knowledge of the biomass project, and her willingness and enthusiasm to connect me with other energy professionals in Yellowknife who could contribute to the research.

Key informants (**Table 2** and **Table 3**), were identified for 18 semi-structured interviews, based upon their expertise, knowledge or interest in sustainable energy in the North, or their traditional knowledge related to energy or wood harvesting, in order to bring a wide depth of knowledge to this research.

Specifically, nine interviewees (community members, youth, and Elders) were selected in Fort McPherson (**Table 2**) based on either of the following criteria:

1) Experience with the Fort McPherson biomass boiler project, in the planning, development, management or harvesting aspects of the project.
2) Traditional knowledge that might help to clarify potential connections between success factors for community energy projects and traditional values.

Table 2: List of interviewees in Fort McPherson

Name	Position
Robert Alexie Sr.	Elder and Harvester
Taig Connell	Adult Educator, Aurora College
Bertha Francis	Elder
Johnny Kay	Project Manager, Past Chief Fort McPherson
Bobby Rose Koe	Youth Coordinator
Chief William Koe	Chief, Tetlit Gwich'in Council
Bill Prodomidis	Mayor, Hamlet of Fort McPherson
Mary Taya	Elder
Richard Wilson	Co-initiator of biomass project

In Yellowknife, nine interviewees (energy professionals) were selected (**Table 3**) based on having at least one of:

1) Expertise or professional involvement for a minimum of one year in the planning, development or coordination of alternative energy initiatives for NWT communities;

2) Expertise or professional involvement in NWT territorial energy policy, support or funding;
3) Professional involvement in industry aspects of alternative energy provision.

Table 3: List of interviewees in Yellowknife

Name	Position
Wade Carpenter	Alternate Energy Specialist (Solar), Environment and Natural Resources, GNWT
John Carr	Senior Technical Specialist, Arctic Energy Alliance
Bruce Elliot	Owner, Arctic Green Energy (started biomass industry in NWT)
Mark Henry	Senior Analyst, Energy Policy and Planning, Industry, Tourism and Investment, GNWT
Matt Kennelly	Energy Management Specialist, Public Works and Services, GNWT
Rob Marshall	Energy Consultant, Past ED Arctic Energy Alliance, involved in early NWT biomass policy
Bryan Pelkey	Alternative Energy Specialist (Biomass), Environment and Natural Resources, GNWT
Leanne Robinson	Energy Management Specialist, Arctic Energy Alliance
Linda Todd	Community Energy Planner, Arctic Energy Alliance

Fort McPherson interviews were designed to provide insight into the desires and challenges that face the community regarding energy, and to give perspective on the drivers that led them to develop the project, and the internal and external success factors that enabled them to move forward. Yellowknife interviews were designed to provide understanding of the governmental and industry support behind sustainable energy decisions that affect northern communities in NWT. The guide of interview questions for each community can be found in Appendix A and Appendix B.

Semi-structured interviews were chosen as the interview format because they align with what Willig (2013) describes as giving the participant freedom to talk about a

certain aspect of their life or experience. They provide a less directive and more relaxed form of interaction than fully structured, directed interviews. Corbin and Strauss (2008) suggest minimizing the structure in qualitative research interviews, to allow for a more free flow of information from the interviewee, which may lead to greater data density. While a less structured organization may lead to more complex and time-consuming coding and analysis of the interviews than a completely structured and directed interview, in this case the advantage of greater data density and diversity of information made this approach worth adopting. Missing pieces can then be gathered by means of subsequent interview questions and document analysis.

Since semi-structured interviews are conversations between two people, it is possible that the interview might result in new knowledge or understanding of the issue for both the interviewer and interviewee (Willig, 2013). As a result, the results that come out of the data are similarly co-constructions, products of the interaction between the researcher and participants (Gilgun, 2005). This implies a certain amount of reflexivity on the part of the researcher; how we speak or write about a subject necessarily incorporates our experiences, worldviews, culture, gender, class, politics and beliefs (Creswell, 2013), and cannot realistically be unbiased, but rather is imbued with the personal experience of the researcher.

3.2.3 Participant Observation and Participatory Research

Data from interviews was supported and in some cases augmented by participant observation, discussions and meetings with people not selected as official interviewees,

during both the initial research trip to NWT and the subsequent data validation trips. These sources are presented in **Table 4** below.

Table 4: Participant observation sources, Fort McPherson and Yellowknife

Name	Position
Louis Azzolini	Executive Director, AEA
Johnny Charlie	Elder, Fort McPherson
Yichao Chen	Energy Management Specialist, Arctic Energy Alliance
David Cook	Industry, Tourism and Investment, GNWT, Fort McPherson
Burkard Fink	Owner, Fink Machines Inc.
Alfred Firth, Gary Jerome, Phillip	Rat River Development Corp employees and biomass harvesters, Fort McPherson
Lisa Kenney	Industry, Tourism and Investment, GNWT
David Krutko	Rat River Development Corp. Board of Directors; Past MLA; Part Owner Energy North
Jan Larsson	President, NWT Biomass Energy Association; Founder, Energy North
Ben Linaker	Environment and Natural Resources, GNWT
Dwayne Noseworthy	Manager, Rat River Development Corp.
Steve Outlet	Program Coordinator, Arctic Energy Alliance
Rafe Smith	Coordinator Silvicultural Operations, Environment and Natural Resources, GNWT
Jim Sparling	Manager of Climate Change Programs, Environment and Natural Resources (Supervisor to Wade Carpenter and Bryan Pelke)
Dwayne Wohlgemuth	Owner, Ko Energy; Professional Engineer and Certified Energy Manager, Yellowknife
Liz Wright	Past MLA; Rep. to MLA Frederik Blake; Past Chief Fort McPherson

Project manager Johnny Kay was engaged as an active collaborator in the research, in order to bring a participatory aspect to the research project. As gatekeeper and project champion, he helped to guide the focus of some aspects of the research, by directing me towards aspects of the project I might not have emphasized in the

interviews, but were nonetheless important to the community. An example of this was the focus on the development of the wood marshalling yard for the processing and storage aspects of the project, which was shown to be a flexible local marketing model that also stimulated other forestry, milling and firewood sales activity in the community. According to Creswell (2013), participatory research attempts to aid self-determination and improve the lives of participants or related groups; it is practical and collaborative, and completed *with* others rather than *on* or *to* others. Mr. Kay's involvement in the research aligned well with both the objectives of the research and the belief in participatory values of the researcher.

3.3 Data analysis

The stages of qualitative data analysis used for this research project were preparing and organizing the data for analysis, organizing the data into concepts and codes, combining codes into broader themes, then representing the data as results and discussions within the thesis (Creswell 2013). A key element in this data analysis is the coding of the data. Coding is a process used in interpreting qualitative data, whereby a word or short phrase is assigned to represent patterns of salient, repetitive or summative elements of the data (Saldana, 2013). In this research, the qualitative data analysis software NVivo 10 was used to input and organize the codes, which were developed based on common responses to questions asked in the interview guide. The initial coding process used an open-ended approach, where multiple possibilities of interpretation are considered and where assigned codes are provisional (Charmaz, 2006), as opposed to a fixed structure of interpretation imposed from the beginning. This descriptive first cycle

coding was used as a starting point in data analysis, whereas subsequent re-coding and organization into relevant categories, termed second cycle coding, was used to further filter data, clarify meaning and develop theories (Saldana, 2013).

In the second cycle coding stage, data was re-grouped using the lens of the three "Pillars of Sustainability" (Gibson, 2006), a commonly-used framework which states that overall sustainability of a system must integrate the three areas of environmental, social and financial sustainability. Although much of the data aligned within these three groupings, codes also showed considerable emphasis on governance factors at play in the development and maintenance of alternative energy projects. As such, a fourth category for analysis, "Governance Factors", was created and added to the classic three-pillar sustainability framework (Figure 7). This category includes government support, Arctic Energy Alliance support, industry drivers, and the policy, strategies and programs created to help advance northern alternative energy initiatives in NWT. An example of a coding map is in NVivo is shown below in Figure 8 for the Governance category, displaying the Governance parent node surrounded by its various child nodes.[2] Further analysis of these Governance child nodes resulted in their aggregation into a smaller number of subcategories, as well as a reorganization and transfer of the Industry Support subcategory from the Financial Factors to the Governance Factors, as shown in Figure 9.

[2] Acronyms: CEP=community energy plans; FMA=Forest Management Agreements; AEA=Arctic Energy Alliance

Figure 7: Framework of data analysis for case study

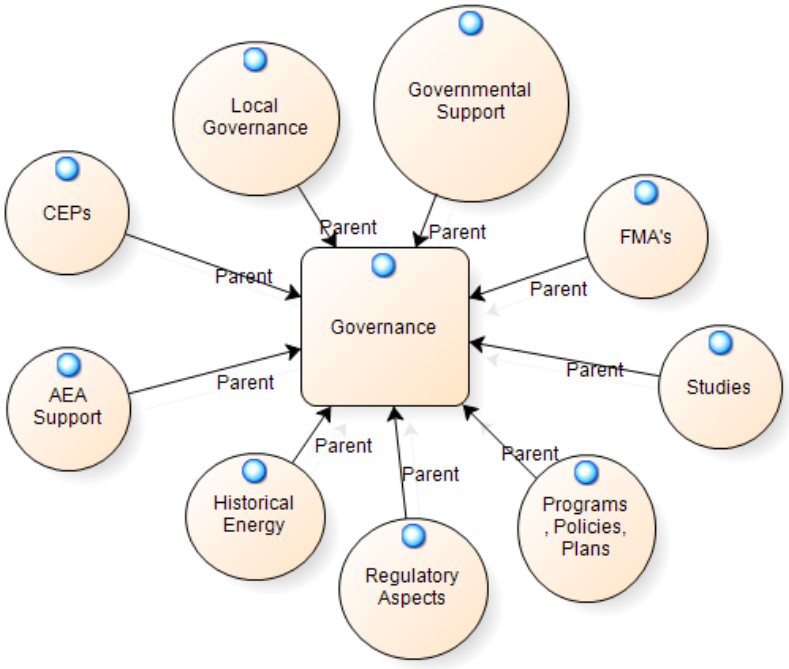

Figure 8: Governance node and child nodes as organized in NVivo

The coding structure developed from the interviews was reviewed by an independent researcher with experience in qualitative analysis, to check for validity and reliability in the application of codes to the data. Feedback from the second coder was incorporated into the coding structure before final coding was conducted. This agreement among multiple coders, called intercoder reliability, increases the validity of themes and constructs that arise from qualitative data, helping to ensure quality and enhance credibility of analysis (Burla et al, 2008; Kurasaki, 2000).

Unlike the interviews, documents were not coded directly into NVivo 10, and were not analyzed in the same systematic manner. Instead, documents were highlighted and coded either manually or electronically, depending on whether the document was obtained in hard copy or in PDF format. Similarly, participant observation notes were coded manually, and assigned to the themes and categories that arose from the interviews. These highlighted codes and themes were then used to develop and support the findings from the interviews using triangulation, a method that qualitatively compares, corroborates and cross-validates data from the different collection methods used in the study (Oliver-Hoyo & Allen, 2006; Wiersma, 2000). In situations when triangulation converges upon the same result, that result is thought to be more accurate and valid than if a single collection method had been used (Mark & Shotland, 1987).

3.4 Assumptions

The Fort McPherson biomass project is seen, at least in part, as a "success story." Initial discussions with energy experts in NWT, representing GNWT, Arctic Energy Alliance, Pembina Institute and Ecology North, all suggested Fort McPherson as a good

choice among northern community alternative energy projects for a study of success factors. Not only has Fort McPherson recently installed a multi-fuel biomass boiler as a renewable source of district heat (the first in NWT) and kept it running for its first year as a pilot project, but it is also developing a local wood chipping industry to support it, employing locals to sustainably harvest local willow as fuel.

There is, then, an assumption in this research that this case study represents a positive example of an isolated northern community moving forward with a sustainable energy initiative, and that success factors learned from McPherson might be transferable to other northern communities who, while they may have different resources available to them, nonetheless share a common thread of fossil fuel dependence, and the challenges that result.

This research is also based upon the assumption that Fort McPherson is representative of many northern communities who find fossil-fuel dependence an undesirable, unpredictable and expensive situation, and one that does not lend itself toward community autonomy, pride, sustainable economic development and resilience.

While it is further assumed that interviewees will at least partially represent the opinion of the community, it is less important in qualitative research than in quantitative that participants are representative of a larger population, and more important that they shed light on concepts through examples and experience (Corbin & Strauss, 2008). Variation is therefore seen to be more important than sameness in participants. There is nonetheless the expectation that the interviews in both communities will give insight into the factors behind Fort McPherson successfully beginning to move out of fossil fuel dependence.

Chapter 4 Results

4.1 Overview

Research results are broadly categorized into four factors that exert influence on the biomass boiler and willow harvesting case study in Fort McPherson:

1. Environmental factors
2. Social factors
3. Financial factors
4. Governance factors

These categories are further divided into subcategories (Figure 9), each of which will be presented in turn in the subsections of this chapter.

While there is inherent overlap between these categories, the findings are placed within the category in which there is the strongest fit. The Environmental and Social factors were represented in greater numbers in the coded data from the Fort McPherson interviews, and were often conveyed by community members in the form of stories or cultural values rooted in an Indigenous worldview. In contrast, the Financial and Governance Factors contained more references from the Yellowknife interviews, and were often in line with territorial policy or industry initiatives, as seen from a Western science worldview.

Unless otherwise noted, all quotations in the Results section are from personal interviews. All interview quotations are in italics.

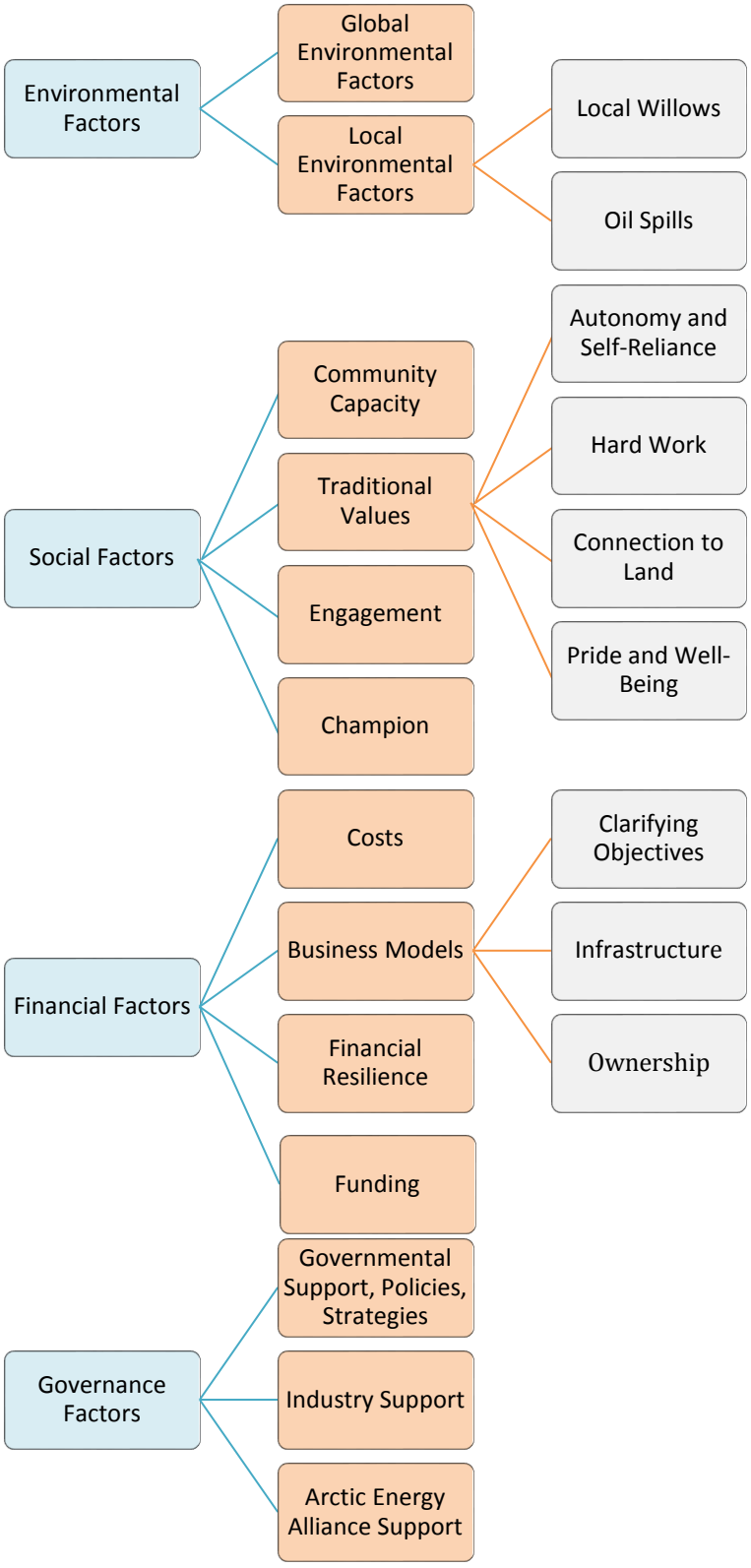

Figure 9: Overall hierarchy of factors in the case study

4.2 Environmental Factors

Results from interviews, document review and personal observations regarding the environmental factors influencing energy decisions in NWT are grouped into two main categories: Those reflecting global environmental concerns and those more reflective of local environmental factors. Among the local environmental concerns, participants emphasized local factors that were either concerns or motivations to decisions related to local energy challenges. The most frequently discussed local influencing factors were the existence of abundant local willow, and the reduced potential for oil spills if biomass energy displaces imported oil. The hierarchy of environmental factors is shown in Figure 10.

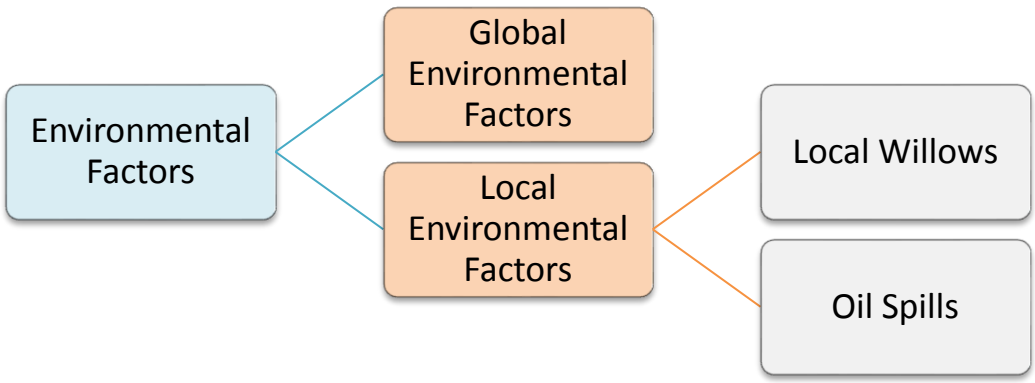

Figure 10: Hierarchy of environmental factors in case study

Concerns regarding climate change and greenhouse gas emission reduction have been placed in the "Global" category, whereas concerns over local environmental drivers, such as the local willows and oil spills, are discussed under the "Local" category.

4.2.1 Global Environmental Factors

In response to questions about the importance of clean energy sources, Yellowknife interviewees frequently mentioned greenhouse gas emission concerns. Several Arctic Energy Alliance and Government of the Northwest Territories (GNWT) employees stated that greenhouse gas reductions are a major policy driver in the government's decisions around energy. Greenhouse gas emissions reduction is one of the main objectives of the NWT Energy Plan, with others being lower energy costs, reduction in imported oil, and increased renewable forms of energy (GNWT, 2013).

"GHG reduction is a driving force. When we make investment decisions … we want to measure the impact those investments or policy would have on greenhouse gas. It's a matter driver. It's cited by decision makers and the legislature, and it filters down to the bureaucratic level" (M. Henry, GNWT).

According to Rob Marshall, co-founder and past Executive Director of the Arctic Energy Alliance, greenhouse gas reductions drove the grassroots efforts to develop the 2014 Yellowknife Community Energy Plan. The Government of the Northwest Territories also tracks emission reductions associated with their renewable energy projects, with these reductions being used to benchmark project success.

In contrast, there was little mention of greenhouse reductions among Fort McPherson interviewees. The community's environmental concerns were focused more

locally, as described below. Leanne Robinson of Arctic Energy Alliance offered an explanation. *"Greenhouse gas emissions are … one of those things you think about after you've looked after your people" (L. Robinson, GNWT).*

4.2.2 Local Environmental Factors

4.2.2.1 Local Willows

In Fort McPherson, most interview data collected referred to local rather than global environmental drivers for the biomass project. There is significant environmental motivation to use the local willow resource as a source of heat energy for the community. Chief among these motivators is a strong desire in the community to "clean up" the willows in front of village that block the view of river.

Fort McPherson is on a height of land that overlooks the Peel River. Historically, villagers could look up and down the river and see people approaching by boat or dog sled. The open view down the river is part of the historical fabric of the community. This view is now completely blocked by willows that have grown up on a large sand bar that shifted towards the village about 60 years ago (J. Kay & R. Alexie, Fort McPherson). Where people in the community used to play soccer and have community gatherings, there is now a dense willow forest between the village and the river. *"We used to look out from the bank and see all the way down the river. Now we just see willows... It looks ugly" (R. Alexie, Elder Fort McPherson).*

Interviewees were proud of the river view that many in the community anticipate returning once the willows are harvested. *"Soon we'll get to see our river again. And bring pride back to our people" (J. Kay, Project Manager, Fort McPherson).*

There is a general distaste for the presence of the willows, which is reflected in the almost unanimous support for their removal. Several Elders expressed concern that the willows are growing out of control.

"We can cut all the willows and make chips or pellets… It's a way to preserve the environment… Because right now all the water is draining into the plants and everything is starting to grow really big. You almost need a chainsaw to cut them now" (W. Koe, Chief, Fort McPherson).

A local harvest is seen as solving social and local environmental problems simultaneously. *"It's creating local employment and cleaning up our backyard at the same time" (J. Kay, Biomass Project Manager, Fort McPherson).*

Figure 11: Bundles of harvested willow drying on channel of Peel River (L. Keyte)

Because the willows along the Peel River and on the Dempster Highway regenerate at a rate up to one meter per year (J. Kay, Project Manager, Fort McPherson), community members are confident that a sustainable, long-term willow harvest for

heating the community is possible. This was confirmed by a pre-feasibility study by FP Innovations (2010), which states that an annual harvest of only three acres of willow will produce enough chips to supply heat to the band office and health centre, which are two of the larger buildings in the community. With thousands of acres of willow growing around the community, there seems to be more than enough to sustainably provide heat to the community. No concern was expressed by either community or forestry consultants that the willows will not support a long-term sustainable harvest. *"Willows grow fast, like a weed" (W. Koe, Chief, Fort McPherson).*

Of note was the unanimous support heard for removal of the willows, both in the interviews and in the May 2014 project stakeholders' meeting. *"Would be good if the whole thing were cut down, and we could use (the land between the village and the river) again" (W. Koe, Chief, Fort McPherson).* This desire to be able to see the Peel River again from the village, and to be able to use the flats now covered with fast-growing willows, was emphasized by most of the Fort McPherson participants, and is considered a contributing factor behind the support the project has received in the community. (Biomass stakeholders' meeting, 2014).

4.2.2.2 Oil Spills

Some interviewees expressed relief that wood chips or pellets as a heating source would decrease the chance of oil spills, and their environmental consequences. Johnny Kay spoke of an accident along the Dempster Highway involving a truck that overturned while carrying pellets, which caused very little environmental damage. Reduction in this risk of oil spills and their damaging outcomes is considered an important justification for integration of alternatives (J. Kay, Project Manager, Fort McPherson; B. Pelke, GNWT).

4.3 Social Factors

Of the four categories of factors that exert influence on the biomass boiler and willow harvesting in Fort McPherson, social factors were the most frequently cited by interviewees (Table 5). This was particularly the case for participants in Fort McPherson, where frequency of social factors mentioned in the interviews considerably outweighed environmental, financial and governance considerations.

Table 5: Number of interview references per coding category

Category	Total number of coded references from interviews
Environmental factors	65
Social factors	602
Financial factors	219
Governance factors	223

Social factors most frequently cited were divided into four subcategories (Figure 12): Community capacity, traditional values, engagement, and “champion”, meaning factors related to the community champion or project champion.

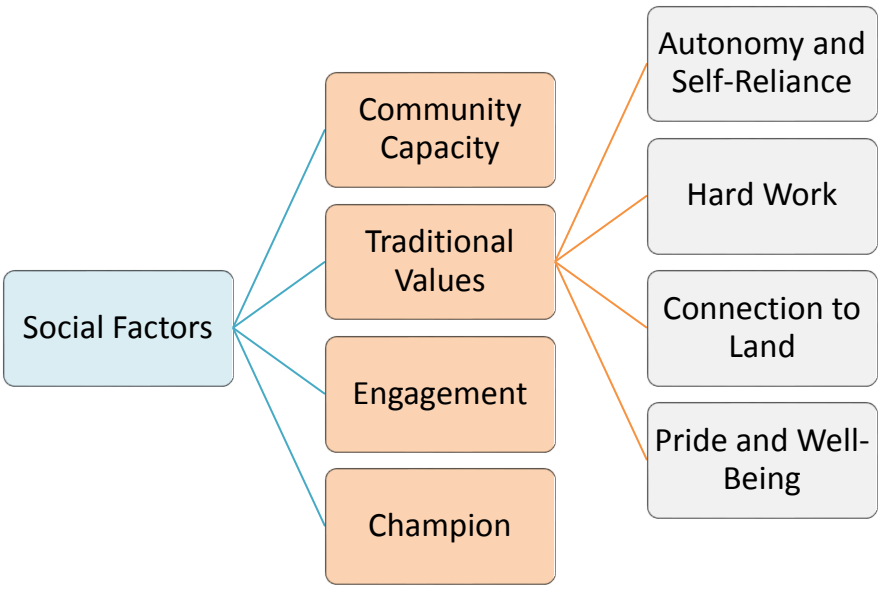

Figure 12: Hierarchy of social factors in case study

4.3.1 Community Capacity

Fort McPherson interviewees demonstrated strong interest in the increased employment and capacity building associated with the biomass project. An example of this keen interest was the high turnout for a biomass boiler workshop given in May 2014 by Berkhardt Fink, owner of Fink Machines, who provided the boiler for the project. The space housing the boiler was packed with interested community members interested in the maintenance training Mr. Fink provided (See Figure 13).

Figure 13: Biomass boiler training for community members, given by Burkhardt Fink, center right (L. Keyte)

There has been very little capacity developed and sustained in the community through the existing energy provision in Fort McPherson, especially since the oil-heated low-rental homes were installed in the 1960s and 70s (M. Taya, Elder, Fort McPherson; B. Francis, Elder, Fort McPherson; J. Kay, Project Manager, Fort McPherson). The fuel truck carrying oil or diesel generally comes up the Dempster Highway, unloads its fuel, and leaves again. A local driver is employed to distribute the fuel**.** Beyond that, little capacity is built into this system, and almost all of the energy money leaves the village with the fuel truck, providing profit to a single, non-local supplier.

Compared to this situation, being able to heat local buildings with local fuel obtained by paying local harvesters is, as Johnny Kay described it, a "no-brainer."

"If I have a choice between pellets and wood chips, by choosing wood chips I'm adding value to it. I'm paying someone in my community to harvest a local resource, so

value is added compared to paying the same dollar to someone out of town" (J. Kay, Project Manager, Fort McPherson).

More than 50 people were employed in jobs related to the biomass heating project during its first year of operation. For example, a local hockey team helped cut and stack cordwood, and used their earnings to fund a trip to a tournament in Whitehorse. *"The money has stayed local" (J. Kay, Project Manager Fort McPherson).*

Figure 14: Cordwood for biomass boiler stored in cabin at wood marshalling yard (L. Keyte)

In a community of 800 with an unemployment rate of 32.7% (Statistics Canada, 2011a) and few new employment opportunities, the significance of this income cannot be overstated. Johnny Kay tried to involve as many people as possible in the initiative. He initially liked the idea of distributing the money among many people rather than a few. *"If I need 30 cords of wood, I could pay 30 guys here to get a cord each rather than one supplier" (J. Kay, Project Manager, Fort McPherson).*

After some experiences with challenges in the efficiency of workers, however, Mr. Kay's opinion evolved somewhat to support the idea of having fewer, more skilled

workers. *"It's better to have a few guys working who really know what they're doing and are more efficient" (J. Kay, Project Manager, Fort McPherson).*

In this case study, capacity was increased by the decision to heat with local wood chips and cordwood, which resulted in community members being employed to harvest, transport, process and store the fuel. This was seen as an advantage over heating with pellets, which were imported from outside the community, and therefore did little to increase local capacity. *"When you purchase pellets, you eliminate your community; you're only paying the supplier and one driver" (J. Kay, Project Manager, Fort McPherson).*

Finally, in Old Crow, a fly-in Gwich'in community to the west of Fort McPherson in Yukon, the community school used to be heated by wood. One man in McPherson spoke of the project's benefits for the community, and what he observed when it was replaced by fossil fuel

"You know Old Crow had a school. And their main source of heat was two big stoves… your wood was four foot long. And they burned wood every day in that stove all winter. People went up and brought cords and cords of wood in the summer, they'd raft it down from way up… And the Band bought all that wood off them for $400 - $500 a cord. You get 10, 20 cords, man, you're just rich! They threw that out the window and brought diesel in. Now look at that, everybody's drunk… So one of the things we try to do is to keep our people busy all the time. And this (biomass project) will be a great opportunity for our people to be busy." (Anonymous resident, Fort McPherson).

4.3.2 Traditional Values

"We don't know, in this community, about that biomass. But we do know how to harvest. It's what we've been brought up with" (J. Kay, Project Manager, Fort McPherson).

There is a longstanding connection in Fort McPherson to the traditional use of wood for heating and cooking. As a result there is a sense of ease with technology related to wood heating, even new technology such as the biomass boiler. People say it "feels good" to see wood smoke coming out of the biomass boiler stack in front of the band office, and how seeing it relates to coming off the land and seeing wood smoke rising from a log cabin chimney (R. Alexi Sr., Elder, Fort McPherson).

Because gathering and burning wood for heat is deeply rooted in Gwich'in tradition, the thought of going "back to wood" instead of oil is welcomed by most of the participants. Since the oil-heated low-rental housing is seen to have distanced the community from traditional heating ways, the biomass project is considered a reconnection to this practice.

The traditional values supported by the biomass initiative most commonly mentioned by participants included:

i. Autonomy and self-reliance;

ii. Hard work;

iii. Connection to land; and

iv. Pride and well-being.

4.3.2.1 Autonomy and Self-Reliance

Many in northern communities feel that dependence upon imported fossil fuel for their energy needs has diminished their sense of autonomy and self-reliance. A move toward heating with locally-sourced wood is seen by some as a way to regain a measure of that self-reliance.

"And our people don't have to be buying oil. We've got our wood out there, and we've got young people to get it. And we can help people who still use wood in their homes… And everything we do is our work. And we have to continue it" (B.R. Koe, Youth, Fort McPherson).

The desire for autonomy was an important motivator for locally-sourced energy expressed by Fort McPherson interviewees, as was frustration with oil dependence.

"So the community members then will take pride knowing that at least if they bring one cord of wood in, then they've done something for our community. Whereas if a fuel truck comes into our community, you just see it come in, take its hose out, fill up the tank and then they're going again" (J. Kay, Project Manager, Fort McPherson).

"I like to see the smoke coming out of that pipe. But every day it makes me feel proud. We're doing something for the people… That system will work for us. We'll sell it to outsiders, it will be a resource for the rest of the region. Likewise, we got lots of work. We've got the wood cutting. We've got the willows cutting. We've got everything" (W. Koe, Chief, Fort McPherson).

In both of these statements, local biomass harvest is seen as a way to provide for the community, and is linked to a sense of pride and community spirit. This is in contrast to the feeling associated with imported fuel. *"It makes me feel good, when I go*

down there by the river with my snowshoes, go looking for dry wood. I don't think many of us feel very good when we go to the Co-op and buy our fuel" (J. Kay, Project Manager, Fort McPherson).

Autonomy appears to be so important to some northern communities that projects that may increase autonomy are sometimes given priority over those that could make more money. When Lutselk'e, NWT was in the development phase of their community solar photovoltaic project, they decided that once connected to the local grid, they would become an independent power producer (IPP), meaning they sell power produced by their solar array back to the utility. Being an IPP brings with it ownership, power in decision making, and a strong sense of autonomy and independence. The community was advised instead to consider net metering, which would provide several times the revenue per unit of energy produced, but does not have the same ownership and self-determination that comes with being an IPP. Lutselk'e decided nonetheless to become an IPP, for significantly less revenue that net metering would provide, in order to increase their energy autonomy (L. Todd, AEA, March 2014; W. Carpenter, GNWT). This example, and the emphasis on autonomy in the Fort McPherson interviews, suggests that autonomy is a high priority for some northern communities when considering energy choices, even above the traditional financial metrics that normally dictate energy decisions.

4.3.2.2 Hard Work

During one of my interviews in McPherson, a man in the room got up and showed me his harvesting permit. "*This paper*", he said, "*means I can work hard out on the land to bring in wood, get paid for it, and feel good about doing something for my community.*" Working hard is preferred by many to the forced idleness of

unemployment. As another community member stated, *"People are tired of having nothing to do."*

The physical aspect of harvesting, transporting, cutting and chipping wood out on the land is counted as one of the principle benefits of the biomass project by those involved. A physically demanding lifestyle is seen by some participants as part of the traditional culture that enabled the Gwich'in to thrive. The following quotes refer to the hard work involved in cutting, hauling, storing and burning of wood.

"And all the time we worked. From when we get up 'til when we go to bed… Because living out on the land you had to do those things in order to have a nice warm place, a lot of wood overnight" (B. Francis, Elder, Fort McPherson).

"We hauled all of our willows right from the bush there. We cut them and dried them and all summer we'd make dried fish. Nighttime we'd burn wood when it'd get cold. Then wintertime we'd haul all that wood for winter and we'd store it there. We'd do a lot of hauling. We worked hard when we were young" (W. Koe, Chief, Fort McPherson).

The end of this hard-working lifestyle was felt by interviewees to coincide with the arrival of the low-rental housing provided by the Canadian government in the 1960s and 70s. Many Gwich'in came off the land, out of log homes heated with wood, and stopped gathering wood to cook, dry their fish and meat, and heat their homes. One Elder said this harvesting, transporting, storing and burning of wood traditionally took up over half of the waking hours of the day. The resulting gap was filled, according to some Elders, by boredom and "mischief" and drinking.

"You know, when people were hauling wood, they all had something to do… And from working all that and keeping yourself busy, and keeping yourself fit and doing all

your own work, and being proud of doing all this for yourself, well government brought in these low rental housing. Where there was no more wood to be hauled. You didn't have to look for water. Everything was in there. And that was not good for our people" (B. Francis, Elder, Fort McPherson).

"We hauled wood all the time in those days. Nobody rests, nobody take break. Summertime you're going to haul lots of willows, make your dry fish all summer and dry your meat… People worked really hard, until the furnaces came around, and the TVs. And people destroyed their lives sadly. Nothing else to do. That changes social things in the community where people started drinking lots… People used to visit all the time. People stopped visiting, people stopped going to different homes. Even your brothers and sisters don't visit each other as much" (W. Koe, Chief, Fort McPherson).

The following two quotes illustrate the preference by some to eschew the comforts of the low-rental homes, in favour of a more strenuous and demanding existence in their log homes.

"(The housing corporation) asked me, 'How come you don't apply for that house (with a furnace)?' I tell them, 'I got kids growing up. Boys and girls growing up. What they going to do? What they going to do in the house if everything's ready? I don't want that. They can work; I can work'" (R. Alexie, Elder, Fort McPherson).

"But if we stay in this old log house, they could haul wood, they could haul ice and make water. That was work for them. And in the low-rental housing, they had no more work to do. It was boring. What do you do? And that's when mischief starts" (B. Francis, Elder, Fort McPherson).

The biomass boiler project, with its need for local people to continually harvest spruce and willow, is viewed with hope as it brings the benefit of daily physical work.

"One thing that I feel that's nice about this project is that there's people out on the land now, either harvesting the dry trees, or they're getting the willow, who otherwise maybe wouldn't be working. So they're getting jobs where they have to use their hands and their bodies" (B. Francis, Elder, Fort McPherson).

Below is the plea of one Elder that his community return to the Gwich'in tradition of heating with wood, and the physical work of gathering the wood and tending the fire.

"Get my people back where we use stoves. Me and my wife get up at night and make sure it's going, we're used to that stove going all of the time… I still cut wood and split wood. If I've got no stove like that what I going to do? There's absolutely nothing to do" (R. Alexie, Elder, Fort McPherson).

4.3.2.3 Connection to Land

Harvesting wood on the land was argued to build connection to the land, happiness in the community, and pride in the people. The healthy Boreal forest that surrounds Fort McPherson has always provided for the people, and allowed the community to thrive. *"The land can provide all the wood we need to heat our homes. All you need is out there" (J. Kay, Project Manager, Fort McPherson).*

"In the wintertime, I remember getting up in the morning and it was still kind of dark, and already you could hear dogs barking all over. Everybody had their own teams… dogs were tied down the hill, and people were already going down looking for wood with dog team. And they know where the wood is, they haul in the wood. Sometimes people already got about a cord in front of their houses. And they all used

swede saw and cut their wood. They haul ice for their water. Everybody did everything for themself and they were proud people. I remember people standing around outside on the woodpile, the men standing around there and talking, laughing, and everybody was just so happy. You know you never seen anybody feeling down over anything. Not like today" (B. Francis, Elder, Fort McPherson).

Traditionally, the entire family was involved in some element of the harvesting and heating or cooking with wood, be it cutting, hauling, stacking the wood, finding kindling, making the fire or keeping the fire going. There was connection at a very early age with this practice, which nurtured a feeling of connectedness to the land, of being "a part of everything."

"Well I always say that when we make fire in our house, it's better heat. It makes you feel good. When we were out there on the land, we always had a nice warm fire going, nobody was cold. And it wasn't only the men in the family that kept that up, it was everybody. Even us little children were told in our language, put wood in the stove. And we didn't know, but in time we learned. We were a part of everything" (M. Taya, Elder, Fort McPherson).

There was a sense of hope among those interviewed that the biomass boiler project, and its expansion to heat more of the community in the future, will nurture this traditional connection to the land. The Elder quoted below related happiness, strength and pride in the past to connection with tradition, and saw hope that this biomass project can encourage reconnection to those values.

"I think to myself that since 1968 (when my family came in off the land) is not that long. And yet there's a big change among our people. Anything that can be connected to

our way of life, our culture, our tradition, would be really good because people will go back to having that pride, get back their self-esteem. There's a lot of things since 1968 our people are not doing anymore. Whereas before, our people were so happy. And they were so strong. And they saw good in everything. So when I see these (projects), anything that means connection with our way of life, it makes me feel happy, it makes me feel that things can just go on" (M. Taya, Elder, Fort McPherson).

4.3.2.4 Pride and Well-being

Pride and well-being, according to interviewees, are enhanced by increased autonomy, by working hard in projects that align with traditional values, by connection with the land. On the other hand, there seems to be little pride associated with dependence on imported fossil fuel. Harvesters in McPherson all reported being proud to provide for the community, and a sense of comfort seeing the wood smoke coming from the band office stack.

Chapin et al (2005) found a strong link between well-being in circumpolar Indigenous populations and the strength of their connection to traditional land-based activities. The Fort McPherson biomass project exemplifies this, in that the biomass harvest has led those involved to feel good about themselves, to "feel a part of everything", as Elder Mary Taya said (see Section 4.3.2.3 above).

There is a sense of returning to traditional values at the same time as the community moves forward into the future; of reaching into the past for what was lost. This full circle thinking, this sense of connectedness with how things were and could be again with biomass heating, was expressed by Johnny Kay.

"Now we've gone full circle…. Now we're going back to how things used to be long ago. We used to get up in the morning, we used to make fire. Once we made fire and they cooked and they made our meal, then afterwards we have to go outside and we start to cut wood, we start to split wood, we start to pack wood inside the house. Now we're going back to that lifestyle again. And people take pride in that. We're not going back to when we're just turning the thermostat up when it gets cold. We're actually making the fire now, and feeling the heat and seeing it".

4.3.3 Engagement

The interviewees suggested that the means of communication used while developing community energy projects, and who is engaged in that discussion, has longstanding implications for community buy-in and thus longevity of the project. Community members need to feel they have input and control as to the outcome (R. Marshall, Co-founder AEA). Elder Mary Taya in Fort McPherson stressed that people need to be heard in order to feel a part of events that affect the community.

"Anything and everything when decisions have to be made, it should happen ***in*** *the community. If it's for the community they should be a part. Consultation has to happen. Too long now have we been talked to from up there, whether it be regional or territorial. They've made too many decisions without us and for us that we're not happy about. And when the community makes their own decisions and decides was is good for them, they're strong to it. They are willing to do whatever it takes."*

Engagement should include, whenever possible, a wide diversity of interest, expertise and opinion. A review of the community energy planning literature by

Keyte (2013) informed the following list of groups with whom early and ongoing engagement is recommended (Arctic Energy Alliance 2007, 2011; BC Government, 2012a, 2012b; CANMET Energy Technology Centre, 2005; Community Energy Association, 2006; Ecology North 2004; Fraser Basin Council, 2010; Henderson, 2013; Kavik-AXYS 2010; Natural Resources Canada, 2007; One Sky 2008; Pembina Institute 2005; Sheltair Group 2008; Stantec Consulting 2010a, 2010b).

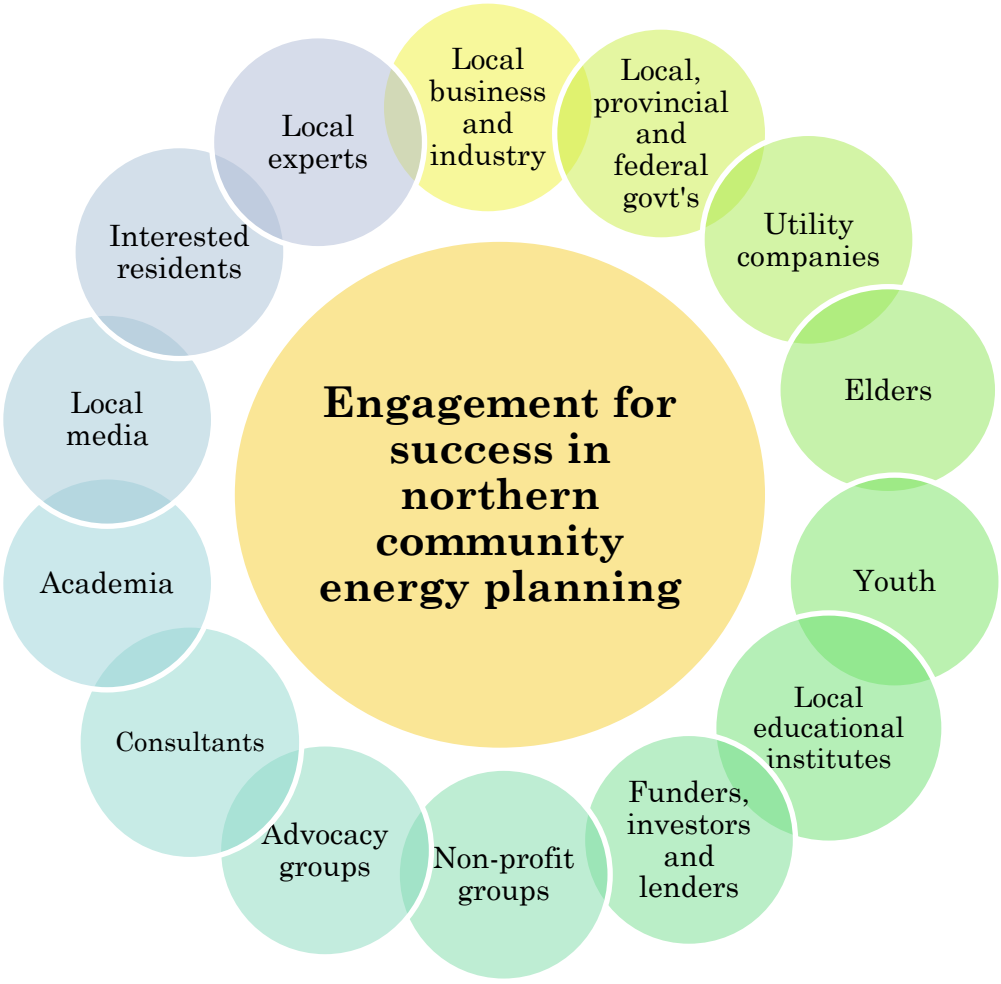

Figure 15: Groups to consider for successful northern community energy planning (Keyte, 2013)

The likelihood of bringing all of these groups into discussions about a small northern community energy project may be slim. Yet including as many as possible helps inform the process with a rich diversity of knowledge, experience and opinion. Ideally an energy advisory council is established at an early stage, which includes representatives from many of the groups above, to ensure expert and local input into decisions, and to create a clear pathway for reporting to and advising Council (Keyte, 2013; Biomass stakeholders meeting, 2014).

Participants from Fort McPherson stated that in northern communities, where sensitivities may exist over past and present colonial attitudes, it is important that engagement be undertaken with respect, and a willingness to carefully listen and respond to opinions and ideas. Respect includes bringing youth, Elders, men and women to the table, and time spent educating as many people as can be reached about the project, regardless of education level or experience with the technology.

Education should ideally include sharing the project's purpose, costs, benefits to the community, relevant terminology, and how the technology works, and when possible, it should engage students and staff in the local school, who can help to spread awareness to their families (Biomass stakeholders' meeting, 2014; Kavik-AXYS 2010). This can include the formation of Youth Groups, as in Wha Ti, NWT, where youth were trained by experts to help disseminate basic information about an energy project in the community (Ecology North 2004).

Interviewees indicated that if people are shown examples of success stories from other northern communities, it helps them to understand the paths that others have travelled and the hurdles they have overcome. In this vein, other northern communities

are already looking to Fort McPherson as early leaders in the field of local biomass harvest. McPherson takes pride in this, and wants to do continue along the path of positive achievement.

"It's going to be a really good thing for the community. And if other communities see, they might say to themselves, hey let's go to McPherson, see what they're doing. Inuvik come up here and say, look at that opportunity we can do. Aklavik. All kinds of willow and trees around there" (W. Koe, Chief, Fort McPherson).

"And then if you set it up down the road really good you could provide a fuel source to Aklavik. And then to Inuvik. And Tsiigehtchic. It's something that could just get bigger as we go along" (J. Kay, Project Manager, Fort McPherson).

Johnny Kay stated there will always be those who do not embrace a project, but that it is important to focus on those who do support it, to keep the energy positive and to focus on what's working (J Kay, Project Manager, Fort McPherson).

Wade Carpenter of GNWT cites the importance of putting "boots on the ground" in the communities, in roles of support that don't necessarily relate directly with the project. This can help to minimize perception that the government is only there to achieve its own ends, and can promote trust in a mutual desire to maximize benefit to the community.

"Lots of renewable energy projects won't be successful in communities because it's often perceived as just some government thing. If somebody parachutes in a bunch of solar panels into your community, doesn't consult on where they go, what they look like, who owns them, who operates them, all of a sudden they wake up one day and it's there –

do you think those solar panels will last longer than a couple of weeks? No" (W. Carpenter, GNWT).

Community buy-in is needed to ensure interest extends "not just for the capital project but for the 15, 20, 25 years of operating it" (M. Kennelly, GNWT). For Fort McPherson, support came from engagement of the community and its leadership from the outset, and from the project being community-driven, reflecting the values of the people. Wade Carpenter (GNWT, 2014) stated that the having community support behind a community-driven project diminishes the risk of failure due to neglect or capacity issues, and reduces the likelihood of vandalism. Linda Todd of AEA described the community attitude for well-supported solar projects. *"Don't you dare throw a rock at those panels because I hauled them up there."*

In summary, data gathered from participants in Fort McPherson, Yellowknife and from a review of pertinent documents on the topic suggests that ensuring careful, thorough and respectful engagement is a vital step towards maximizing the chance of community support, buy-in and long-term successful maintenance of northern community energy projects.

4.3.4 Champion

"I didn't want to give up… I wouldn't give up this winter and would just not shut that boiler down" (J. Kay, Project Manager, Fort McPherson).

There is a face to every successful community energy initiative, and in the case of the Fort McPherson biomass project that face is Johnny Kay. He has been the champion of this project from its conception to the present day. It began with Mr. Kay and his

colleague Richard Wilson attending a biomass conference in Whitehorse in 2009. On the long drive back to McPherson from the conference, they discussed the abundance of willow around their community, and the potential for creating jobs if the willow could be harvested as fuel for biomass boilers to heat buildings in the village. Then they went to work bringing the idea to the community. "*My hat's off to Johnny and Richard Wilson, for going to a conference and looking at something, and making something out of it. Not just going to conference and that's the end of it. These guys did something with it (W. Koe, Chief, Fort McPherson).*

Mr. Kay became the point of contact with ENR and AEA, and once it was clear that they had the support of the community and of Chief and Council, he drove the project forward, resolutely working through the many obstacles that presented themselves along the way. His sense of direction, his willingness to educate himself in areas where he lacked knowledge, his belief in the voice of the people, his readiness to listen to concerns, and his constant communication with his support network in Yellowknife and Vancouver, all contributed to the project's success. He believes above all that this is a *community* project, which will have immeasurable benefits for Fort McPherson down the road. This is what drives his perseverance.

"This is what I want to do for my community, I want to do it because people are believing in it. So with that I ate and slept this whole initiative. I had a passion for it. So when I walk to work or drive to work I'm already thinking well what can I do today, or who can I call today? And that's just the way I am. That education, I was just hungry for it" (J. Kay, Project Manager, Fort McPherson).

This importance Mr. Kay places on community support, and his belief in focusing on the positive, was summarized in the following advice he gave to other potential community champions trying to get projects off the ground:

"They have to take this project on and more or less live and eat the project. They have to take it on with a passion. You'll never fail, you'll never fail, if you have the community support. You always have the ones who are not in support of what you're doing too. And they'll have their reasons, but that's okay. That's okay. We'll focus on the ones who believe in it and the ones who want to see this through" (J. Kay, Project Manager, Fort McPherson).

When researching potential case studies for this thesis project, I was told by two GNWT departments, several Arctic Energy Alliance employees and the Yellowknife-based NGO Ecology North, that I should go to Fort McPherson and talk to Johnny Kay about their biomass boiler initiative. There was unanimous recognition that Mr. Kay was the face of the project, and acknowledgement that this was a potential success story, even in its early stages.

Bryan Pelke of ENR called the quality of a successful champion "stickiness", meaning determination, resolve, and an unwillingness to give up in the face of adversity. The quotation that begins this Champion section above, where Mr. Kay refused to let the boiler go out, exhibits this quality. Mr. Pelke elaborated on this characteristic.

"Johnny calls me every other day, because there's a lot of challenges just with this small boiler; the technical challenges, the planning challenges, the business challenges – we're going through them all. Very easy to give up at that point. I don't know of any other community where I've been able to deal with someone year after year.

I've been working with Johnny for four years on the project. There's no other community that I can say that's the case. He knows what we did last year, he knows what we're doing, he's developed his own vision, he's spreading that vision within the community, it's getting bought into. That's the stickiness (B. Pelke, GNWT).

This is echoed by Rob Marshall, co-founder of the Arctic Energy Alliance.

"(A champion is) totally critical. It doesn't happen very often that a guy like Johnny Kay emerges in a community. In the absence of it, not much happens. Ideas are formed, plans are made, but execution usually falls apart pretty quickly."

Champions existed not only on the community side. Bryan Pelke of GNWT, although based in Yellowknife and not Fort McPherson, has championed the biomass project from the government side since its inception. He has brought many consultants and experts together in support of the project, and has found solutions to problems and funding throughout the process. Mr. Pelke and Mr. Kay have each worked hard to move the initiative forward. When two champions such as these, with "stickiness" and sustained determination, work together on a project, obstacles can be overcome through hard work, and the chances for the project's success and long-term resilience considerably increase.

4.4 Financial Factors

Financial factors that affected the Fort McPherson biomass boiler and willow harvesting project can be divided into four main categories, as seen in Figure 16 below: costs, business model, financial resilience and funding. Factors dealing with business

models are further broken into the following three sub-categories: clarifying objectives, infrastructure and ownership.

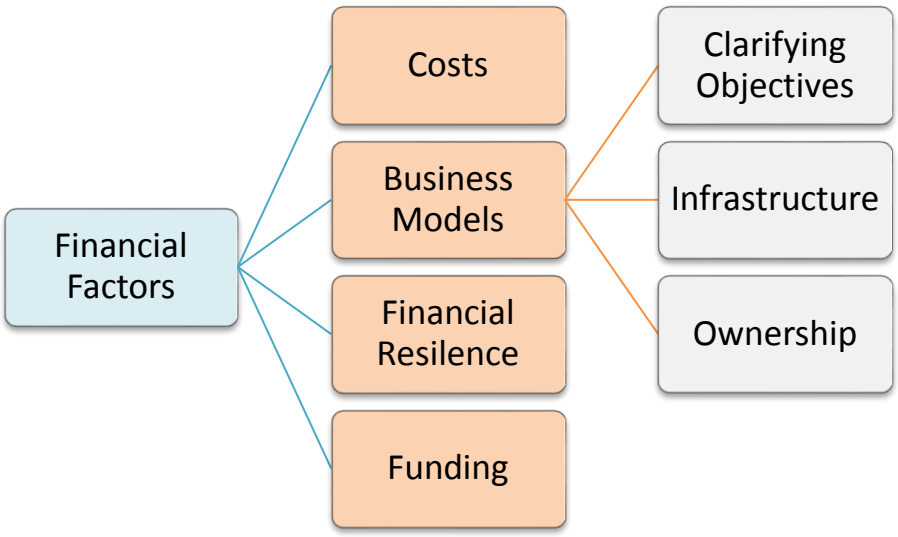

Figure 16: Hierarchy of financial factors in case study

4.4.1 Costs

Reducing high energy costs in northern communities is one of the key objectives stated in the 2013 NWT Energy Action Plan, along with reducing imported oil and GHG emissions, and increasing use of renewable forms of energy (GNWT 2013a).

To understand how these costs can be reduced, it is important to recognize that Northwest Territories currently gets 80% of its energy supply from imported fossil fuel, whereas wood and pellets, whose potential sources abound in the territory, make up only 4% of the energy supply (GNWT 2013a). There is therefore potential to increase the proportion of locally-supplied biomass fuel for heating in the NWT energy mix, while accomplishing the objectives of reduced cost, reduced fossil fuel reliance and lower greenhouse gas emissions from the 2013 Energy Action Plan.

The Northwest Territories government currently spends $30 million per year on fossil fuel subsidization (GNWT, 2013). This is a large ongoing operational expenditure, given that it is for an imported fuel source that does not meet the long-term sustainability goals of the government. With these fuel subsidies in place, any renewable technology must prove itself against the cost of fossil fuels that already have built infrastructure in place, without taking hidden life cycle costs into consideration. Wade Carpenter of GNWT explained.

"(The cost of oil) is not the real cost because the oil sands were subsidized by the Canadian government for years. All of their extraction techniques. The transportation has hidden tax subsidies…. Then we have the territorial power subsidies… Governments do not follow full cost accounting. We subsidize the heck out of diesel to get it to a cheap cost. In NWT, in order to be competitive with fossil fuel, you have to beat the displaced cost of diesel. That means all the infrastructure that has been purchased; the diesel generators, tank farms, all the fixed costs. The only non-fixed cost is the fuel that comes in. Your renewable energy system has to produce power at less than the displaced cost of around $0.30 a kilowatt-hour here. How do you beat $0.30 a kilowatt-hour? It's tough with a renewable energy system that's intermittent, and… not subsidized to the level that the oil and gas industry is. You're not on a level playing field."

This inequities inherent in comparing alternative energy costs to subsidized fossil fuel costs was echoed in the statement below by Leanne Robinson of AEA.

"Colville Lake is the most expensive (community in NWT for power costs). Before the subsidized rates came in, electricity was well over $2/kWh, huge compared to all the NWT communities, and just astronomical compared to any southern community… They

just give you a price based on displaced cost of diesel, rather than giving you an infrastructure cost, and a cleanup cost, and all of that. Just that number is over $2/kWh. What is the true cost to produce power there? Much higher."

In addition to the $30 million per year that GNWT spends of fossil fuel subsidization, another $34 million has been spent to reduce the rate shock of Northwest Territories Power Corporation's (NTPC) 15% rate increase, which is being spread out from 2012 to 2015 (GNWT, 2013). These figures suggest a significant financial advantage for the Northwest Territories if it were to decrease its dependence upon imported fossil fuel, and utilize more sustainable local energy sources.

"(Fossil fuel energy is) not affordable. Suppliers milk consumers. Oil costs 80 cents per liter more (in NWT) than Edmonton. We're over a barrel in the north. In Nunavut they get oil wholesale. Here it is privatized, so the cost depends on the supplier. It's $1.89/L for diesel, and $1.78/L for natural gas" (B. Pelke, GNWT).

This statement reflects the general frustration northerners feel about the high costs of energy associated with fossil fuel. Northwest Territories power bills are already the highest in the country, with an average cost of $8.39/day (Figure 17), more than double the national average of under $4/day, and rates are continuing to rise (CBC News, Sep 04, 2014).

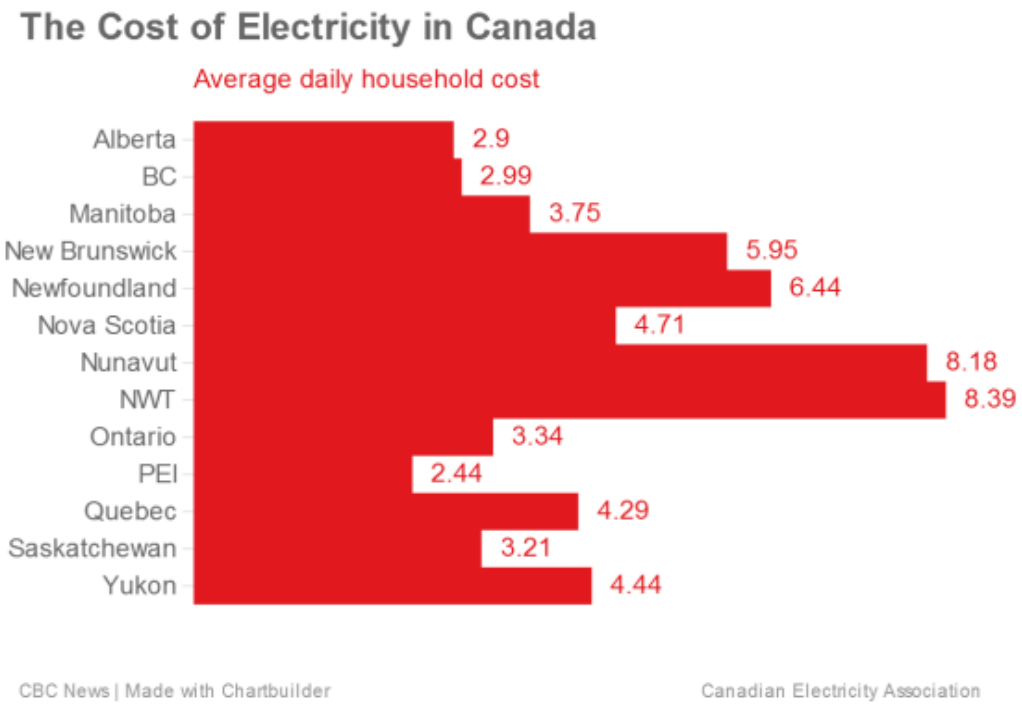

Figure 17: The cost of electricity in Canada (CBC News, Sep 04, 2014)

These elevated power costs, combined with high fossil fuel consumption for heating and transportation, take up a disproportionally large part of northern communities' budgets, as illustrated in an example below given by Linda Todd of the Arctic Energy Alliance.

"1.9 million dollars a year, that's what Lutselk'e was spending in 2007/2008 for their heat, and light, and driving around town basically. That's a significant part of a budget for a community of 320 people."

Energy professionals interviewed felt that the high cost of northern energy is not likely to decrease until fuel is sourced more locally. The Northwest Territories imports, according to energy consultant Rob Marshall, about 500-600 million litres of refined fossil fuel per year. *"Even at the conservative estimate of $1.00 per litre that's $500-*

$600 million a year, straight out of the economy. A truck brings in the fuel and somebody sends a cheque south."

Anything that involves local harvest, he went on to say, is infinitely better than reliance on imported fuel. These benefits even extend to pellets brought in from out of province, although they are not strictly a "local" harvest.

"Even if you're importing the pellets, you've still got substantial cost savings… somebody can go borrow some money to install (a biomass boiler)… and they can legitimately pay it off in 2 or 3 heating seasons, then it's gravy. It's a no brainer" (R. Marshall, Co-founder AEA).

The Northwest Territories government focuses much of its energy strategy upon reducing dependence on fossil fuel used for heating. Taken as a percentage of NWT's total 2011 energy needs, space heating for communities required 21% of the 20.6 million GJ total, whereas community electricity required only 9% of the total (GNWT, 2013). The potential savings are therefore large if heating energy demand and supply can be addressed.

There is widespread concern in the Northwest Territories that oil and diesel prices will continue to rise. Residents have become even more alarmed after seeing the meteoric rise in energy prices in Inuvik and Norman Wells, both communities that converted to natural gas from oil 15 years ago. However, with the depletion of the natural gas wells feeding both communities, energy prices have doubled or in some cases tripled 15 years later. Although liquid natural gas (LNG) is being imported to replace the depleted local natural gas, and although pellet and wind options are being analyzed (GNWT Interdepartmental Energy Coordinating Committee, 2012), the high energy

prices associated with the depleted natural gas resource have left a bitter taste for many residents about promises around fossil fuel pricing relief.

In the case of biomass, there is a secure supply of pellets from northern Alberta and northern BC, and progress toward a new pellet facility being developed within the territory, near Enterprise, NWT. Pellet prices, like those of local wood chips or cordwood, tend to not experience the fluctuations that characterize oil prices. Prices tend to be more stable, and fluctuate mainly with the cost of the fuel required to transport the pellets. Cordwood and wood chips experience no such fluctuations with fuel prices, as they do not require transportation over distance.

Thus, there was a cautious confidence among some interviewees that once biomass facilities are established in a community, there will not be as many surprise fluctuations in cost as those associated with natural gas, LNG, oil or diesel. At the end of the day, people want to see their energy bills coming down, and will likely support technology that offers this.

"I think people are going to have to take a look at it first and see how it runs. And if the people find out that it's going to cost them less to have this wood chip or (pellets), I'm sure everybody will be behind whatever goes on like that" (B. Francis, Elder. Fort McPherson).

Initial savings have indeed been realized from the Fort McPherson biomass boiler project, although savings at this early stage have not yet translated into heat savings for residents. The boiler provided 101,000 kWh of heat to the Band Office and community health centre in its first four-month partial season of heating, displacing approximately 11,000 L of oil (B. Fink, Fink Machines, personal communication). Rat River

Development Corporation, who pays for this heating, states that their mid-winter monthly fuel bills were down from about $7000 to $4300, a decrease of about 40%. These cost savings do not include the additional $700 per month in electricity required to power the boiler's augers, pumps and lights.

4.4.2 Business Model

The business aspects that relate to the Fort McPherson biomass boiler project, and business-related barriers and opportunities for success in northern alternative community energy projects, are discussed below.

4.4.2.1 Clarifying Objectives

GNWT has made it clear that the biomass initiative in McPherson is a pilot project, not intended to make money as a business case in its first years of operation (B. Pelke, GNWT). However, they are equally clear that the long-term objective for the project is to prove its financial viability, and to stand on its own as a business within the next three to five years (Biomass stakeholders' meeting, 2014). To do this, the project will have to compete with the price of oil as a heating fuel, and ultimately (unless it wants to rely on imported pellets) ensure that the price of locally-sourced wood chips competes with that of pellets imported from northern Alberta or BC.

Viewed in purely financial terms, substantial government money has gone into initial support of the Fort McPherson biomass initiative, which, with its relatively small boiler of 85 kW capacity, has resulted in fairly modest initial savings from oil displacement. However, GNWT and Arctic Energy Alliance recognize that it takes time to iron out challenges, create supply chains, fine-tune business models and streamline

efficiency. Pilot projects are viewed as being along a continuum of learning, with early obstacles providing lessons for others to build upon as the project evolves. Leanne Robinson of Arctic Energy Alliance elaborated on this philosophy.

"The GNWT has led so many of the (northern alternative energy) projects, supporting them even though they don't make economic sense the first time, and they don't make economic sense the second time. By the 10th time, they start to make economic sense. That's just the reality of doing those things. It seldom makes (economic) sense the first time."

FP Innovations (2010) suggested the small scope of the pilot project would allow the community to develop skills and infrastructure that may help in the future should they decide to expand. Starting small is seen by most interviewees as a good strategy. Bryan Pelke of GNWT added, however, that it is important to remember that the size of a pilot project does not necessarily reduce its complexity.

"You're trying to figure out the logistics of bringing wood pellets to a place that they've never been before. It's all quite new. With the willows, you're harvesting something that is different to harvest than a typical tree, so trying to find ways of harvesting it cost effectively… There's a lot of arms on the spider… In the marshalling yard, how best to organize things? How do you season the wood to let it air dry out? Then chip it up or what are the options there? What kind of equipment should be used and how is the business run? How is it managed? What's the corporate structure? You get all these elements that you would find in a $20 million project in this tiny little project."

The project elements are shown below in Figure 18, as presented in the Project Definition Memorandum by Associated Engineering (2013).

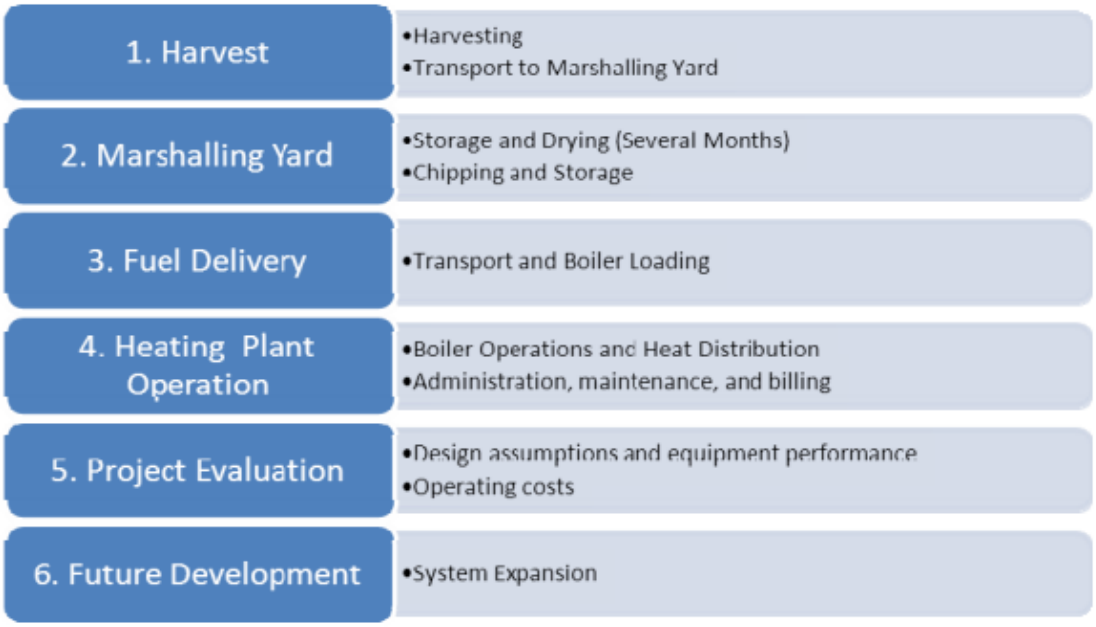

Figure 18: Elements of the Fort McPherson biomass heat project

(Associated Engineering, 2013)

There was much discussion from interviewees as to what defines success of pilot projects such as these, with factors including local employment and capacity building on one side, and financial viability on the other.

In the financial camp is Bruce Elliott of Arctic Green Energy, who feels that mechanization with large industrial willow harvesters/chippers will lead to earlier financial success in Fort McPherson. In the same vein, some interviewees raised concerns that an exclusive focus on community jobs and health may not be financially sustainable in the long run.

"What do you want to achieve? With these decisions, you have trade-offs. If you want to maximize employment, then the automated approach is not going to achieve your

objective as well as hiring a number of people. If you hire a number of people and your focus is employment, and health of your community, you may be running the risk of a system that isn't financially viable, which can't operate in the long run, which isn't sustainable. Maybe (you need) to compromise the cost effectiveness of your project to maximize local employment… Just having it on the table and being honest about those trade-offs is essential" (M. Henry, GNWT).

Several interviewees stressed that the McPherson biomass initiative is first and foremost a pilot project, whose mandate from the outset was, among other objectives, to create local employment via the willow harvest.

"For (the) McPherson (biomass project), it's managing expectations and reminding people this is a pilot project. We know it's not financially viable right now." (L. Robinson, AEA).

Different criteria for success may be applied if the project is strictly a business venture, although there is much debate about this in government circles, with opinions varying widely. It is not obvious how to quantify social benefits when justifying projects by using standard business models.

"Somehow, we have to be able to think of all of the other successes that come along with (northern projects) and our payback needs to include those. I don't know how you do that. If you're really going to do it on a business model, you kind of have to say: "15 guys working is actually worth this much to the community because we're offsetting this much in other things, either in other jobs that we have to create or assistance programs" (L.Robinson, AEA).

Other suggested indicators of success include social outcomes such as improved community well-being, reduced health care costs, re-connection to the land and traditional values, reduced addiction levels, and young families choosing to stay in the community because of steady work.

To this end, the Fort McPherson biomass boiler project is seen by many people as an early success because of its associated social benefits.

"The Fort McPherson project is probably the best example of a sustainable community employment opportunity and investment that's going on right now. That's an untapped focus right now. I find it quite interesting and quite attractive from a policy standpoint" (M. Henry, GNWT).

4.4.2.2 Infrastructure

A key element to the choice of location for a biomass pilot project is the pre-existence of infrastructure to support the harvesting, transportation, processing and storing of wood. Without an existing sawmill and wood storage facility, the mandate of harvesting local biomass becomes significantly more of a challenge. Bryan Pelke of GNWT underlined this when he discussed the importance to the project of the McPherson's wood marshalling yard.

"We've been focusing on communities with existing community sawmills because you can build on that. The wood fuel business can help support sawmilling. For McPherson we needed a yard with equipment to move pellets around, to do wood chipping, to store wood chips, sawmilling, storing bundles of willows. It needs a space and it needs a corporate structure to function. We've invested a lot over the years and supported investment by the Gwich'in in improving the yard, making it more functional.

Now they've got equipment there, investment in wood chippers, sawmilling stuff, edger, the big Quonset tent to move things in and out."

Figure 19: Spruce logs stacked at Fort McPherson wood marshalling yard (L. Keyte)

These community wood marshalling yards exemplify a flexible marketing model, one that allows for benefits to both the sawmill industry and the biomass fuel industry (B. Pelke, GNWT). Harvested wood can move through a wood marshalling yard for processing to either lumber or fuel, which can be stored there and then sold and re-distributed from the yard. Wood pellets can likewise be stored and distributed from the wood marshalling yard.

Adding to these advantages is the seasonal and temporal flexibility of the marshalling yard model. In the Gwich'in culture, as in many Indigenous cultures where traditional hunting, fishing and trapping are a vital way of life, flexible, seasonal work that doesn't interfere with these activities is seen as a huge benefit.

"A wood marshalling yard could be like a marketing board where someone who goes out and harvests a few cords, they can actually monetize it, but they don't have to be

doing it all year round and not be able to go on winter or spring hunts or miss the fish run. Because those are important things. It gives that flexibility and so it fits well, I think, to be able to provide seasonal work" (B. Pelke, GNWT).

4.4.2.3 Ownership

At some point in a project's development, ownership of the project must be clearly defined. In Fort Macpherson, the understanding is that GNWT will continue to provide financial support (for certain infrastructure needs, and possibly further training and funds to support harvesting; not for purchase of pellets) for the project for the first few years, and that third-party ownership will not be considered until the project is closer to standing on its own financially (Biomass stakeholders meeting, 2014).

Until recently the project was owned by the Tetlit Gwich'in Council (TGC), and its previous business arm, Rat River Development Corporation (RRDC). However, TGC and RRDC have recently divided their governance and operations, resulting in RRDC currently owning the project. RRDC is not clear as to its commitment to the project in the future, possibly due to the project being in its early stages, without yet having proven its long-term viability. Should they wish to sell the project, various alternative ownership models have been discussed, including: a) 100% ownership by TGC; b) RRDC or TGC leasing assets and management to a third party and getting a portion of the heat revenue; or c) partial ownership of the business by a third party investor, along with TGC or RRDC. Whatever model is chosen, GNWT stresses the importance of having biomass expertise involved at the ownership and management level (Biomass stakeholders' meeting, 2014), rather than the current situation where the project relies on outside expertise. Louis Azzolini, Executive Director of Arctic Energy Alliance, provides a

metaphor for the need for ownership expertise: *"Shipping companies don't buy nuclear power plants. Nuclear power companies buy nuclear power plants."* He strongly recommends involving biomass expertise at an ownership or management level.

Notwithstanding the uncertainty of the project's long-term ownership structure, ownership of the project by the community (TGC or RRDC), even partial ownership, is desired by those involved with the project in Fort McPherson.

Wade Carpenter of GNWT corroborated this as a desired outcome, stating that Indigenous ownership is a desirable outcome for the government-supported solar PV projects he has helped to develop and fund. "*One of the biggest successes is for all these (solar PV) projects from 2006 onwards, is none of them were utility owned, they're all community owned. These are all owned by Aboriginal groups or the community."*

Community ownership also brings with it a greater ethic of care for the project from within the community. This has had real consequences, for example, in terms of vandalism of solar arrays. Where most community-owned solar photovoltaic projects in NWT have not had a problem with vandalism, there was great community concern over potential vandalism in Colville Lake, NWT, where the community does not own the solar array. As a result, a fence has been constructed around the array to protect it from vandalism, which has greatly increased the total cost of the project (W. Carpenter, GNWT; L. Todd, Arctic Energy Alliance). Community ownership is thought by several participants in Yellowknife to maximize stewardship and long-term care of a project.

"I think the key is… having the community put down money. It's like anybody else, if somebody gives me something for free, a shiny new toy, I might like it… but I don't value it as much because I didn't put any work into purchasing it, building it… it's

just something that landed there, neat but not mine, it's yours. As soon as you have that "it's yours" attitude, vandalism becomes a problem, and O&M costs come in" (W. Carpenter, GNWT).

"The business model needs to be structured in a way where there's something on the line. That's a critical first step in my mind" (M. Henry, GNWT).

How will income be generated from the Fort McPherson initiative? A rate structure for selling heat is the most likely model for long-term income from the project, and from expansion that might occur in the future. A typical model is one whereby heat is sold to customers at a rate fixed at either a lower price than oil, or at a fixed percentage (e.g. 10%) lower than oil. Bryan Pelke of GNWT states that if the pilot project proves successful, a larger biomass boiler could be installed to provide heat to the existing district heating system, which supplies several buildings with residual heat from the Northwest Territories Power Corporation's diesel power plant in the village. The heat demand of this system is approximately ten times that of the current pilot project, which would increase the income from heat sales from its current approximate potential of $50,000 to half a million dollars per year.

Several outcomes of success for the business, listed below in Table 6, were discussed in the interviews and during the May 2014 stakeholders' meeting, as well as outlined in the GNWT's Biomass for Energy Strategic Plan (2013b).

Table 6: Biomass project outcomes for success (Biomass stakeholders' meeting, 2014; GNWT 2013b)

Biomass Project Outcomes for Success
1. Business generates profit without government support
2. Price of wood chips is lower than that of imported oil or pellets
3. Biomass expert is in charge of hiring and running business
4. Business is at least partly community-owned
5. Benefits and profits stay in community
6. Sustainable employment is provided
7. Workers are dependable, efficient and skilled
8. Advisory committee is established
9. Clear pathway exists for effective decision-making
10. Detailed accounting is in place for the project
11. Business model spreads to other communities
12. Biomass industry is scaled up to incorporate larger boilers
13. Wood marshalling yard expands to accommodate a larger sawmill industry
14. Technology is adjusted to thrive in the northern climate
15. Supply chain is developed for pellets
16. Ongoing education and outreach takes place in community

Much is being learnt and much is evolving as the project gets underway and runs for its first few years. As such, it is recommended that consultants be hired after three years of operation, to re-evaluate business options for the project as it moves forward (Biomass stakeholders' meeting, 2014).

4.4.3 Financial Resilience

Financial upheavals such as unstable fuel prices, interruptions in supply, market disturbances, or cessation of funding support, can all negatively affect a community energy system, including its business owners and end users. Becoming resilient to these disturbances is important to stakeholders in the project (Biomass stakeholders' meeting, 2014).

One path to increased resilience would be to reduce the need for government funding. Mark Henry of GNWT elaborated: "*That's maybe a primary objective, not to be reliant on outside funding, because what's the difference between being reliant on outside funding and reliance on oil? They're both things that we don't like and they're potentially not sustainable."*

Reliance on imported fuel may lead to a lack of community resilience in the face of unstable and fluctuating oil and diesel prices. Locally-sourced wood chips, or even imported pellets, are seen by some as financially less risky.

"Right now in Norman Wells and Inuvik… there is shock in the heating and the electrical department because all of a sudden the heating costs are going to double or triple in Inuvik. Either you leave or you just adapt. In Norman Wells we're funding wood pellet heating in apartment blocks, because it's cheaper for them to bring in pellets" (W. Carpenter, GNWT).

However, pellet dependence also has its drawbacks. While it is generally cheaper to burn pellets than fossil fuel in NWT, pellets are still an imported fuel source, bringing with it the possibility of vulnerability and lack of resilience associated with dependence on any non-local supply.

"(With pellets) we have such a reliance on supply from the south; it's tough to be completely resilient. Wood pellets are still produced in the south, they're transported, you're still going to get the transporting costs; you're still subject to the rising cost of diesel" (M. Kennelly, GNWT).

Isolated communities in NWT are nonetheless somewhat insulated from extreme fuel price increases, in that the government absorbs some of the price fluctuation.

"In 2008 when oil went to $142 a barrel, the next buying year you have to purchase at that price, it was very expensive for the government; our cost went up huge. The cost in the community stayed the same. Communities are sort of insulated in the fact that we're not going to let them fail – we can't. That's why the PUB (Public Utilities Board) has a mandate of 110% capacity. We have resilience built into the energy systems" (W. Carpenter, GNWT).

Whenever the government has to pay unexpectedly high fuel costs, however, this is money that could have been spent elsewhere in the communities, stimulating economic growth or providing social services. Furthermore remote communities, while insulated from extreme price increases, still tend to pay heavily for fuel, as shown in this photo taken in Fort McPherson May 30, 2014. By comparison, the Canadian average on that date was 23 % lower, at $1.34/litre (GasBuddy.com, 2014).

Figure 20: Gasoline price in Fort McPherson on May 30, 2014 (L. Keyte)

Fort McPherson Elder Bertha Francis spoke of these high-energy prices in the community, and how dependence on oil leaves people vulnerable.

"But everybody in the community burned wood and I think that was a lot better than having this oil. Because they're running short of oil and even in Inuvik they're changing, and the cost is going up and up, and you know we don't have jobs that's going to cover all that for us."

A common theme in these concerns is that dependence upon imported fuel leaves northerners more susceptible to the vagaries of fuel cost and supply. Introducing a local, sustainable fuel source into the energy mix is one way to buffer these communities from energy insecurity, and to increase their resilience in the face of unpredictable external disturbances.

4.4.4 Funding

There are several funding mechanisms, both territorial and federal, that have greatly aided in the development and implementation of biomass and solar projects in Northwest Territories, and supported energy efficiency retrofits and energy conservation in the territory.

Northwest Territories programs providing funds for alternative energy projects are administered by the either the Arctic Energy Alliance or GNWT, through two departments, Environment and Natural Resources (ENR)[3] and Public Works. Federal funding for biomass projects is received and distributed by GNWT under an umbrella fund called the Northwest Territories Forestry Industry and Biomass Initiative (FIBI). The following table summarizes a) *territorial* funding, and b) *federal* funding available for community alternative energy projects in NWT. The table lists programs reported by interviewees as the most common sources of funding. (AANDC, 2013; AANDC, 2012; Arctic Energy Alliance, n.d.; B. Pelke, GNWT, September 2014; Canadian Northern Economic Development Agency, 2014; M. Kennelly, GNWT, September 2014; Natural Resources Canada, 2014; W. Carpenter, GNWT, March 2014).

[3] In 2015, the portion of the renewable energy portfolio that ENR was hitherto responsible for was transferred to Public Works.

Table 7: NWT programs that support energy efficiency and renewable energy

Program	Administrator
NWT	
Alternative Energy Technology Program (AETP): Residential Renewable Energy Fund (RREF)	Arctic Energy Alliance
Alternative Energy Technology Program (AETP): Business Renewable Energy Fund (BREF)	Arctic Energy Alliance
Alternative Energy Technology Program (AETP): Community Renewable Energy Fund (CREF)	GNWT (Environment and Natural Resources)
Biomass Energy Program	GNWT (Environment and Natural Resources)
Energy Efficiency Incentive Program (EEIP)	Arctic Energy Alliance
Energy Conservation Program	GNWT (Environment and Natural Resources)
Commercial Energy Conservation and Efficiency Program	Arctic Energy Alliance
Capital Asset Retrofit Funds Program (CARF)	GNWT (Public Works)
Deferred Maintenance Fund	GNWT (Public Works)
Energy Priorities Investment Fund	GNWT (Industry, Tourism and Investment)
Electric Hot Water Heater Replacement Program	Arctic Energy Alliance and GNWT (Environment and Natural Resources)
Net Metering Pilot Program	Northwest Territories Power Corp (NTPC) and Northland Utilities
CANADA	
EcoENERGY for Aboriginal and Northern Communities Program	Aboriginal Affairs and Northern Development Canada (AANDC)
Strategic Partnerships Initiative (SPI)	Aboriginal Affairs and Northern Development Canada (AANDC)
Strategic Investments in Northern Economic Development's Targeted Investment Program (SINED TIP)	Canadian Northern Economic Development Agency (CanNor)
Aboriginal Forestry Initiative	Natural Resources Canada (NRCan)

Funding for the Fort McPherson biomass project was accessed through CanNor's SINED TIP program ($819,000 between 2010 and 2015) and ENR's Biomass Energy Program ($238.000), which received funding support from the four federal programs listed in Table 7 (B. Pelke, GNWT, personal communication; C. Correa, GNWT, personal communication), in addition to in-kind support from the community.

Of the other programs listed in Table 7, the one used most extensively by ENR to implement solar projects in the territories is the Community Renewable Energy Fund (CREF), which assists with the installation of larger community-run energy systems. CREF provides up-front capital as a grant which, while not providing a guaranteed feed-in-tariff such as Ontario offers, is nonetheless an incentive for communities to implement renewables, providing up to $50,000 up front to communities for renewable energy projects. Wade Carpenter of GNWT attributed some of NWT's success in renewable implementation to CREF.

"It is really a program to help communities become less dependent on (fossil fuel) systems. It's been around, it's been wildly popular, was fully subscribed this year. A lot of these projects here in the communities were done with a combination of that money and ecoENERGY funding, and sometimes some of their own money."

The other program that has had a notable effect on the Northwest Territories energy landscape is GNWT Public Works' Capital Asset Retrofit Fund (CARF), used to improve and maintain government assets with energy efficiency retrofits and biomass boiler installations. This fund receives support from the GNWT Industry, Tourism and Investment (ITI) Energy Priorities Investment Fund. Through the CARF program, realized savings from retrofits are reinvested into subsequent capital projects. This

funding resulted in the installation, by the end of 2014, of 20 biomass boilers in GNWT-owned public buildings (M. Kennelly, GNWT). Public Works initially prioritized public buildings that consume the highest amounts of oil per year, all of which have now been converted to biomass boilers, resulting in enormous savings realized annually in displaced cost of oil and GHG emissions. The remaining smaller public buildings are now being targeted by Public Works for biomass boiler retrofits (M. Kennelly, GNWT).

Indirect funding is available for the Fort McPherson biomass project from GNWT Department of Transportation, which contracts the cutting of willows along the highway sides (R. Wilson, Fort McPherson). Potential future funding in Northwest Territories might include money from Service Canada, to provide labour for the willow harvest or chipping (D. Noseworthy, Rat River Development Corp), and Bullfrog Power, who may provide help for future solar installations (W. Carpenter, GNWT).

Community energy plan funding (through gas tax money) from GNWT Department of Municipal and Community Affairs (MACA), is seen by some as having provided limited benefit (J. Kay, Project Manager Fort McPherson; R. Marshall, Energy Consultant).

4.5 Governance Factors

Governance factors that affect the biomass boiler and willow harvesting initiative are subdivided here into; a) governmental support, policies, and strategies; b) industry support; and c) Arctic Energy Alliance (AEA) support (Figure 21).

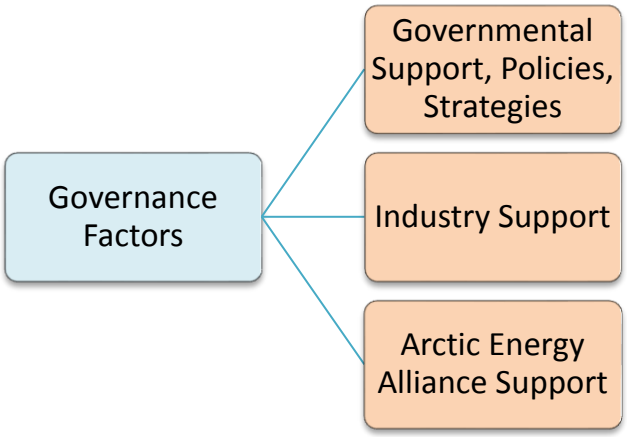

Figure 21: Governance factors in the case study

4.5.1 Governmental Support, Policies and Strategies

There is a strong, if not entirely unanimous, support for environmental programming in GNWT that has enabled a large number of alternative energy initiatives to take place in the territory, both in the remote diesel communities and in the capital of Yellowknife. The territorial government has created strong, clear policy signals that have facilitated this move towards renewable energy, as detailed in their 2013 Energy Action Plan, the 2013 Net Metering Policy, the 2012 Solar Energy Strategy and 2012 Biomass Energy Strategy, and the 2011 Greenhouse Gas Strategy (GNWT, 2013, GNWT ENR 2012a, GNWT ENR 2012b, GNWT ENR 2011). GNWT has pledged $31 million for local renewables in the next three years, in addition to the $50 million they spent on renewables since their 2007 Energy Plan (GNWT, 2013). Local procurement of supplies and infrastructure for renewable projects is favoured through incentive policies, which also favour employment of northern residents and locally awarded service contracts whenever possible (M. Henry, GNWT, personal communication).

"I think we are leaders in a lot of ways. Environmental issues are important to all of our politicians, as opposed to lip service… We've had significant investment in alternative energy and programs and policies that have been set up under the context of our greenhouse gas strategies… It's working and there's nowhere else in Canada that's using those kind of incentives. They've been supported right up through to the leadership and territorial government, and local governments and First Nation governments" (B. Pelke, GNWT).

These policies drive much of the alternative energy project implementation in NWT. This includes support for small hydro, wind, geothermal, solar and biomass projects, although exploration into the first three technologies are primarily still at the feasibility stage. NWT's principle policy focus for alternative energy is on solar photovoltaic use for power needs, and biomass energy for heating (GNWT, 2013).

Targets of the Solar Energy Strategy include the deployment, by 2017, of solar systems to meet 20% of community power needs in all 25 of the diesel communities. In addition, two communities will have solar systems sized to 75% of community load (GNWT ENR 2012b).

The policy push for increased biomass use for heating stems from the NWT Biomass Strategy and the NWT Greenhouse Gas Strategy, which call for doubling the biomass heating in NWT by 100% from 2011 levels, by 2015 (GNWT, 2013).

There is also a push from GNWT to reduce the territory's GHG emissions, from which many of these other strategies arise. To that end, the GNWT GHG Strategy lists the following emission reduction targets (GNWT ENR 2011):

1. Stabilize emissions at 2005 levels by 2015;

2. Limit emissions increases to 66% above 2005 levels by 2020; and
3. Return emissions to 2005 levels by 2030.

In terms of energy efficiency, Yellowknife has stringent building codes that require buildings to be constructed to EGH-80 standards, although NWT as a whole has no such efficiency standards (L. Robinson, AEA)

Also missing in NWT policy is carbon pricing mechanism, as is in place in three Canadian provinces (BC, Alberta, and Quebec, with Ontario committed to adopt a cap and trade system similar to Quebec) where carbon emitters have to pay a price per tonne of carbon emitted. In the opinion of Wade Carpenter of GNWT, the price would have to be fairly aggressive to make a significant difference in the alternative energy industry. He uses the example of wind power, which has proven economically unfeasible in NWT.

"Even if there was a price on carbon, it probably would only be $30 a tonne which still doesn't make it feasible. Then your turbine breaks down once, and if you don't have anybody locally trained to fix it, your one call out to bring the guy from Vermont to fix it, wrecks your payback… It will never pay itself off."

When seeking examples of how to build a successful biomass industry, GNWT looked initially to Europe and Scandinavia (B. Pelke, GNWT). One lesson learned from Europe was the use of strong incentives to spur on biomass integration. To this end, GNWT provides an incentive of 30% rebates for anyone switching to modern automatic biomass pellet boilers. GNWT is also a leader in their creation of a biomass industry association (NWT Biomass Energy Association), to address industry concerns regarding outdated regulatory codes and standards, which are based upon wood stove standards rather than modern pellet boilers.

"Those early movers are important in moving the industry along. We want to get it to a point where someone who knows nothing about boilers and cares nothing about energy, that they just look at the options, look at the costs, and say: "Yeah, I'll go with the wood pellet." They know that there will be a supply of fuel and all these things" (B. Pelke, GNWT).

Much government effort also goes into market development, in trying to grow the pellet market to a scale that makes it viable for industry. To that end, GNWT has supported many strategic projects, demonstration projects and pilot projects with their funding (and federal funding), to help create demand for biomass boilers and pellets, and to establish northern supply chains (B. Pelke, GNWT).

Prior to 2015, the GNWT department most directly involved with the communities in terms of alternative energy initiatives was Environment and Natural Resources (ENR), although as of April, 2015, that mandate was transferred to the GNWT Department of Public Works and Services. ENR had the mandate for renewables, with a separate portfolio and budget from Northwest Territories Power Corp, which allowed them to fund renewables without affecting the cost to the end user. Northwest Territories Power Corp and ENR share a minister, however, which was seen to help with communication between the agencies regarding alternative energy systems (W. Carpenter, GNWT).

ENR worked to promote solar and biomass installations in residential, commercial and institutional settings. They were also involved with regulatory initiatives for biomass and solar energy, and conducting lifecycle analyses for their projects (B. Pelke, GNWT).

According to interviewees in Fort McPherson, ENR has done an excellent job of supporting the community to bring the biomass project to fruition.

"I think it's the good rapport with ENR, the good bunch of guys that have come here over the last year and a half and who have helped Johnny. I've met them all and everybody seems like a great bunch of people. They are understanding, quiet, they listen, and they weighed everything. And there was this approach that we'll try it as a pilot and we'll see how it goes" (T. Connell, Adult Educator, Fort McPherson).

Leanne Robinson of AEA emphasized ENR's vital role in the biomass project, and particularly that of Bryan Pelke, the ENR biomass alternative energy specialist who championed the project.

"Having the Bryan Pelke's on your side… he was super helpful, but he was also a cheerleader too. That's always good. Sometimes you just need a: 'You're going the right way'."

ENR's "boots on the ground" mentality exists on the solar side as well. ENR put dedicated effort into working with communities and establishing lasting relationships, as solar alternative energy specialist Wade Carpenter describes.

"We've travelled to each one of these communities, we've talked to the leaders, we've talked to the people interested. We, in some cases, have written the proposals for them because either they don't have the capacity…[or] they're dealing with something else in the community that's far more pressing than energy issues. So often we would help, we would go meet with them. Build confidence amongst them that we're not some government group parachuting in some sort of system, some technology."

In addition to the departmental roles of ENR and that of Public Works described in the funding section, the department of Industry, Technology and Investment's (ITI) energy section also plays a considerable role in NWT renewable energy policy, focusing largely on policy review and development, budget outlays and investments in energy (M. Henry, GNWT).

4.5.2 Industry Support

It is interesting to note that it was industry, concerned with reducing heating costs, not reducing GHG emissions, that initially introduced biomass boilers as a viable alternative to oil heating in Northwest Territories. Bruce Elliott of Arctic Green Energy, considered the pioneer of biomass in Northwest Territories, was the first to successfully petition the government to install a biomass boiler in a public facility. It was a 1.5 MW boiler for the Yellowknife correctional facility installed by Mr. Elliott in 2007 to supply 90% of the base load of the facility. In its first year of operation it saved GNWT over $300,000 (B. Elliott, Arctic Green Energy). This is a remarkable savings for the government, for only one facility in the first large-scale trial of biomass in the territory. Mr. Elliott installed and maintained the boiler at no cost to the government, and still paid off his $800,000 boiler in five years, by signing a 10-year contract with the government whereby he sells them heat at 12% less than the price of oil (B. Elliott, Arctic Green Energy).

Thus at no cost or risk to themselves, GNWT was almost overnight enjoying large savings due to biomass. It did not take long, given these demonstrated savings, for the government to begin installing their own biomass boilers in GNWT public facilities.

Policy supporting biomass, as well as government incentives to support increased biomass implementation, quickly followed (B. Pelke, GNWT).

This success story is made the more interesting by the incongruence of Mr. Elliott's cost-driven motivation as a businessman with that of the government's GHG reduction policy. (*"I'm no Greenie"* he states in his interview for this case study). His move away from using oil began with his displeasure with exorbitant oil bills from heating his commercial fiberglass workshop. He called La Crete, Alberta to ask them if he could buy coal, which he discovered would heat his shop more cheaply than oil.

"They said: 'Why do you want coal?' I said: 'I don't care what I burn, as long as it's cheaper' and then he said: 'Why don't you burn wood pellets?' I go: 'What are wood pellets? Never heard of them.' He sent me all the information. I said: 'Okay,' so I put one in" (B. Elliott, Arctic Green Energy).

Seven years after the installation of the first biomass boiler in Yellowknife, the biomass industry is thriving and continuing to grow. It is seen to have reached a critical mass where a) a secure market exists, b) a service industry of forestry workers, engineers, boiler technicians and installers are working to support it, c) growth is strong, and d) people continue to invest in expanding the supply chain (M. Henry, GNWT, March, 2014; B. Pelke, GNWT).

"I think a big part is, they see that it's not going away. This isn't like a lot of the energy policy and initiatives in different jurisdictions doing, say, a feed-in tariff, and five years later, there's a backlash and they move away from it… They see it as certainty" (B. Pelke, GNWT).

It took industry, motivated by business interests and evident significant energy savings, to introduce modern biomass technology to NWT, and to bring the government firmly on side. The combination of strong government policy and attractiveness to industry enables it to continue to thrive.

"What we're seeing is an industry that is flourishing outside of the government office. There's businesses, companies that are now focusing on building capacity within human resources, technology capacity. That's an industry that I would describe as meeting that tipping point. Now you're starting to see innovation. That's exciting in the policies that are now associated with its development. Government is invested in creating a market for it" (M. Henry, GNWT).

4.5.3 Arctic Energy Alliance Support

The Arctic Energy Alliance (AEA) is a not-for-profit society with a mandate "to help communities, consumers, producers, regulators and policymakers to work together to reduce the costs and environmental impacts of energy and utility services in the Northwest Territories" (AEA, n.d.).

The Arctic Energy Alliance works at arm's length to GNWT. It was created to consolidate the activities of various energy functions in the government and other agencies, in the hopes of eliminating duplication and providing a single point of contact for the public.

Rob Marshall, co-founder of AEA, discussed the drive behind its formation.

"We (realized) the need for an agency like the Arctic Energy Alliance that could be given mandates to tackle this stuff and work outside the structures of government

because it can do things a lot more efficiently. It's not bound by procurement rules and some of the paperwork that will slow down a government bureaucrat."

When asked why organizations like AEA don't exist in southern jurisdictions, Mr. Marshal cited the extremely high cost of energy in the North as pushing the need for such an organization in NWT: "*Those conditions don't exist in the southern provinces. People aren't looking at $1,000 a month power bills."*

The Arctic Energy Alliance continues to work with all of the agencies in NWT, and a few in other jurisdictions, involved with energy efficiency and alternative energy. For example, when working with Inuvik to determine energy options in light of their dwindling natural gas, AEA worked with ITI, ENR, NT Energy, NTPC, and Public Works to determine the best options for ways forward (L. Robinson, AEA).

The Arctic Energy Alliance helps to educate residents, communities and businesses on choices around energy efficiency measures and renewable energy implementation. They provide guidance as to the environmental and financial costs of energy choices. AEA conducts energy audits, building performance evaluations, and pre-feasibility studies for communities and residents. In addition, they provide incentives for adopting efficient and renewable practices, and give advice on policy and regulations.

A number of training programs exist under the AEA, such as the "Wood Energy Technology Transfer" (WETT) certification, which trains local technicians to operate and maintain wood stove and boilers, and the "Burn It Smart" training workshops that teach the safe and efficient use of wood burning appliances.

The Arctic Energy Alliance also monitors and evaluates the Northern Sustainable Houses, built in each territory through a partnership between the Canadian Mortgage and Housing Corporation (CMHC) and local housing corporations, as a means to evaluate different designs for sustainable housing units in the North (L. Robinson, AEA).

In terms of help specific to the Fort McPherson biomass project, AEA provided support in the form of expertise and advice throughout the project, as well as hiring and training a local student (Bobby Rose Koe, an interviewee for this research) as the videographer for the film produced by AEA about the project.

Finally, AEA is involved in community energy planning, which was part of a larger initiative by the federal government requiring Integrated Community Sustainability Plans that were once required in order to receive federal gas tax funding. While there are varying results from community energy plans and mixed feelings as to their effectiveness, community energy plans completed by AEA are seen to be of the highest standard.

"A lot of them do still sit on the shelf collecting dust and were never looked at again. Some of them weren't done that well. The ones that were done through the Arctic Energy Alliance were done very well, and some leaders in those communities are still talking about their energy plan and actually acting on it" (W. Carpenter, GNWT).

The above praise for AEA reflects the unanimous support among interviewees for the organization. There exists a true appreciation in Yellowknife and Fort McPherson for what is viewed as AEA's indispensable role in the NWT energy landscape, and praise for the professionalism and care with which they carry out their mandate.

Chapter 5 Discussion

5.1 Discussion overview

This research is concerned with two central objectives:

a) To understand factors that advance an alternative energy initiative at the community level in a remote northern community, and
b) To explore how a community energy initiative can affect the resilience of a community's energy system.

The discussion that follows addresses these questions in their component parts in Sections 5.2, "Key success factors for northern community energy projects" and 5.3, "Exploring the relationship of the biomass initiative to resilience". It does so by highlighting the case study research findings from the documents analysis, interviews and participant observation, and situating these finding within the relevant literature (resilience, community alternative energy, and biomass). The Discussion chapter finishes with conclusions and recommendations in Section 5.4.

5.2 Key success factors for northern community energy projects

The following section includes summary tables of success factors from this case study, and a discussion of these factors.

While some of these factors are specific to the Fort McPherson case study, Fort McPherson may in certain ways be representative of other remote northern Indigenous communities in Canada, many of whom are likewise dependent upon fossil fuel for their energy, and somewhat dissatisfied with the resulting lack of autonomy, high prices and

lack of sustainable local benefit associated with their energy systems. Also like many northern communities, Fort McPherson faces challenges such as limited infrastructure, local capacity and employment.

For these reasons, the factors for success revealed from the Fort McPherson biomass heat case study may be useful in developing community alternative energy initiatives elsewhere in the North. As such, the critical success factors for northern community alternative energy initiatives, as revealed by this case study, are summarized in Table 8 (factors internal to the community) and

Table 9 (factors external to the community) below.

Table 8: Internal success factors for sustainable northern community energy initiatives

	Internal Success Factors	Interviews		Participant Observation		Literature
		FM	YK	FM	YK	
1	The energy system aligns with cultural identity, traditional values, and local connection to landscape	✓		✓		Berkes & Ross, 2012 Stephenson, 2008
2	The community feels it has an integral role in the decision-making process	✓	✓	✓	✓	Walker & Devine-Wright, 2008 Walker et al, 2010
3	Flexible local jobs are created, local capacity enhanced, and energy dollars kept local	✓	✓	✓	✓	Cambero & Sowlati, 2014 Hodbod & Adger, 2014
4	Local environmental drivers and resources are thoroughly understood	✓	✓	✓	✓	Amundsen, 2012 Fournier, 2012
5	The community embraces change, innovation, and diversification of its energy system	✓	✓	✓		Dale, 2010 Wu & Wu, 2013
6	The community is willing to engage outside expertise and build new partnerships	✓	✓	✓	✓	Fournier, 2012 St. Denis & Parker, 2009
7	Residents perceive benefits to the community to be sustainable and long-term	✓	✓		✓	Fournier, 2012
8	Ongoing community education regarding the project is provided, and success stories are shared between communities	✓	✓			Federation of Canadian Municipalities, 2012 Walker & Devine-Wright, 2008
9	Community champions are dedicated, respected by the community, and supported by government partners	✓	✓	✓	✓	Roege, 2014 Walker et al, 2010
10	The community has a direct financial investment (at least partial ownership) in the outcome of the project		✓		✓	Hoffman & High-Pippert 2005 Walker et al, 2010

Table 9: External success factors for sustainable northern community energy initiatives

	External Success Factors	Interviews		Participant Observation		Literature
		FM	YK	FM	YK	
1	Strong, clear, coordinated policy is in place regarding greenhouse gas reduction and uptake of renewable energy.		✓		✓	Fertel et al, 2013 O'Brian & Hope, 2010
2	Strong support and trusted collaboration is provided by industry and government	✓	✓	✓	✓	St. Denis & Parker, 2009 Walker et al, 2010
3	The government supports strategic pilot projects beyond capital cost: investment includes expert training (with redundancy), operational support and supply chain development during the first crucial years.	✓	✓	✓	✓	Thornley, 2006
4	Robust and easily-maintained technologies are chosen, designed to thrive in northern environments.	✓	✓		✓	Arriaga, 2013 Roberts, 2009

5.2.1 Internal success factors

The interplay of the case study energy system with landscape identity and historic cultural identity was shown to be a success factor in the early development of the biomass project. For the project to succeed, it required fuel, and the community offered almost unanimous support to the idea of providing this fuel in the form of local willow. This strong support was based upon more than simply the willow's usefulness as an energy source. Residents longed to once again enjoy the historic view of the Peel River from the village that had become blocked with dense willow growth, and to be able to once more use the flats (now choked with willows) between the village and the river. The high value given to this area being free of willows as it was in the past is part of the cultural identity of residents who remember it as an open space, and identify with its history as un-forested flats leading to the river. This importance of understanding landscape value according to local connection to place and cultural identity, while discussed by some researchers (Stephenson, 2008) is not present in the northern energy literature.

This cultural connection applies not only to the land that provides the wood, but extends to cultural identity and familiarity around the traditional Gwich'in harvest of wood for heating, cooking, drying meat and fish, and the familiarity and comfort felt toward the biomass heat system as a result. The potential connectedness between energy systems and cultural identity is exemplified by the feelings of well-being described by Elders when seeing the wood smoke coming from the boiler. Connection to place, and incorporation of local cultural values, is seen as a significant component of community resilience (Berkes & Ross, 2012; Kulig et al, 2008; Robards & Alessa, 2004; Ross et al, 2010). The resonance of the biomass project with these values, and the community support, sense of comfort with the technology and acceptance of the project that resulted, is considered a key success factor in this case study.

Similarly, values such as autonomy and self-reliance were shown by the research to significantly outweigh the more common metrics of financial benefit when it came to energy decisions for the community. With implementation of the biomass system, most Fort McPherson participants noted an increase in perception of their energy independence, which is thought by some researchers to be particularly associated with biomass energy systems, through local job creation (due to harvesting requirements) and economic stimulation (Cambero & Sowlati, 2014). Interviewees expressed a strong desire for even greater autonomy around energy provision, and described feelings of pride, sense of belonging and well-being related to providing for themselves regarding the willow harvest. The community energy literature corroborates this link between active, direct involvement in local energy provision, and community sense of ownership and support (Walker & Devine-Wright, 2008; Walker et al, 2010), while the resilience

literature highlights the link between pride in place (expressed by interviewees when referring to their involvement/ownership in the biomass project), well-being and community resilience (Amundsen, 2012; Chandra et al, 2012).

The creation of flexible local harvesting employment on the land aligned strongly with the Gwich'in traditional values of hard work, community pride and connection to the land. Indeed, time on the land is seen as directly linked with well-being in northern Indigenous populations (Todd, 2010). Work on the land brought with it not only a sense of ownership and support within the community, but also a sense of well-being and cultural resonance (as opposed to dissonance expressed by participants with oil heat) associated with the project. The creation of flexible harvesting jobs, and their association with the above traditional values, is therefore seen as another significant factor in the success and long-term local support of community energy projects such as this case study. Moreover the flexible nature of harvesting work (part-time, seasonally flexible) aligns with resilient qualities such as livelihood flexibility and diversification of economy (Buikstra et al, 2010; Burkes & Ross, 2012; Fournier, 2012; Hovelsrud et al, 2010, Ross et al, 2010).

Success factors such as the community's willingness to embrace change, innovation and new technology, to seek outside expertise, to build new partnerships and to take a risk in diversifying its energy sources displayed an inherent resilience that likewise played a vital role in the development of the biomass heat initiative. This idea is elaborated upon in Section 5.3 below, "Exploring the relationship of the biomass initiative to resilience".

Community champions can be a key factor in a project's success, as evidenced by Johnny Kay in Fort McPherson, who showed dedication, determination and perseverance in overcoming challenges as they arose. By bringing the project idea to the community and leadership at an early stage, he gained public support and understanding for the project, which Walker (2008) states lends to greater social cohesion around energy projects. By explaining the benefits to the community (jobs, local capacity, economic development, keeping energy dollars local, and work on the land) and by receiving support from the Elders and Chief and Council, the project was viewed as collectively benefiting the community, which is understood to significantly enhance long-term support (Walker et al, 2010).

5.2.2 External success factors

The formation of trusting partnerships with government and industry agencies was a factor in the success of this project. A community's willingness to draw upon outside support and form partnerships is a hallmark of resilience (Dale, 2010; Founier, 2011; Fournier, 2012; Wu & Wu, 2013), and Fort McPherson exhibited these traits. Examples of these partnerships formed with the community include the territorial government departments of Environment and Natural Resources, and Public Works and Services, as well as the Arctic Energy Alliance, whose accessibility and ability to put people on the ground in remote communities was seen as a strong factor in the project's success. Industry support from the boiler provider, Fink Machines, was also considered a critical success factor in the ongoing management of technical challenges that arose with project. Because of respectful and early engagement on the part of these organizations, the community felt it had an ongoing role in the decision-making process. As exemplified

by Fort McPherson, this sense of being a part of the decision process normally leads to stronger community sense of ownership in alternative energy projects (Walker et al, 2010).

Financially, funding from Canadian Northern Economic Development Agency (CanNor), the ecoENERGY for Aboriginal and Northern Communities Program, and the GNWT Biomass Energy Program were crucial to the project's development, along with in-kind support provided from the community.

The decision to start small with a pilot project, rather than to implement a larger-scale project from the beginning, was viewed by the government as a success factor. Given the complexities and challenges of developing such a project for the first time in a remote northern community, this decision to start small proved invaluable in terms of managing the risks associated with a new technology and business model, securing funding, and for building capacity at a manageable rate.

Finally strong, clear policy signals from the territorial government's Energy Action Plan to reduce greenhouse gases and imported fossil fuels helped to move the project forward (GNWT 2013a). Similarly, the NWT Biomass Energy Strategy, which promotes uptake of clean burning biomass energy technologies, community forestry initiatives, wood marshalling yards and the creation of a Biomass Industry Association, has provided crucial policy support for the project.

5.3 Exploring the relationship of the biomass initiative to resilience

5.3.1 Overview

It has been previously reported that resilience within a system is a critical component of its sustainability (Lietaer et al, 2010; Walker & Salt, 2006; Wu & Wu, 2013). It is also argued that the world is made up of dynamic systems where change is normal, and that systems must be able to respond fluidly to that change in a manner that does not overly disrupt their function (Molyneaux et al, 2012; Redman, 2014; Wu & Wu, 2013). A community's ability to thrive in the face of this change, and across multiple time frames, events and conditions, may be facilitated by moving away from a single source of energy (Roege, 2014). This may increase resilience by decreasing vulnerability in the face of unexpected disturbances, while increasing local self-reliance and flexibility. The results from this research suggest not only that the resilience of the energy system must be one of the guiding factors in decisions around northern energy provision, but that the relationship of the energy system to *community* resilience must also be given priority. It is argued that without a resilient community in which to imbed a system, an energy system is less likely to remain resilient, and is therefore less likely to be sustainable. Energy resilience in northern communities is therefore argued to encompass the notion of both *energy system* resilience and *community* resilience. Three triangulated findings pertaining to resilience from the research are summarized in Table 10 below.

Table 10: Selected resilience findings

Selected Resilience Findings	Interviews		Participant Observation		Literature
	FM	YK	FM	YK	
1 Increased autonomy leads to enhanced sense of belonging, pride, well-being, and greater resilience	✓	✓	✓		Amundsen, 2012 Chandra et al, 2012
2 Transformative thinking that harnesses local resources in response to change enhances community resilience	✓	✓	✓		Amundsen, 2012 Robards & Alessa, 2004
3 Diversification and a willingness to experiment and innovate increases energy resilience	✓	✓	✓	✓	Molyneaux et al, 2012 Roege et al, 2014

The case study highlights important aspects of resilience, and its importance when considering northern community alternative energy initiatives. In the following sections, resilience is examined as it relates to the environmental, social, financial, and governance factors revealed in this research.

5.3.2 Environmental factors and resilience

Results from this research show that a measure of community resilience was required initially in Fort McPherson, in order to respond to stresses from the changing environment with flexibility and innovation. Amundsen (2012) describes this community resilience as the ability to overcome adversity by taking advantage of opportunities provided by change. Two circumstances could have remained perpetually in stasis without this inherent resilience. One was the dissatisfaction with the community's dependence upon imported fossil fuel. The other was the residents' distaste regarding the thick willow forest that had grown over the last 40 years in front of the village, restricting access to the Peel River and blocking their view of the river. Rather than accepting the status quo, members of the community imagined a way to move from stress and dissatisfaction with these circumstances into action, by harvesting the thriving but

unpopular willows, and chipping them for combustion in a biomass boiler to provide heat for the community.

This shift in thinking, this movement from prevailing community annoyance to one of how the change (explosive willow growth) could be used to their advantage, exhibits the transformative thinking characteristic of resilience in stressful, dynamic environments (Amundsen, 2012; Pelling, 2011). The dynamic local environment did cause stress initially, but also provided resources to the community (abundant willow) that were not previously accessible. The biomass heating initiative resulting from this environmental change enhanced not only energy system resilience (discussed below) but community resilience moving forward, by putting the focus of the solution on working with system *dynamics* rather than maintaining system stasis (Wu & Wu, 2013).

Furthermore, the response to change was more than merely adaptive, it was transformative, a key resilience quality discussed by Amundsen (2012). In dealing with a local problem (dense willow growth blocking the Peel River from the village) by creating a sustainable solution which provided renewable heat, created local jobs, brought economic opportunity and increased self-reliance while opening access to the river, an alternative, emergent future was made possible. A new, "untried beginning" was created for the community (Walker et al, 2004, p.7). Change in the local environment was not only dealt with, but used to benefit the community, both short-term and over the long run, thereby increasing the resilience of the community (O'Brian, 2012; Redman, 2014).

Another aspect was the resilience of the community energy system itself. Energy system resilience is characterized by decentralized, diverse, and modular capabilities, rather than system over-connectedness (Cambero & Sowlati, 2014; Li, 2005; Molyneaux

et al, 2012; Roege, 2014; Wu & Wu, 2013). It can be argued that the biomass project attended to these criteria, by moving the energy system from complete reliance upon fossil fuel heat into a portion of heat being generated by local biomass, thereby providing more diverse and decentralized heating capabilities to the village. By continuing to use the existing oil-heated system while experimenting with another source of heat, Fort McPherson bolstered the resilience of its energy system by diversifying to multiple sources of energy (Li, 2005; Molyneaux et al, 2012).

The fact that the heat source is not only local but also renewable further increased the resilience and sustainability of the energy system, as biomass energy can be locally managed, and results in decreased air pollution compared with fossil fuel combustion (Li, 2005; Molyneaux et al, 2012). Being smaller in scale than conventional centralized energy systems, community energy systems that incorporate local renewable sources like the Fort McPherson biomass boiler project are also more able to adjust to local values and resources (Hoffman & High-Pippert, 2005), which enhances the resilience of the system by increasing community support and buy-in for the project. This, in turn, has long-term implications for the community's desire and determination to see it succeed.

The specific choice of energy source further affects the security and resilience of an energy system. The Fort McPherson willows are an abundantly available, regenerating local biomass resource, providing a more sustainable and resilient source of heat than imported oil, whose global reserves are diminishing (Sovacool & Mukherjee, 2011). Unlike many other renewable energy sources, the willows, and indeed most forest biomass, are reliably and consistently available year-round, and not subject to daily or

seasonal fluctuations, which decreases vulnerability of the system (Akhtari, Sowlati & Day, 2014).

In environmental terms, new boiler technology helps to ensure that biomass sources such as wood chips burn cleanly. Furthermore, as oil dependence within a community decreases, oil spill potential also diminishes, which removes one source of stress that could harm the resilience of a remote northern system and its surrounding fragile environment. Finally, biomass sources such as the Fort McPherson willow chips provide a carbon-neutral source of heat (Eero et al, 2014), which ultimately affects system resilience in the broader sense, by providing heat in a manner that does not contribute to climate change.

5.3.3 Social factors and resilience

As discussed in the previous "Environmental Factors and Resilience" section, the community exhibited resilient characteristics, *and* further enhanced its resilience, in the way in which it responded to change by conceiving the biomass project. Many of these resilient characteristics are socially related, such as the community's ability and willingness to self-organize, experiment, innovate, and approach issues proactively. They are related to social capacity and cohesion, trust, local values, pride, autonomy, and even the psychological and emotional resilience of a community. This section elaborates upon the specific relationship of these social characteristics with community resilience, as seen in the Fort McPherson case study.

The ability to self-organize when faced with change is a vital characteristic of resilient systems (Hodbod & Adger, 2014; Wilson, 2012; Wu & Wu, 2013). The idea for

the Fort McPherson biomass initiative came from within the community, and was presented very early to the Chief and council, the Elders, the Hamlet government, and the people, who largely supported the project, providing the framework for the project development to proceed. While the territorial government helped immensely with project details, the self-organization and drive to move forward still had to come from within the community. Local resources (willow) and local knowledge (organizational and harvesting expertise) were effectively harnessed when faced with change, which is part of a required response in a resilient system (Amundsen, 2012; Founier, 2011; Robards & Alessa, 2004). In this case the change was the unwanted willow growth and rising oil prices at the time.

As the biomass boiler was a new technology, a willingness was required to experiment, learn, adapt and be innovative as the idea was developed into reality. These are key aspects of resilience, along with an openness to create and embrace an alternative future (Hodbod & Adger, 2014; O'Brian, 2012; Redman, 2014; Wu & Wu, 2013). These characteristics were frequently required in Fort McPherson as southern boiler technology was adapted to the Sub-Arctic setting, as harvesting and transportation techniques were experimented with and adapted, as combinations of multiple fuels were tried, and in the many instances when limited capacity in the village required experimentation and innovation in order to solve problems that arose.

The biomass initiative aligns with the research of Molyneaux et al (2012), who find that prioritizing resilience requires not simply a response to change, but rather a proactive approach. A resilient approach also tries to diminish vulnerability and foster sustainable growth (Roege, 2014). In choosing to develop a sustainable local resource

that keeps jobs and income in the community rather than leaving the community as with oil use, Fort McPherson is thinking proactively in a way that is likely to reduce vulnerability and bring with it a measure of sustainable growth.

Amundsen (2012) finds that increased resilience will feed back into a community, enhancing well-being, job creation, and encouraging residents to stay rather than leave, all of which create a greater sense of belonging and pride in place. While it is too early to tell if this is the case in Fort McPherson, this research found that those involved in harvesting willows are proud of what they do, feel they are helping to provide for the community, and are happy to have the opportunity for flexible part-time work in a village with so few employment opportunities.

Also adding to the sense of well-being related to the project is the fact that the biomass harvest aligns with traditional values, such as autonomy, self-reliance and connection to the land. Some of these values are felt by residents to have been compromised by the current dependence upon fossil fuels. For example, the historical loss of autonomy experienced with being coaxed off the land into low-rental oil-heated homes in the 1960s and 70s is still felt keenly by some in the community.

"It was good to burn wood, and everybody was so happy. They were so proud people, that nobody had to hand out something to them. They did it all their own with their own two hands … they had everything. Until the government come in (with the oil-heated low rental houses) and then all that stuff is gone, and hardly anybody goes out on the land." (Bertha Francis, Elder, Fort McPherson)

The strong desire of the community to *decrease* dependence and *increase* autonomy speaks clearly through the results of this research. The biomass heat project is

seen as bringing back a measure of this autonomy, and with it pride and resonance with traditional practice in providing for one's people from the land that surrounds the community. The resulting well-being and connectedness helps to drive the feedback mechanism mentioned above (Amundsen, 2012) that increases resilience in the community.

The connection of community resilience to the psychological health of the population is echoed in the resilience literature (Chandra et al, 2012; Berkes and Ross, 2013) who argue a strong link between the two, as well as in the concerns of participant Rob Marshall (Energy consultant and co-founder of Arctic Energy Alliance):

"*I would say right behind energy resilience are all of these other more human issues of resilience; like emotional resilience. What's the history? Has this community gone through tons of upheaval?"*

In this light, the inherent vulnerabilities of Fort McPherson, like many remote northern Indigenous communities, are apparent, with its history of residential schooling, relocation, cultural upheaval and the resulting social challenges. Bolstering resilience becomes even more of a priority for communities such as this that have experienced disruption and whose emotional resilience might be stretched thin.

Another important aspect of resilience is the community's willingness and agency to form partnerships and draw upon outside assistance and expertise when necessary (Dale, 2010; Fournier, 2012; St. Denis & Parker, 2009). This is in evidence in Fort McPherson not only by the initial attendance at the biomass conference by community members who then conceived the biomass boiler project, but by the project manager's ongoing open communication with the GNWT, the Arctic Energy Alliance and various

industry partners. The trust, cooperation and positive communication channels built between Fort McPherson and these government and industry allies have allowed the community to optimize the benefits of these relationships, and are vital elements in building community resilience (Dale, 2010; Fournier, 2011; Roege, 2014; Wu & Wu, 2013).

A final aspect of resilience that relates to social aspects of the Fort McPherson case study is that of community ownership, and its relation to community energy. Small community alternative energy projects are often driven and overseen by community members, as is the case in Fort McPherson. If the community is actively involved during the process, small alternative energy projects are often perceived as collectively benefiting the local community more than larger non-local centralized systems, leading to a sense of community ownership of the project (Walker et al, 2010; Walker & Devine-Wright, 2008). Participants in this research corroborated this link. Having been involved in the decision making, development or harvesting aspects of the project, they felt much more connected to the biomass boiler heating system than to the existing oil system, and as such, were more invested in working to ensure its success, bolstering the resilience of the system in the face of future change. It should however be noted that some participants in Yellowknife felt that ownership should extend to a financial commitment on the part of a community, not merely in-kind commitment. In this way, a community has not only something to gain if the project is successful, but something to lose if it fails.

5.3.4 Financial factors and resilience

One of the driving factors behind the desire to reduce dependence upon fossil fuel heat was the high price of oil at the time when the project was being developed. Although prices in Fort McPherson decreased slightly after global oil prices dropped late in 2014, high fossil fuel prices still affect residents (e.g. gasoline at the pump was $1.48/L on March 26, 2015), and there exists a desire to move into less expensive and more financially stable energy sources. As with many scenarios that draw on community resilience, the need for a response is often caused by change as a result of being connected to the *global* system, yet the action required by that change is often *local* (Amundsen, 2012). This is the case in Fort McPherson, where high oil prices were part of a global system that produced a local response. For the community to be resilient, healthy function had to be maintained regarding its energy system, even in the face of declining energy security due to high prices, occasional disruptions in supply, and reliance upon a finite resource (Li, 2005; Molyneaux et al, 2012).

By starting down the path of diversifying its energy sources, Fort McPherson is creating redundancy in supply, which enhances resilience by allowing the community to respond to stress (rising prices, supply fluctuations) more flexibly than is possible with a single overly-connected system (Hovelsrud et al, 2010; Roege, 2014; Ross et al, 2010; Wu & Wu, 2013). Some measure of flexibility is required in resilient systems. This is exhibited in Fort McPherson by the flexible, innovative solution envisioned to the joint problems of willow growth, oil dependence and reduced autonomy, as well as by the characteristics of the biomass system itself. It burns multiple fuels, and its functional centre is the wood marshalling yard, itself a flexible model of a local market economy.

A resilient local energy economy is one in which resident markets can compete through local adaptation, where energy supply and sales generate local income, and where local control and management results in lower energy costs (Lovins, 1977; Walker, 2008). The biomass heat project has not yet resulted in lower energy costs for the community at large, although it has substantially reduced oil expenses for the band office for which it provides heat. What it *has* done is provided a local source of heat whose price is not subject to the vagaries of the world market, as is the case with oil. As biomass increases its share of the energy provision in Fort McPherson and other northern communities, its stable, lower prices and sustainable local supply is likely to substantially increase energy security in the region (Sovacool & Mukherjee, 2011).

From a business perspective, as time progresses and wood chips are incorporated into the heating mix, and the project is expanded to other biomass boilers in the village, it is reasonable to anticipate the local market stimulation described above, where oil and wood chips will be competing as sources of heat. An expanded biomass industry in the village will mean more local jobs, not only in harvesting but in transporting, chipping and delivering the chips, and in the management and administration of the business. Already, sustainable jobs are associated with the willow harvest, and money to pay the harvesters is generated from within the business model by heat sale to the health centre. Furthermore, the expansion of the wood marshalling yard has stimulated the local forestry industry, with more efficient space available for milling, drying, storing and selling lumber and cordwood. All of the above bolsters local capacity and resilience in the community, and helps to create an environment more appealing to private sector investment and public funding, bringing further capital into the region (Fournier, 2012).

5.3.5 Governance factors and resilience

In order to achieve a resilient energy system in northern communities such as Fort McPherson, there has to exist strong support and collaboration between government, industry and the community (Chandra et al, 2012). This includes accountable leadership, and trusting communication between and within effective, overlapping governance frameworks, which in turn allows a more flexible response to disturbances (Dale, 2010; Lebel et al, 2006; Wu & Wu, 2013). In many respects Fort McPherson achieved this communication between governance structures, enjoying steady contact and support from the territorial government, the Arctic Energy Alliance, and their industry partners. However, governance within the community itself has several layers (the Tetlit Gwich'in Council, the Rat River Development Corporation, and the Hamlet of Fort McPherson), and the project was treated with varying degrees of support and enthusiasm by these different agencies, leading to issues with project imperatives, such as securing pellets until the wood chips are dry and ready for use. This occasionally conflicted local governance affects the resilience of the biomass energy system by dampening the projects manager's ability to engage the required resources in order to flexibly respond to the needs of the project.

The private sector was an important player in the project governance in that it was pivotal in laying the groundwork for biomass uptake in the Northwest Territories, and exhibited many resilient qualities when first making the transition from oil. As discussed in the Governance chapter, Bruce Elliot of Arctic Green Energy saw a need for a heating option in Yellowknife cheaper than oil heat, and responded by finding a far cheaper source of energy (wood pellets) that he could import from northern Alberta. By installing

two industrial-sized pellet boilers (at his own cost and risk) in the Yellowknife Correctional Facility and selling the government heat, he saved the government large annual energy expenses, and paid off the $800,000 boilers in five years. Once the government saw the proven savings in biomass heat, they quickly followed suit, installing biomass boilers in all of their largest facilities in the territory, thus establishing critical supply chains and regional expertise.

Thus in the Northwest Territories, industry led the biomass wave, and government followed suit with policy, funding, capital projects, and supply chain investments. This in turn created the conditions for community alternative energy projects such as Fort McPherson to take hold. Effective collaboration between multiple governance structures resulted in diversification of community energy systems, and increased energy resilience in the territory's remote northern communities such as Fort McPherson.

5.4 Conclusions and Recommendations

To date, the literature related to northern energy has focused largely upon the technical, financial or environmental aspects of these projects. In cases where social concerns are addressed, the literature does adequately cover the social context specific to *northern* community energy systems. A further gap can be found in the resilience literature, which addresses energy system resilience and community resilience as separate entities, with very little written that combines the two in southern settings, and nothing that combines the two in the northern context. This thesis addresses this gap by discussing energy resilience as it applies to northern communities, moving forward our thinking by bringing together the concepts of general resilience, community resilience

and energy system resilience, and layering these concepts with the environmental, social, financial and governance factors that are unique to the Canadian northern community context.

This research shows that community resilience is a key component in the success and sustainability of northern community alternative energy projects. A more resilient community, better able to respond to disruption, innovate and maintain its projects, ultimately produces a more resilient local energy system. In the North, where resilience might be stretched thin by challenges with unemployment and limited capacity, this focus on community resilience when considering energy is especially important. By diversifying into local, clean energy sources, a northern community can better respond to change and even thrive in the face of change. Community resilience is both required for this response, and enhanced by it. It is suggested here that understanding how a northern alternative energy system affects community resilience should be an integral part of the decision-making process around northern energy.

Other key findings include the importance of incorporating traditional values such as autonomy, self-reliance, cultural practice, cultural identity and connection to the land, into decisions when considering northern community energy systems. These are often overlooked in favour of more conventional financial metrics. However, they are linked intrinsically to pride, well-being, social cohesion and sense of belonging, all of which impact community and system resilience.

Important contributing factors to community resilience exhibited in the case study were an ability to self-organize, a willingness to experiment and be innovative, a willingness to form trusting partnerships, and an ability to harness local resources, drivers

and knowledge in a way that benefits the community in a transformative sense (e.g. local jobs, increased capacity, and enhanced autonomy).

The flexible livelihood provided by a biomass energy system in the form of harvesting jobs, and the resonance of this work with the traditional wood harvest and time out on the land, were key components of success of the project and its potential to enhance community resilience.

Strong governmental and policy support also appears crucial to the success and resilience of northern community energy systems such as in Fort McPherson, especially in the establishment of pilot projects such as this case study where new technologies are being introduced.

Significant literature gaps identified in this case study include a) research related to social factors affecting northern energy systems, and b) research related to energy resilience in northern communities. It is recommended that future research should consider an examination of the following:

1. What defines "success" of a northern energy project from the community perspective?
2. How can energy systems better align with traditional values in northern communities?
3. How can we measure social benefits of alternative energy projects in such a way that they can be incorporated into energy decision models?
4. How can community resilience be better factored into northern energy decisions?
5. What are effective policy incentives for uptake of renewables in northern communities?

6. What business models can facilitate community ownership of northern energy projects?

For action recommendations, this research strongly suggests that local autonomy, cultural connectedness and community resilience be included in northern energy decision models in order to strengthen community acceptance, improve chances of enduring project success, and increase long-term community benefit.

Finally, based on this work it is recommended that policy be strengthened to facilitate the uptake of clean, alternative local energy in the North. Making clean energy accessible to more communities through targeted policy will help to reduce northern dependence on imported oil, decrease greenhouse gas emissions, increase regional autonomy, and enhance cultural resonance with northern energy systems. Clean energy uptake will` not only lead to more resilient energy systems, but also contribute to community capacity, self-reliance, pride and well-being, and ultimately strengthen the resilience of Canada's northern communities.

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Appendix A : Interview Questions Fort McPherson

1) What is your experience with the way you get energy in Fort McPherson? What are the advantages and challenges?

2) Do you think there is an adequate supply of energy in your community, and that it is affordable and reliable?

3) In what way have you been involved with the wood chip boiler initiative?

4) What do you feel are some of the features that make this wood chip project a positive thing for the community?

5) What factors do you think helped the wood chip project to successfully move forward?

6) Are you aware of any support (financial, political, logistical) from the NWT government that helped the wood chip project? If so, what was that support?

7) What do you think made it difficult for the wood chip project to move forward?

8) What do you feel needs to happen to help future development of alternative energy projects in the community?

9) Do you feel it is important that your energy should come from a local source? That energy decisions should be made in the community? Why?

10) Do you feel it is important that the way you get your energy builds local skills and jobs that stay in the community? Why?

11) Do you feel it is important that the energy you use comes from a clean source that does not pollute the air? Why?

12) Are there elements of traditional knowledge or values that you feel are important when it comes to decisions about energy in Fort McPherson?

13) How would you picture the ideal energy scenario in your community?

Appendix B: Interview Questions Yellowknife

1) What is your experience with alternative energy efforts in the North?

2) How would you describe the state of energy supply and provision in remote Indigenous communities in NWT?

3) What has been done in the last five years regarding sustainable energy planning and policy in your community? And elsewhere in NWT?

4) In your opinion, which alternative energy initiative in NWT has made the most impact?

5) Why do you feel this initiative successfully moved forward while others didn't? What has been the impact?

6) In the case of the Fort McPherson wood chip initiative, what do you feel has helped the project move forward? What has been the impact of the project?

7) What are some energy initiatives or ideas that have not moved forward in NWT?

8) Why do some energy initiatives not move forward in NWT?

9) How would you describe the support, both political and financial, the Government of the Northwest Territories provides to its communities for sustainable energy initiatives?

10) How has territorial policy affected the outcome of community alternative energy initiatives?

11) Describe what role, if any, the following have played in territorial energy policy and outcomes.

    a) Community energy planning
    b) Cost considerations
    c) Local sourcing of energy
    d) Clean energy
    e) Community capacity building
    f) Indigenous traditional values

12) How would you describe a resilient northern community energy system?

Appendix C : Informed Consent Form

Informed Consent Form

Project title: Energy Resilience in Northern Communities

You are being invited to participate in an interview that will help with research to gain further insights into energy resilience in northern communities. This research will be part of a Master's thesis exploring how northern communities can successfully transition out of fossil fuel energy, into more sustainable, autonomous, clean and locally-sourced energy futures. It is hoped that the research can help other northern communities by providing success factors which help with this transition, as well as helping to inform policy about northern energy planning.

To achieve this, we are reviewing documents related to northern sustainable planning and initiatives, and conducting interviews in Yellowknife and Fort McPherson, NT, with people involved with, or interested in, northern sustainable energy planning and projects. The research is funded by Carbon Management Canada (www.cmc-nce.ca).

Your involvement would be through an interview with the researcher to provide a more complete picture of the issue. We will be asking about your understanding, opinion or thoughts about sustainable energy in the North, and its challenges and opportunities. The interview would be approximately one hour and would be recorded. Recordings and the interview notes will be securely stored on an encrypted computer and in an office at Trent University and destroyed within five years of the completion of the project, unless you prefer that they are placed in a pubic archive.

Participation in this research is voluntary. You may choose whether your participation in the interviews will remain anonymous or not, and whether your interview recording will be archived or not. Ideally, we would like to use your names in the final report. However, you may choose to remain anonymous, and in this case we may use quotations and ideas from this interview, but we will not attribute these to you. You should however be aware that, given the nature of case study research and the fact that details surrounding the case study will be discussed in our research, the potential remains that some people may be able to guess that you have been an interview participant based on circumstantial information.

While we consider the risks surrounding your participation to be minimal, you can refuse to answer any question or to stop the interview at any time. If you choose to stop the interview, your comments and answers will not be included in the research project. In either case, you will receive a copy of the case study report. The products of the research may be published in academic journals and books, and may be presented at conferences, but are not intended to have any commercial value.

This project has been reviewed and approved by the Research Ethics Board at Trent University. You may contact them through Karen Mauro (Certifications and Regulatory Compliance Officer), Phone: 705-748-1011 ext. 7896, Email: kmauro@trentu.ca. If you have questions about the project or how the data from the interviews will be used, please contact the researcher or the supervisors, listed below in the Contact List.

The information within this informed consent form will be discussed with you at the outset of the interview and a copy of this form will be given to you to keep. If you wish, the form can be read out loud to you before the interview. By choosing to participate in an interview, you agree that you understand the nature of this project and your role as a participant.

I have read the above information and agree to participate in the study
Yes ☐ No ☐

Please check the boxes that are appropriate for you.

___ I want to remain anonymous in the final report.
___ I agree that my interview be audio recorded.
___ I agree to be photographed and have my photo(s) used in the research.
___ I agree to be quoted or cited as needed, without further consultation.
___ I agree to be quoted or cited, after confirming the wording and context.
___ I agree to have my interview put on deposit with the Gwich'in Social & Cultural Institute.
___ I want to have the raw data/recording of my interview to be destroyed within five years.

_____ _____ _____

Participant Name Participant Signature Date

Contact List

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