Woody Biomass as an Alternative Energy Source for Ft. Yukon, Alaska

By

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Abstract

Using renewable energy to offset or to transition completely from fossil fuels is a global trend. Some countries are moving at a faster pace than others. Motives are usually derived from a concern to reduce greenhouse gas emissions but for the southeast interior Native Alaskan village of Ft. Yukon offsetting diesel fuel use is related to costs associated with its purchase. In this rural village, the Gwitchyaa Zhee Corporation is currently pursuing a project to offset diesel fuel used to heat public buildings to using sustainably harvested woody biomass (woodchips), a resource abundant in their area. The focus of this research set out to ask, "What are the factors that led the village of Fort Yukon to pursue woody biomass as an alternative energy source?" The question derives from an idea that the entire project may be motivated by other reasons aside from high diesel fuel costs. As such interviews and a content analysis of archival materials related to the project were conducted to search for additional motivating factors. This case study demonstrates the connection Indigenous communities are making to renewable and sustainable energy are for numerous reasons, one not always being climate change although evident and experienced in these communities.

Acknowledgements

Before getting into the paper, I would like to offer a prayer for the people of Ft. Yukon for whom I wrote this paper. Koodo hozho doleel Nahasdzan Shima, Yadilhil Shitaa, Hayolkaal, Nahoditlizh, Nahootsoi, Chalheel, Sisnaajinii, Tsoodzil, Dook'o' osliid, Dibe Nitsaa, Dzil Na oodilii, Cho'ool'ii', Shi Chei Haasch'eelt'i'i', Shi Chei Hashch'e'ooghaan, Yoolgai Asdzaa Shima, Asdzaa Nadleehi Shima, Nada'algai Ashkii, Nada'altsoii Ateed, Yodi Altass'ei, , Nitliz Altaas'ei, To Altasshchiin, To Biyaazh, Tadidiin Ashkii, Anilt'anii Ate'eed. Shi Diyin Dine'e this pray is not just for me but for the people I am thinking about while I say this. May you bring protection to the lands in Ft. Yukon, Alaska. Bring protection to my Gwichin' relatives. With that a blessed growth in health, spirituality, good thinking, and harmony. Shi Diyin Dine'e thank you for bringing me to Alaska, a place where a piece of my heart will always stay. Bless this project for which I am involved. Bless all the hands that are helping this project come to fruition. May this be a project that is handed down to coming generations. May this teach our young ones there are many ways to go forward in life with sustainability for people, land, animals, and all that exists in this universe. May you hear this prayer and others that consider this project shi Diyin Dine'e. May we always offer prayers, however we offer them, and with them come blessings. Whether we are in a good or bad situation may be always offer prayer. I thank you. May we strive to hold onto our Native tongues and teachings. May we always have water and food to eat, may the animals always have water and food to eat. May we be their voices. Bless our natural cycles in life. As five-fingered people may we honor and respect each other. A harmonious life may we always pursue. Sitsiji' hozho, shiyagi hozho, shiki'igi hozho, shinaadee' taa altso hozho. Hozho nahasdlii, hozho nahasdlii, hozho nahasdlii, hozho nahasdlii.

A gracious thank you for the hours spent by the eyes and ears that have guided my work into a presentable form. Starting with the Indigenous Writing Group, led by Natalie Parker, who were always there to offer important suggestions and critiques to the paper. Beyond this group, I thank Natalie for the many meetings we had to go over this work. I am sure my writing has strengthened largely because of you. I would also like to thank the faculty and staff of the University of Kansas that I came in contact with over my graduate career. Any learning and understanding I gained does not go unused. Many thanks to my academic and thesis advisor, Jay Johnson who has guided me every step of the way ensuring that I picked myself up on the days I felt overwhelmed in my own work and let me know when I was on the right track because we all know there is never a final product in writing. I would also like to thank my co-advisor and mentor, Joe Brewer. You played an instrumental role in my decision to attend graduate school. Thank you for your constant inspiration to be a better scholar and individual. I would also like to thank Kelly Kindscher, my committee member, for your passion as a plant biologist and ethnobotanist. Your work is always of interest to me, thank you for giving flora a voice. Thank you for always showing interest in my work, especially this important work. A special thank you to Joane Nagel, without her this thesis would not have been funded by the NSF Kansas EPSCoR program. Thank you for not giving up on me.

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Ahee'hee. A huge thank you to everyone may our deities that live in the sun, mountains, land, animals, bless all of you many times over for your help in my journey that is surely not done.

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Chapter I: Introduction

Ya'at'eeh altaal'aasiilgoo shi'kei doo shidine'e shihastoi, shizaanii. Shaylee Vandever dashijini. Adoone'e igii ei Tobazhniaazhi nishli doo Kinya'aanii bashishchiin, Chishi Dine'e ei dashicheii doo Tach'ii'nii ei dashinali. Akwot'ao Dine asdzani nishli. Hello everyone, my family, and my relatives. My name is Shaylee Vandever. I am the Two-Who-Came-to-the-Water Clan, born for the Towering House Clan. My maternal grandfathers are of the Chiricahua Apache Clan and my paternal grandfathers are the Red Clay Clan. I am Dine and this is how we introduce ourselves, it is an identification we use to show our deities and relatives that a child of theirs is present in this world. In respect to this paper, it identifies me as the author of this paper but it must be mentioned that I could not have done this alone. A big thank you to those who helped shape my voice and gave suggestions. As with all Indigenous papers, it is one perspective and attempt to voice many people's voices with one.

Globally, communities are transitioning from nonrenewable resources to renewable and sustainable resources for energy and power. A reliance on nonrenewable energy sources has been one of the leading factors contributing to climate change. It is also well documented that this and other human drivers are at the core and cause of climate change (Oreskes 2005, 1686). While this is important and relevant to the overall conversation it will not be the focus of this paper. Instead communities making an energy resource transition for economic reasons will be reviewed. Some renewable energies include solar, wind, and bioenergy. Under the bioenergy umbrella there is woodchip biomass. This renewable resource will be highlighted throughout the paper, as it is the energy choice employed by those within the case study.

In the small interior Native Alaskan village of Ft. Yukon a central heat and power facility (CHP) currently powered by diesel fuel is adding new facilities and generators, and some

retrofitting to existing boilers that will accept local woody biomass (woodchips) but this has yet to begin. Until recently, woodchip biomass was not a viable resource option for heat in this remote community. Though this resource is easily obtainable from the abundant forest surrounding Ft. Yukon, the lack of access to and funding for utilizing the biomass to heat a large number of buildings made it impossible. Diesel fuel became available as a fuel source in recent decades due to the introduction of planes and motorized boats. However diesel fuel purchased for heat continues to be viable yet expensive and undesirable for the community which is one reason why they are pursuing this project.

One reason not aiding this transition is climate change effects although very apparent and realized in the community. Instead their interest in renewable energy sources lies primarily with economic pressures stemming from rising diesel fuel costs associated with using the fuel for heat within the current boiler system and the livelihood of future generations. The CHP project provides one possible alternative to address their economic concerns.

Not only is using biomass a sustainable option it is easily accessible to this predominantly Native Alaskan community as it is surrounded by forest with wood species favorable for wood chipping. When woody biomass is processed using highly efficient technology it allows energy to be captured with lowered greenhouse gas emissions. According to Saidur et al. (2011), "Biomass co-combustion has significant positive SO2 reductions of up to 75%...[and] moreover, the thermal utilization of biomass can contribute to the reduction of CO2 emissions since the same amount of CO2 is extracted from the air during the growth period of the plants as it is released by combustion CO2 balance (2279)." In their report on woody energy use in Alaska Nicholls, Brackley, and Barber note:

> Given the peak in fuel oil prices during 2008, there has been an increased interest in renewable energy for home heating in many areas in Alaska. Wood energy is an important renewable energy option in forested regions of the state, and can be easily implemented on a small scale using local resources (2010, 1).

For some areas in Alaska, where the use of wood in residential homes is the secondary heat source, with heating oils as the primary, studying the incorporation of woody biomass projects is a worthy endeavor as there are few exploring the surge of using this renewable and sustainable energy in Alaska (Census 2000).

To gain an understanding of where Ft. Yukon stands with other woody biomass projects around the world it would be beneficial to introduce biomass' role in other countries. Various countries are moving at different paces in recognizing renewable energy as an option or continue to utilize nonrenewable resources due to the lack of infrastructure that promotes its use. In countries developing renewable energy goals and policies their motivations are generally dissimilar from Ft. Yukon's reason for pursuing renewable energy. Such that pursuits are aimed at reducing their contributions to atmospheric climate change. For example the 2010 European Commission report aims to, "reduce greenhouse gas emissions by 20%...to increase the share of renewable energy to 20% and to make a 20% improvement in energy efficiency [in the year 2020] (11)." What we can learn from the European Commission, that is executive to the European Union that represents 28 member states, is important because their renewable energy goals and policies are premised primarily on mitigating climate change. In the United States, compared to European counterparts like Germany, slowed national involvement with renewable energy is partly attributed to shifting views beginning in the 1970's, a time of energy crisis. While the United States did push "for greater domestic supplies of fuel, and dramatically

increased research and development spending on all forms of energy, including renewable energy" this push was always put under scrutiny, even today (Laird and Stefes 2009, 2620). For example the Persian Gulf War of 1991 that affected the prices of fossil fuels helped with the development of the 1992 Energy Policy Act yet two years prior the decline of Alaskan oil production in 1989 informed us of the unstable reliability in nonrenewable energy yet the status quo remains intact today keeping nonrenewable energy at the fore (ibid, 2621). Furthermore, national attitudes about energy are affected when there is a lack in understanding them which "perpetuates public apathy and misinformation about it" (Sovacool 2009, 365). One issue, Sovacool states, could be the way the United States provides information about renewable energies in such a technically feasible manner that not enough attention is paid to "increase public understanding of energy systems and challenge deeply entrenched values" (ibid., 372).

For Indigenous nations and tribes energy policies encouraging sustainable energy use is being brought to the forefront. For example, the 2013 Navajo Nation Energy Policy aims to balance nonrenewable and renewable energy by creating a Renewable Energy Portfolio Standard for the nation. One current project, is using solar energy to provide electricity to rural homes on the reservation (Meisen and Erberich 2009, 19). For Indigenous communities there is a consistent need to get involved with renewable energy, oftentimes the reason/s do not parallel with national goals for using renewable energy (Gay and Phillips 2015, 26-27). It is this difference I would like to explore in this paper.

The study area

Before the villages' permanence and up till now Native Alaskans in the area have had their rights to and reduction of land, culture, and traditional practices drastically change. One recent culprit, among others, is the Alaska Native Claims Settlement Act (ANSCA) of 1971 that

swiftly brought Alaskan Natives into the corporate world by organizing them into corporations altogether with ownership of over 40 million acres and so being the core "vehicle for integrating geographically isolated Alaska Natives in the dominant capitalist political economy" (Anders 1989; Price 1979). As shareholders of assets, the social aspect of the corporations was largely left out because unlike the lower 48 tribes there was little interest in the state to help foster self-governance nor as corporations, "no authority over personal conduct or behavior, and, without specific statutory aids, has no governing power to control what kind of development or subsistence activity occurs within its sphere of influence (ibid, 96-99)." Before this beginning in the 1850's Ft. Yukon became an outpost, not yet a village, for fur traders to trade with local Native peoples, like the Gwichin'. This preceded the onslaught of establishments such as schools and churches further colonizing the Native people of this region and turned this outpost into a permanent settlement. Occurring simultaneously was the overuse of traditional game and fish species by non-Natives, which brought on a decline in access to these sources of food (Redwood et al 2010). For example, the decrease in pulses of fish species affects the amount of fish harvested for the season. This decline, only two generations later, added a new facet of community living, an imported goods economy and the search for job labor outside of the community or other means to supplement old forms of income. Today, these declines are still experienced but to a greater degree (Snyder and Meter 2015). This will be discussed further in chapter three. These combined factors, has forced an increased dependence on and participation in importing food and other products nearby to supplement what traditional hunting, fishing, and gathering cannot provide. It is hard to say if the prescription of projects practicing good land management practices will help bring these traditional game back into the area whereas there is an abundance of woody biomass in the region. Such abundance brought the community to

consider the efficacy of woodchip biomass boiler systems as a means to help offset current uses of diesel fuel for heat.

Today, the resources used for heat are diverse. Historically, wood was used for heat. Now, approximately 61% of the community uses diesel fuel and other heating fuel sources to heat community and residential buildings, while 38% continue to use wood, and less than 1% use electricity (US Census 2010). Purchasing fuels creates a burden on the community's economy. Each year, this community of approximately 560 people, spends $816,000 on 145,000 gallons of diesel fuel (USDOE EA 2013). This expense does not yield significant benefits to the local economy or workforce but does accomplish the task of heating public buildings.

Not every social, economic, or environmental need of Ft .Yukon was met when ANSCA occurred (Price 1979 and catg.org). Still in limbo, with the permanence of the village, was a growing need to establish good health care, a stable economy and a resources management plan (ibid.). While some of these needs are met in Ft. Yukon with their local clinic employing village members and a natural resources department, both happening after the Council of Athabaskan Governments was organized in 1985 with ten villages pledging, "to conserve and protect tribal land and other resources; to encourage and support the exercise of tribal powers of self-government; to aid and support economic development; to promote the general welfare of each member tribe and its respective individual member; to preserve and maintain justice for all" (catg.org). There is still a lack of funding and resources or the workforce to implement changes. Nor can we forget the ruralness of Ft. Yukon that heightens costs to get access to many resources or the years prior to and after ANSCA spent trying to make the community their own. Each member is always faced with how to manage their time and money. Keeping a job or finding one (seasonal, out of the village, or local), traditional hunting and gathering, travelling, basic

necessities, utility bills are everyday thoughts. As such 18.6% of the community is defined to be living below the poverty line, much higher than the state and national averages (US Census 2010). In light of these issues the CHP project like other projects going on in the community are working to address these issues so as to lessen them.

Project goals and objectives

Using the remote interior Alaska Native community of Ft. Yukon as a case study, this thesis examines sustainably harvested woody biomass in the form of wood chips as a source for heat and its beneficial incorporation into Native communities. The research has three primary goals:

1. Explore why the community of Ft. Yukon decided to pursue a central heat and power facility to provide heat for major community buildings;
2. Explore the Ft. Yukon experience as an example that can be helpful to other communities with similar geographies, social conditions, and energy needs;
3. Add to the literature about renewable and sustainable energies being implemented within Indigenous communities

Approach and methodology

While it would be most appropriate to say I chose to work for the community of Ft. Yukon, I choose to believe the community gave me the honor of helping write their experiences with the sustainable harvesting of woody biomass for heat. Although we are both Indigenous peoples of the land, we are geographically distant with varied environmental and social pressures, but with similar shared experiences. I believe writing myself into this research is important because it is through my lens that I attempt to understand and portray Ft. Yukon.

I chose to focus on Ft. Yukon because like their experiences, nine other member villages of the Council of Athabaskan Tribal Governments (CATG) are in the same position. The nine

other villages also have to pay high costs for fuel, food, and other imported products. Jobs are scarcer than in Ft. Yukon, as they are smaller villages with fewer resources, for Ft. Yukon is the hub for these villages. In a broader sense this can shed light on how Alaskan Native communities work together in projects geared toward community improvement with the help of having reorganized their governmental structure from less of a corporate ideology.

The second reason why Ft. Yukon is the focus of this research is because the community is viewed as the pilot project for all villages in the area. Whether or not this project proves feasible for the community can have potential implications for villages who also wish to pursue this renewable energy. Of course, this does not preclude other villages from eventually transitioning to different renewable energy options like solar power, but makes an impact on which source they choose. Additionally should this project be unsuccessful it may detract other villages from pursuing this sort of project but answers to this is beyond our research scope.

This thesis, including the article within this thesis, utilizes two primary means of gathering data. The first, which I performed was archival research in the community of Ft. Yukon, as well as a literature review relating to biomass in general, sustainable harvesting of woody biomass, relevant policies, studies of communities and countries worldwide involved in biomass, as well as Indigenous experiences with renewable sustainable energies. The second means of gathering data was through informal interviews. This will not be discussed in this section to avoid a repetition of thoughts already elaborately explained in chapter three. Both means of gathering information were first conducted in Ft. Yukon between May 2015 and July 2015. Further analysis of these materials was conducted between August 2015 and February 2016 at the University of Kansas.

The archival research was conducted at the villages' Natural Resource Building. Natural Resource employees are tasked to cover the harvesting logistics of the Central Heat and Power project. In their capacity they developed a large inventory of documents related to the project. There was a substantial amount of records that helped the research team develop an overall sense of the project since the planning stages in 2007. It also helped us work through the goal of this thesis.

The archival research in Ft. Yukon focused on primary and secondary sources relating to the projects finances, engineering, planning, communications, land surveys, grants, and maps. All of these documents represented the evolution of the project since 2007. But first a separate project I was involved in helped ease my work by organizing and centralizing all the available hardcopy and digital documents into a hyperlinked spreadsheet with detailed attributes of every document for the purpose of easy access and searching for future uses by the village. With this database available to me I was able to find and sort documents that helped answer why the project began. My first task was to gather documents useful to generating a good historic profile about the village which included policies, acts, narratives of the villages' eventual transition into a permanent community, and their traditional and cultural practices. During this search if there was not a comprehensive account of an event I used the University of Kansas' access to several databases that aided my search for filling in this information about Ft. Yukon. I also looked at government census documents about the village. Here my focus was to find the most current statistical information about Ft. Yukon such as population, poverty level, and energy consumption. This was useful because it allowed me to see the transformation of the village over the years. I also cross-referenced this information with books about Ft. Yukon or the Yukon Flats region. The Natural Resources Department also held aerial images of the village overlaid with

where boiler system and channels connecting the buildings for heat will be. There were also images of appointed harvest areas for the five-year harvest plan and the type of vegetation in the area. Although these images were beneficial as a visual aide, the GIS data used to create these images were not located. During this time I was involved in a project that helped develop updated versions of these images with attribute data. This project was helpful because the most recent satellite images of Ft. Yukon were used when overlaying data to create maps that documented harvest areas. As such all the attribute data is available for future use during the project, future projects, and general use by village entities.

Significance of this research

My project demonstrates that Indigenous communities are making a connection to renewable and sustainable energies for a multitude of reasons beyond the common concern of climate change. When we understand these reasons we can appreciate what work goes into bringing these sorts of projects to fruition. We also realize where Alaskan Native history with the United States government and imposed policies and acts by the US created an ideal for a people that once again do not fit with Alaskan Native ideals for living which have stood the same: the ability to access traditional foods, lands, and practice culture unfettered.[1] This project also helps us see that global markets do not always fit local scale markets, especially in Indigenous communities where there may be little economy. Overall my research is another example of Indigenous communities investing in sustainability projects and efforts that ensure for future generations later that the project is feasible for the people, land, and environment.

[1] "Once again" is used because there has been an array of policies and acts before ANSCA that tried to impose US government ideals that were illusory to what was desired as civil living at the time, like the Dawes Act of 1887.

Chapter II: Biomass

Biomass[2] used in the context of energy encompasses a diversified industry of energy as a product created from renewable resources and its byproduct. Historically, the earliest form of biomass for heat is through burning wood. Its' first use may be ambiguous yet globally it continues to be a major source for cooking, heating, and other various capacities (Andreae 1991). This traditional resource is used in sawdust, wood chip, log, and bark form. Additionally, other alternative[3] biomass fuels include: "crop residues, municipal and industrial wastes of plant origin [as well as] dedicated energy crops (Yin, Rosendahl, and Kaer 2008, p. 727)." This paper focuses on woody biomass use for heat particularly sustainably harvested wood chips or sticks. Hereafter, the term woody biomass will be used to refer to this energy resource.

Each biomass resource is dubbed sustainable and good alternatives to fossil fuels for reasons specific to their cultivation and use. In the case of woodchip biomass, studies have shown the resource balances its greenhouse gas emissions throughout its life cycle and consumption which includes cultivating the resource, even its transportation. A report by the European Commission states that it "[can] reduce emissions by 55 to 98 percent compared to today's fossil fuel mix in European power generation even in situations where the biomass is transported internationally" (European Commission 2010, p. 7). Ironically, wood burning just like nonrenewable resources are subject to criticism for the environmental and social controversy it creates. Despite this, the literature from the past supports biomass as a viable renewable energy and heat resource (Brackley, Barber, and Pinkel 2010; Crimp, 2000; and Stasko et. el, 2011).

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[2] There are other terms that are used interchangeably with biomass such as bioenergy, biofuel, biopower, bioproducts. This is not expansive of all terms. The biomass energy referred to in this paper from here on out will be referred to as woody biomass and in some instances woodchip biomass.

[3] Alternative to fossil fuels

European Union

Members of the European Union (EU) are some of the leading countries looking to biomass and other sustainable energy alternatives. In a 2010 report focused on the opportunities of biomass released by the European Commission expert analysts in alternative energy stated there is a great interest in biomass as a source of heat and power but there are steps still needed to ensure its longevity. The report was written in response to a piece of legislation entitled *Energy 2020: a strategy for competitive, secure, and sustainable energy.* In the strategy described in the report, member countries will work "to reduce greenhouse gas emissions by 20%...to increase the share of renewable energy to 20% and to make a 20% improvement in energy efficiency [in the year 2020]" (European Commission 2010, 5). In that same strategy it was predicted that the EU would not meet their 2020 targets.

The 2010 report determined that biomass utilization for the EU "is only being realized at a slow pace" (European Commission 2010, 7). Although, steps to remedy the slow pace are being taken by providing information about biomass in heat and power applications such that it "[can] reduce emissions by 55 to 98 percent compared to today's fossil fuel mix in European power generation even in situations where the biomass is transported internationally" (European Commission 2010, 7). On the other hand there is potential for unwanted "land-use change" if proper management and mitigation is not applied when implementing biomass projects (European Commission 2010, 7). Factors to take into consideration include "the type of biomass used, production methods, geography, and local environmental and social conditions" (European Commission 2010, 47). Overlooking these factors when initiating renewable energy projects will not benefit the strategies and reduction goals for the EU. These critiques can benefit Gwitchyaa Zhee Corporation's project, which relies heavily on forethought and planning.

Since these reports were published by the EU in 2010, great progress has occurred within some member countries. While the European Commission believed some of the goals would not be met by 2020, there are some EU member countries already meeting the stated renewable energy goals such as Sweden, Bulgaria, and Estonia where wind power is becoming a prominent energy source (Shahahn 2014). With this in mind, there is room to be optimistic in biomass' contributions to renewable energy strategies and goals for the EU. Furthermore, in Harboore, Denmark woody biomass in the form of wood chips is used to produce electricity and heat for the town through a district boiler loop. Since its inception in 1994 up to 2005 the "district heating has provided more than 70,000 hours of operation" (Roos 2010, 47) Harboore's success with woody biomass is proof that projects, such as Fort Yukon's, can prove successful when their unique circumstances are wholly considered and attended.

In other countries, like Australia, biomass as a source of power and heat is also slowly gaining acceptance. Moriarity and Honnery (n.d.) discuss this ongoing movement toward use of biomass in Australia in their article, *"Prospects for biomass thermal conversion in Australia."* They argue that "thermal conversion of biomass" is largely dependent on many factors such as government support, biomass availability, fuel flexibility, lack of competing resources like oil, taxes when using fossil fuels, among other factors (Moriarity & Honnery, 1). Similar to Australia's lack of support, Canada also finds itself in the same situation because current laws and regulations do not encourage alternative energy production (Evans, Perschel, and Kittler, 2010). Just like the EU, which has made strides over the years, Australia and Canada, with the correct attention, can work their way into greater renewable energy use.

National

A similar pattern of growing involvement with alternative energy production can be seen in the United States (U.S.) as well. One example exemplifies the tasks beforehand that go into

assessing if alternative energy production is a sustainably feasible decision. In a 1997 article, scholars Graham et al. assessed the costs incurred when delivering biomass products such as wood chips to areas in Tennessee where woody biomass is desired, and the monetary effects it has on the farmers who provide the biomass for the select facilities. The study concluded with a need to "quantifying the geographic complexity of biomass supplies and illustrates the need to consider the likely participation rate of farmers in projecting the possible costs of biomass feedstock" (Graham et al. 1997, 122). This study essentially begs the question: If not all locations have access to local biomass, how does that affect the alternative energy potential of biomass?

When we look at other forms of alternative energy these same questions arise. It is not easy for alternative energies to instantly build a solid platform that allows easy adaptation by consumers. Quite frankly, the U.S. has been slow to accept alternative energies because the nation has a long historical investment in fossil fuels. Ethanol once had the opportunity to be mass produced and used in the early 1900's (Bothast and Schlicher 2004, 19). One can only imagine how far ahead of the alternative energy curve the U.S. would be today if fossil fuels were second to cleaner fuel sources. It was during this time that the Ford Model T car was built to run on both gasoline and ethanol fuels. Unfortunately, Ford held a significant stake in fossil fuels production (ibid.). Recent developments to support ethanol production have paved the way for other alternative energies, like woody biomass, to become an important investment for America. Essentially, the primary reason for the slowed acceptance of alternative energies is our connection to fossil fuels big economic impact and policies that ensure its stay (ibid., 19).

Nationally there is still significant investment in nonrenewable energies as evidenced by Bothast and Schlicher's 2004 article, but autonomy at the state level has proven to be useful in

working against the national trend. A handful of states have developed "renewable portfolio standards (RPS)" which "require local utilities to supply a certain percentage of the electric power that they distribute from renewable sources" (Elliott 2013, 2). In addition to RPS's, citizens at the local level are pushing for a sort-of national RPS that would show the world that they want to be a part of investing in alternative energies and eventually phasing out non-renewable resources. After all, the U.S. is one of the largest consumers of global resources (ibid.). Even if entire jurisdictions do not convert to renewable energy sources, there is still the benefit of select locations investing in alternative fuels like biomass. Such an example is in Gardner, Massachusetts where Mount Wachusett Community College utilizes green wood chips for electricity, heating, and cooling and has been doing so since 2006 (Roos 2010). Similar to this college serving as an example for the town and state, Fort Yukon is serving as a pilot project for all villages in interior Alaska.

Rural Alaska

The state of Alaska has become increasingly interested in biomass, particularly woody biomass, as an alternative source for power and heat (Nicholls 2009). A common mitigating factor fueling the need for woody biomass projects in Alaska is the increased cost of diesel fuel (Crimp, Colt, and Foster, 2007). It is important to keep in mind that Alaskan communities often experience below freezing weather, so when traditional forms of energy are not accessible to sustain their basic needs, they are left to work amongst themselves. Thus, "many agencies, natural resource professional, business owners, and tribal leaders across Alaska are now working toward the goal of increased use of biomass as well as energy independence at the community level."[4] Not always mentioned are rural communities like Ft. Yukon that rely on the short

[4] Ibid.

summer months during which time it is possible to have valuable products like diesel fuel barged in. When unpredictable environmental conditions (USDOE EA, 2013) make such products potentially out of reach they are left to use the wood in their area which opens up the opportunity to look into woody biomass projects.

While there has been a focus on issues and obstacles to the utilization of biomass and other alternative fuels, woody biomass harvesting could have some unintended benefits. Socially, "it can create new employment opportunities…and encourage the building of infrastructure. Environmentally, it can bring back biodiversity once absent in the area and reduce carbon dioxide emissions" (European Commission 2010, pp. 53 & 22). All of which the village of Fort Yukon has documented can be benefits of the woody biomass project (EA 2013, p. 68).

The world needs to continue making concerted efforts to transition to renewable energy sources for power and heat. Although the transition may be slow in the EU, Australia, and Canada because current sources of energy are still viable it is still one step ahead of rural Alaskan communities who are financially stricken by fossil fuel costs. It makes sense to mitigate a potential foreseen issue as no one country, town, or village is immune to social, economic, and environmental effects caused by climate change. Or even unintended issues caused by the global economy or a town's physical geography. With such issues abound we can turn to communities like Ft. Yukon as exemplary leaders in renewable energy use.

Chapter III: Article

Towards Energy Sovereignty: Biomass as Sustainability in Interior Alaska

By: Shaylee Vandever, Joseph P. Brewer II*, Jay T. Johnson

Introduction

Our reliance on fossil fuels for transportation, electricity, and heating is unsustainable. This reliance on fossil fuels continues to contribute significantly to global climate change with expanding impacts predicted over the next few decades and with impacts being experienced to a greater degree in remote Indigenous communities. One response to mitigating these affects is by actively pursuing renewable and alternative energy sources. Globally, remote Indigenous communities are working to secure and reclaim sovereign rights over resources such as energy, food, health, and land management. As Stewart, Harper, and Anda (2011, 3085) note, "The transition to a low carbon economy provides potential opportunities for Indigenous communities living in remote areas." These communities have a high carbon footprint due to "a frequent reliance on diesel-powered electricity generators [and] fossil-fuelled vehicles" (ibid.). Some remote Indigenous communities are responding to this reliance on fossil fuels by pursuing innovative and sustainable approaches to meeting their energy needs (see Johnson et al. 2016). In Western Australia, Aboriginal communities are utilizing bio-energy production in an effort to lower their carbon consumption and gain control over energy production (Stewart, Harper, and Anda 2011). In the remote Amazonian region of Brazil, the Macuxi people are facing similar energy concerns. In 2009, the Brazilian Supreme Court returned approximately 6,720 square miles of land to the nearly 20,000 Macuxi people living in the area of Raposa Serra do Sol in the northern state of Roraima. The Macuxi are planning to incorporate wind turbines for electricity production on these lands in an effort to gain energy independence, because the nearest electric

grid is 185 miles away (Wachsman and Tolmasquim 2002). These communities face challenges in their efforts to produce renewable energy to meet their needs, and provide an example of how Indigenous communities can develop renewable energy production.

Remote Indigenous communities in Alaska operate within a US state whose economy is largely fueled by the export of locally extracted resources (i.e., fossil fuel, fish, and minerals) for global consumption (Goldsmith 2010). Interior Alaskan communities are largely left out of this economy, due in part to their geographic remoteness. While the Alaskan pipeline may run through, or near, many interior communities, direct access to the state's oil resource is largely unavailable to these villages. For remote, interior communities, the only fuel available is provided through the very costly purchase of diesel from corporations that truck, fly, or barge in the resources (Szymoniak et al., 2010). As a result, the interior village of Ft. Yukon, which will be the focus of this paper, is planning to utilize woody biomass in a high-efficiency wood-chip fed boiler system as an alternative energy source in order to heat homes and community buildings.

As a heating source, woody-biomass[5] boiler systems provide remote Alaskan Native villages with warmth in peak winter conditions. The Gwichyaa Zhee Corporation (GZC)[6] has set

[5]From here on, the term woody biomass will be used to refer to the vegetative cellulosic material that can be used to create energy. Woody biomass will also be used because it is consistent with the way the village of Fort Yukon refers to this form of biomass and is also the term used in primary documents related to the project.

[6] An important point needs to be made here, there are three distinct governing bodies in Fort Yukon, Alaska, all of which have a stake in this project. The Gwichyaa Zhee Corporation (GZC) is a Village Alaska Native Claims Settlement Act Corporation, who, like most corporations is responsible to the shareholders (local Gwich'in), they are the proprietors of the Biomass project this paper is about. The Council of Athabascan Tribal Governments (CATG) is a tribal consortium made up of ten Gwich'in and Koyukon villages. The Gwichyaa Gwich'in are the

its focus on woody biomass, specifically cottonwood trees, (*Populous trichocarpa)* for the following reasons: availability, fire suppression, they are not preferred for domestic uses, and habitat enhancement (EA 2013). In the past 10 years, neighboring Alaskan Native villages such as Tok, Craig, and Tanana have become examples of remote Alaskan communities who are utilizing local biomass as a sustainable energy or heat source (Parrent 2001; Nicholls 2009). The project in Ft. Yukon has had many setbacks over the eight years since it was first conceived, including a high turnover rate of tribal employees and the difficulty in convincing community members of its value (Participant 3). Despite these difficulties, the 2013-2015 successful winter harvest of trees for the biomass project has reenergized the village. In order to evaluate the progress of the project, the authors and the Council of Athabascan Tribal Governments were interested in exploring and documenting the key factors driving the decision to pursue woody-biomass as a renewable, alternative energy source.

The central question in this research explores the key factors motivating GZC to pursue a woody biomass boiler system as a renewable, alternative energy source. To explore these factors, the authors interviewed biomass personnel and performed a content analysis of the project's archival materials during the summer of 2015. This article is one component of a larger research effort started in 2012 that continues to document different aspects of GZC's woody biomass heating project in Fort Yukon, Alaska. As such this paper will accomplish three things: 1) it will contribute to the growing body of scholarship about biomass as an alternative fuel source for remote villages and communities, 2) provide insights for other communities with similar geographies, social conditions, and energy needs that can benefit from this information in their

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local tribal government. Each entity is based in Fort Yukon, Alaska, and each entity has responsibly in part or in whole to the people of Fort Yukon, Alaska.

own decision making process, and 3) add to the sparse literature about remote Indigenous communities' pursuits of alternative and renewable energy sources.

Fort Yukon Demographics

Fort Yukon is geographically situated at the convergence of the Porcupine and Yukon Rivers, in the interior Alaskan boreal forest. This Arctic community sees temperatures averaging -35 degrees Celsius during the winter months from mid-November to mid-March, and upwards of 28 degrees Celsius in the peak summer months from early-June to mid-August (Streten 1974). Precipitation occurs primarily as snowfall during the long winter months. The Yukon River is a braided river system 3,190 kilometers in length, draining over 830,000 km^2 of Alaska and the Yukon Territory in Canada. The river remains largely unaltered from its headwaters to the vast deltas in western Alaska. Given the extensive fresh water system, there are countless marshes, wetlands and backwaters scattered throughout the watershed, providing habitat for a number of aquatic species, including summer pulses of a variety of salmon species and year round resident non-salmon species.

Fort Yukon is a remote, off-grid community that is accessible only by plane, boat, or snow machine in the winter and lies approximately 139 miles from the nearest major city, Fairbanks Alaska. Although costly, common household utilities such as electricity, cable television, and Internet service are prevalent. Families offset extraordinarily high grocery costs by hunting, fishing, and trapping year around. According to the 2009-2013 American Community Survey 5-year Profile, 21.1% of the 580 community members live below the poverty level with 57% employed by state, federal, or tribal enterprises. Per capita income in the village is $20,290 annually (US Census 2010).

The majority of the 580 village residents (89.19%) are Gwich'in. The Gwich'in of Fort Yukon represent one band of fifteen related bands of Gwich'in villages and small towns spanning interior Alaska and much of the Yukon Territory in Canada. The Gwich'in of Fort Yukon refer to themselves as the Gwichyaa Zhee Gwich'in, or "the house on the flats," referring to the flats of the Yukon River (http://www.fortyukon.org/).

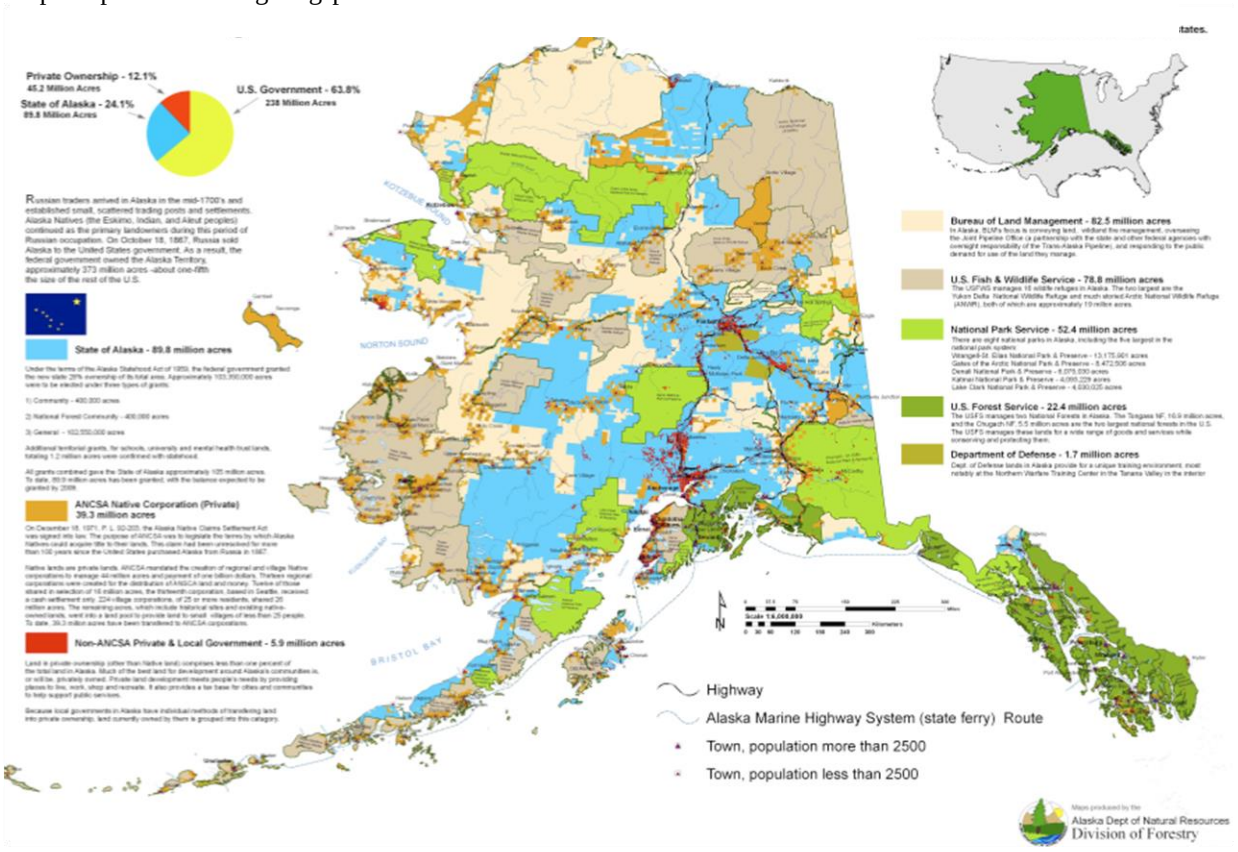
Historic context

Fort Yukon was initially established as a trading outpost of the British-owned Hudson Bay Company by Alexander Murray in 1847 in what was Russian Alaska. (Murray 1847; TCC 2016). The trading companies that operated in Fort Yukon primarily dealt in furs with Gwich'in and Koyukon Athabascan trappers throughout the Yukon Flats (Murray 1847). A Catholic mission school was established in 1862 to educate village children. It was not until the Alaska Purchase by the United States in 1869 that American influences began to predominate, opening Ft. Yukon to the establishment of churches, and additional mission schools. By the early 1900's, Ft. Yukon had become a major trading outpost in interior Alaska, with a number of families establishing semi-permanent residence as they traveled to fish and hunt throughout the year, eventually returning to Ft. Yukon for social gatherings and trade (Shimkin, 1955). Many Gwich'in families made the decision to move permanently to Ft. Yukon for economic opportunities during the 1920s. Ft. Yukon, one of Alaska's largest Native villages, had a population of 500-600 permanent residents during the 1930s-1950s (Osgood 1936). The subsistence lifestyle Gwich'in people had lived for millennia began to change when they started taking up permanent residence in villages such as Ft. Yukon. Still practicing a primarily subsistence or traditional lifestyle in the 1950s, Gwich'in people began to actively participate in the growing mixed commercial and subsistence lifestyle Ft. Yukon provided. While most

Gwich'in living in Ft. Yukon no longer live a subsistence-only lifestyle, what has not changed is the strong connections to the intricate geographies of this vast landscape that still provides subsistence opportunities.

As Alaska became more central to US security interests during World War II, and the Cold War that followed, the accelerated pace to build infrastructure often neglected Native concerns leading to land disputes that continue today. Following statehood in 1958, the Federal Government gave the state free reign to choose one hundred and four million acres from the public domain (Jacobs and Hirsch 1998). Contention arose as the state began selecting lands that interfered with Native traditional and customary uses and occupation of land (Berry 1975). The Alaska Native Claims Settlement Act (ANCSA) of 1971 was enacted to settle ongoing land title disputes between the Federal Government and Alaskan Natives. By terminating land title claims, the Federal Government hoped to bypass the Alaskan Native dependence on federal programs, and provide more economic opportunities for Alaskan Natives (Thornton 1997). ANCSA extinguished Native title to 352 million acres of land, or Alaska writ-large, in exchange for 44 million acres of land in fee simple title and US $1 billion (Berardi 2005). Twelve regional and two hundred remote village/local corporations were formed as landholders, enrolling Alaskans Native as shareholders, and each corporation is Native owned and operated. In total, ANCSA provided economic opportunities in the form of commercial possibilities for Alaskan Natives. At the same time, the extinguishment of title and access to the majority of Alaska lands restricted the ability of Alaskan Natives to access lands that have provided subsistence opportunities for generations. For example, with the establishment of large tracks of state and federally managed lands within the immediate geography of Fort Yukon, the ability to access traditional subsistence

Figure 1Areas designated under ANILCA and ANSCA(amongst other tribal and non-tribal consortia's). Alaska Department of Natural Resources Map #1115. http://explorealaskablog.blogspot.com/2011/10/module-ix-d-ancsa-anilca-fedstate.html.



locations has been virtually cut off, therefore limiting the amount of available land for hunting and gathering.

The Alaska National Interests Lands Conservation Act (ANILCA), passed in 1980, designated 104 million acres as national parks, wildlife refuges, and conservation areas, and 56 million acres as wilderness (PL 96-487) (Figure 1). These land divisions further limited Alaskan Native access to lands and put subsistence uses at odds with recreational and commercial uses. Under federal management, much of the lands transferred were areas Alaskan Natives had long called home, and were fished, hunted, and used for trapping for millennia. Lands were suddenly legally disconnected from Alaskan Natives continual use, as their ancestors once used them. Currently, Alaskan Natives must negotiate for subsistence rights involving lands managed under ANILCA (Krupa 2009). While Alaskan Natives may have access to lands for subsistence

purposes one year, the following year they may not, and some lands are permanently off-limits under ANILCA. Due to the complex legal interpretations of ANILCA, in short, Alaskan Natives no longer have the continuous right to live the subsistence lifestyle their forebears did, as access to lands are only allowed with federal, state, tribal, or corporation approval.

Spanning the nearly one hundred and fifty years since the US purchase of Alaska, Alaskan Natives have been limited in their ability to freely move about and practice a traditional subsistence lifestyle on lands they occupied for generations. Advocates of subsistence rights for Alaskan Natives negotiate with regional and local corporations, local governments, state and federal management authorities for access and use. Clearly, the history of land tenure in Alaska (and by association subsistence rights on lands) is complicated, and distinct from any other US state. Alaskan Natives are both encouraged to participate in economic development while maintaining a strong connection to the land, yet have been slowed in both processes by the cumbersome legal and political relationships they are forced to uphold. The exchange of title from Alaskan Native owned to corporation, tribal, individual (Native Allotments), federal, and state owned or managed land then severely limits the ability of Alaskan Natives to subsist in vast expanses of the resource rich lands of Alaska.

En Route to Unsustainable Times

Due to a conglomeration of growing economic opportunity in the late 1800's (some places earlier) and impending U.S. policy in 1970's-1980's, Alaskan Native populations began to centralize themselves into villages. For Alaskan Natives, the 70's-90's brought about an unprecedented era of finding themselves cut off from geographies they had subsisted in for generations, for reasons that seemed to create space for the oil and gas development industry (Naiman 1995), which remains one of Alaska's primary sources of economic livelihood. The

establishment of villages was a major paradigm shift away from a subsistence driven economy to a mixed subsistence and commercial lifestyle. The shift forced Alaskan Natives to subsist within smaller geographies, and in turn rely on increasingly localized and limited resources (Schroeder 1987). During the 20th century, Alaskan Natives' ability to manage their environment was replaced by state and federal entities' absolute control over large areas of land and resource management (McGregor 2005; Berkes 2009). Without the ability to make larger land management decisions residents were required to acknowledge and rely on the will of multiple authorities. This era ushered in a new dependence not only on fossil fuels but on the delivery systems necessary to transport those fossil fuels and other supplies to remote village locations (Gerlach et al. 4.5). Today 60.8% of homes in Fort Yukon use fuels like kerosene for heating, while 38.4% use wood (white spruce is preferred), and 0.8% use electricity as a primary heating source (US Census 2000).

Historically, Alaskan Natives used sled dogs and canoes, constructed from forest materials, to travel seasonally to their fishing, hunting, and gathering camps as well as trap lines (Anderson 1992). Today, most Fort Yukon residents use motorized vehicles, which require some form of fossil fuel to operate, in order to access these remote subsistence locations (Brinkman et al. 2014). Prior to village life, travel to these seasonal camps meant taking up residence in that location for the entirety of a particular season (Stewart et al. 2011), for example winter months were spent on the trap line, summer months in fish camps. The current dynamic for travel requires shortened stays in camp, or quicker trips. As Brinkman et al (2014, 1) state,

> Households invest monetary earnings into efficient technologies such as motorized vehicles to facilitate harvest of wild resources for their own consumption, rather than for the commercial market. Since the middle of the 20th

century, involvement in wage employment has increased so that residents can afford technological innovations that augment subsistence.

While gasoline dependent vehicles present a number of advantages for subsistence activities, the challenges of a mixed subsistence and commercial dependent lifestyle means community members must obtain wage paying jobs in order to supply the fuel for this lifestyle (Chapin et al. 2009). The constant push-pull of subsistence versus commercial is always present. The subsistence dependent resident cannot offset extraordinarily high commercial costs without participating in the commercial economy. In short, Alaskan Native people living in Fort Yukon went from a subsistence dependent lifestyle, developed over thousands of years, to commercial dependence within the last few decades, leading to a plethora of cultural and economic challenges.

Financial constraints, geographic remoteness, limits to technology, and an inability to manage large scale natural resources on their own terms have compromised many interior Alaskan villages' sovereign right to pursue energy on their own terms. Re/envisioning the production of environmentally sustainable energy as Gwich'in sovereignty is the philosophical underpinning upon which this project centers.

Positive environmental feedback in the form of new technology and management of lands that are accessible gives ample opportunity to diversify the uses of biomass, not only as a heat source but also as an energy commodity available for purchase by local consumers. The Fort Yukon biomass project allows the village to grow in a sustainable manner, while exploring the financial opportunities possible for the region. Unemployment is three times above the national average in Fort Yukon, and economic development is virtually nonexistent (Sumida 1990; US Census 2016). This project is designed to bolster economic development, which will begin

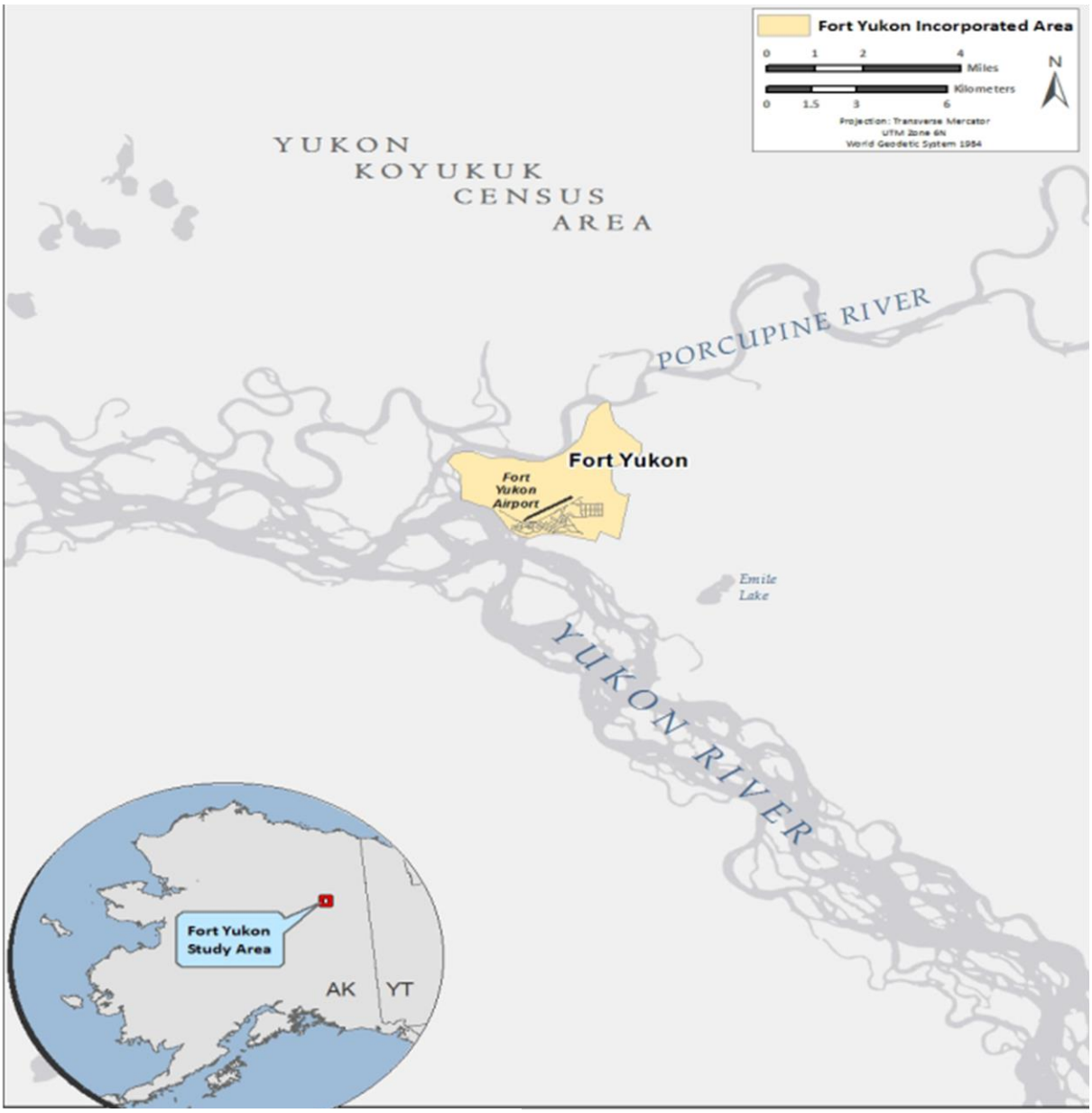


Figure 2 Ft. Yukon USDOE EA 2013

freeing up millions of dollars in fuel costs allowing that money to be utilized for other village needs (EA 2013).

A Sustainable Approach

As Howitt (2012, 824) observes, "sustainable Indigenous futures in communities and territories that are remote from mainstream markets and other institutional arrangements cannot arise from policy interventions that rely on creating wealth for state and corporate appropriation and assume

enough of this wealth can be redistributed or will trickle down to local Indigenous communities to constitute 'development'." Similarly, there is no one-size-fits-all solution to resolving unsustainable fossil fuel dependence. At the state level, Alaska's 2010 Energy Policy seeks to increase energy efficiency by 10% in 2015, and 15% by 2020, creating renewable energy production credits to help fund more alternative energy projects statewide (AEP 2010). Until such goals can be realized, remote locations like Fort Yukon will continue to face high fuel costs. Only internally pursued alternative opportunities will aid in moving away from fossil fuel dependence.

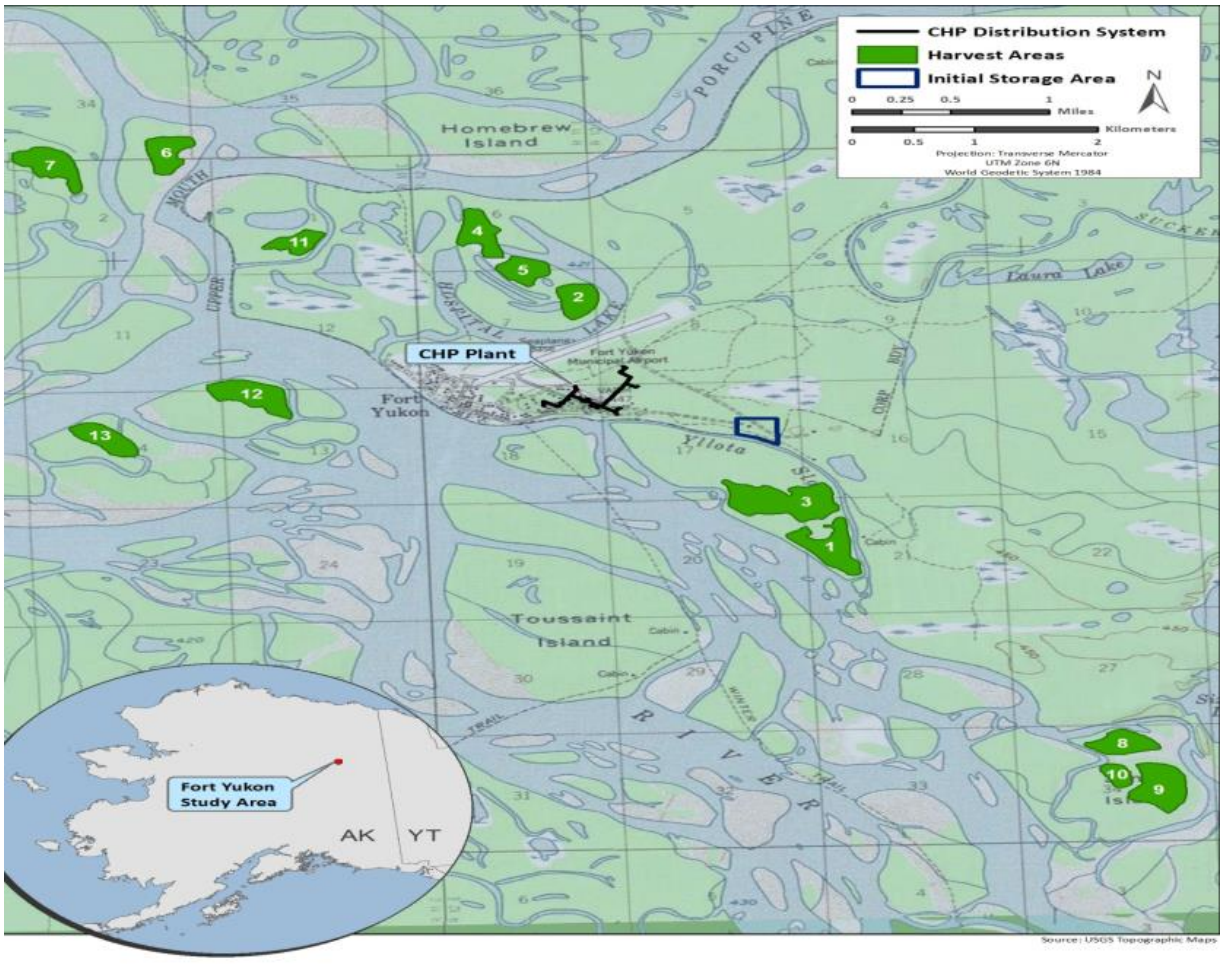


Figure 3 Harvest areas USDOE EA 2013

The premise for GZC is to invest in a sustainable woody biomass project aimed directly at offsetting high diesel fuel costs currently associated with heating buildings. In 2015, the nearly 550,000 liters of low sulfur-diesel consumed by the community every five years cost US$4,080,000. The incorporation of an efficient biomass boiler system is predicted to reduce these fuel expenses by 80%. “The savings would stay in the community instead of being exported to oil delivery companies, and would pay for creating jobs…” (EA 2013). When GZC began making plans to construct a woody biomass boiler system in 2008 they benefited from the work of other Alaskan communities already operating similar projects throughout Alaska. This in part made the buy-in for initiating the project feasible as there were aspects of other projects that could simply be replicated.[7]

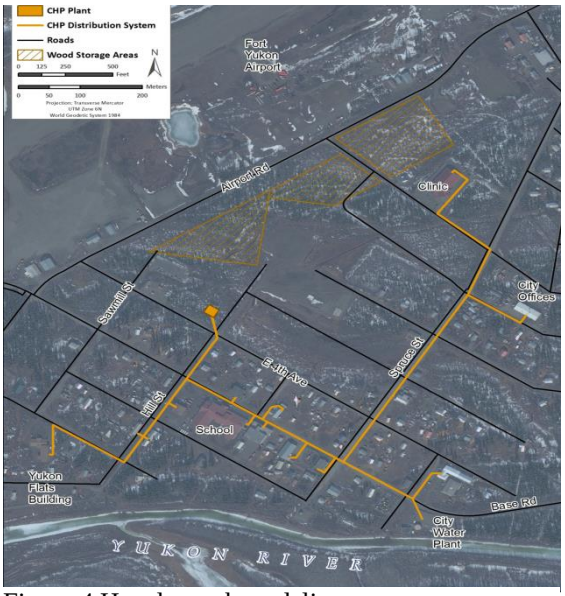


Figure 4 Heat loop= heat delivery

Year	Harvest Area	Hectares
Year 1	1	20
Year 1	2	34
Year 2	3	12
Year 2	4	6
Year 2	5	22
Year 3	6	13
Year 3	7	12
Year 3	8	14
Year 4	9	8
Year 4	10	13
Year 4	11	17
Year 5	12	19

Table 1Harvestable hectares

Currently, heat and electricity is produced and distributed by inefficient low sulfur-diesel dependent generators that are out-of-date, break down often, and have hard to find replacement parts due to the age of the machines. While these systems will stay in place to serve as

[7] An important point is to be made here about the unique quality of this biomass project that no other community in Alaska has faced. Although being an “off the grid” community does present its challenges, such as purchasing and barging in harvest equipment a season before intended harvest.

a back-up in the event of a break-down, lack of woody biomass, or during times of maintenance, the community has developed plans to switch to a new Central Heat and Power (CHP) facility with separate systems, which will combine the heat potential of woody biomass and diesel fuel during peak winter hours (Wall and Koontz 2007).

Steam, generated by the CHP will travel to community buildings via buried pre-insulated arctic piping built to resist the harsh surface and subsurface temperatures. Recipients of the heat will include the school, general store, post office, and various administration buildings. In order to maintain an efficient operation, the proposed boiler systems[8] would annually require 33-40 hectares of cottonwood and woody vegetation, which is approximately 1451-1814 green metric tons of wood chips (EA 2013).

A five-year harvest plan has been created to maximize the energy potential in the area with minimal environmental impact (EA 2013). Logging or harvesting practices are largely dependent on the topography of the area and distribution of cottonwood stands. Operation crews, made up of local community members, use seed cutting techniques to leave smaller stands of cottonwoods and other important species like white spruce to reseed. In other sections of harvest areas, the harvesters clear-cut where there is an abundance of dense growing cottonwood stands

[8] The proposed Garn boiler system is a wood fed boiler system widely used throughout Alaska. In Fort Yukon the system would be housed in two separate locations. The first wood chip fired, and larger of the two garn's, with an output of 950.0 kBTU/h would be housed in a newly constructed combined heating facility (Wall and Koontz 2007). The second wood-stick fired garn with an output of 425.0 kBTU/h would be housed outside of the community clinic. The benefits of using a garn system is the amount of BTU's made available through the built-in thermal storage. The thermal storage potential is a large hot water tank that surrounds the combustion cavity where the wood is burned. With potential the garn system allows for thermal capabilities in both wood at 950.00 kBTU/h and storage of thermal output in water at 2,064.0 KBTU (Garn, 2015). Therefore offsetting the need to constantly burn wood or feed the garn boiler, as the heat from wood is distributed and used the heat is also stored to eventually be distributed over a longer period of time.

shading out the vegetative understory and seed cutting is not advisable.[9] Due to the physiological nature of cottonwood trees as a high water content species, chipping and creating feedstock is delayed for a year minimum after harvest, until the logs are at 25%-40% moisture content to maintain highest possible heat values, or British Thermal Units (BTU), in the boiler systems. Harvesting is carried out in the winter months to avoid or limit environmental impacts on the proposed areas, and make use of frozen watersheds by creating ice roads on the river to access the harvest areas. In order to have a quality product for heat production, those felling trees, transporting, stacking, processing, must all work together and be aware of environmental indicators like ice density and local weather conditions (Stokes 1992).

With such a complicated operation, it is crucial that the community be invested and educated about the work and product. The project includes plans for local foresters and individuals familiar with woody biomass operations to teach community members how to operate every aspect of the CHP, further empowering the community to be self-sufficient. This self-sufficiency is crucial given the geographic isolation of Ft. Yukon.

Government Profile

The local tribal government is made up of a seven-member Tribal Council. The council maintains oversight of nine distinct departments, handling everything from housing and finance, to natural resources, tribal court, schools and elder care. The Council of Athabascan Tribal Governments (CATG), based in Fort Yukon represents and advocates for ten Gwich'in and Koyukon (another Athabascan tribe) villages in the interior. CATG was founded in 1985 as a

[9] An important point to make here is the commitment to habitat enhancement while harvesting. This is a two pronged approach: 1) Reduction of forest canopy to allow understory vegetation to reestablish for herbivores habitat, and 2) Fire suppression. The Yukon Flats, particularly the forested areas where harvest sites have been identified, are prone to wildfires, by reducing the fuel load, i.e., woody vegetation this helps to suppress fire.

mechanism to engage with ongoing social, economic, cultural, health care, education, subsistence hunting, fishing and gathering as well as governmental issues within these villages (http://www.catg.org/). Through grant funding, CATG oversees the forestry and harvest of the biomass project, in partnership with Gwitchyaa Zhee Corporation (GZC) (Figure 1). GZC, is a village corporation created by ANCSA, based in Fort Yukon that represents local shareholders including but not limited to residents of Fort Yukon.

In all, there are three governing bodies located in Fort Yukon that have a stake in the project. For clarity, the biomass project is owned and operated by GZC. The forestry and harvest components of the project were/are funded by grant dollars and overseen by CATG. The tribe is a separate governing entity that does not control GZC, shareholders own GZC, which is managed by a CEO overseen by a Board of Directors.

Methodology

Participant Characteristics

All of the personnel involved in the biomass project, 5 in total, live in Fort Yukon, and along with one previous employee participated in semi-structured, open ended, exploratory, and face-to-face interviews.[10] The interviews were recorded and lasted between one to two hours. One of the participants was female and the rest were male, ranging in age of 22-60 years of age. Three of the five personnel were born and raised in Fort Yukon, but all were living in Fort Yukon at the time of their involvement in the project. All biomass personnel, past and present, are either local Gwich'in community members or from other Indigenous communities.

Interviews and Data Collection

[10] It is important to state that the authors agreed not to quote or directly reference any of the primary documents owned by the village unless they were public documents.

In the summer of 2015, a multi-pronged research approach was employed to explore the Fort Yukon biomass heating project, including to: 1) collect, organize, and analyze all project information; 2) identified the primary factors that lead to Fort Yukon's pursuit of biomass as alternative energy; 3) measured habitat enhancement via regeneration of vegetation during the optimal growing season in harvested areas; 4) identified and assessed initial feasibility of fire stricken (standing dry/dead timber) in harvestable areas near the village; 5) investigated how local traditional ecological knowledge was negotiated with technical knowledge during the 2013-2014 timber harvest. The second of the five research initiatives is the central focus of this article.

Indigenous research methodologies, which rely on various theoretical foundations and are informed by Indigenous epistemological foundations, helped to inform the semi-structured interview approach (Kovach 2010). More specifically, the conversational method that respects the "culturally organic means to gather knowledge within research" while engaging Indigenous people as a part of a research agenda (Kovach 2010, 42). The conversational method allows for some western methodologies, such as semi-structured questions, which allows a precedence in the interview process that engages the participants in more organic conversation as opposed to structured interviews. The semi-structured interview questions were open-ended and exploratory about the participant's experiences as well as their perspectives working on the development and implementation of the biomass project.

All of the interviews were recorded in English using a digital voice-recording device. Recordings were then transcribed verbatim and organized based on responses or themes that arose during the interviews. Using an inductive approach, each theme was assigned a numerical value to establish how often the theme emerged and the significance or how important the interviewee thought it was.

Content analysis and archival materials

A content analysis on all accessible archival materials relating to the project was completed during the summer of 2015. The project focused on gathering hard copy documents, digital photos, audiovisual recordings, and digitizing them into a local network database only accessible to those granted permission (Roche 2001). The metadata related to each document was indexed into a spreadsheet based on the origin of the document. The archival research enabled the authors to look at all the accessible documentation to help determine what factors influenced the pursuit of alternative energy. Once themes were identified in the archival documents, they were compared to the themes established in the interviews.

Findings

Overall, four themes arose in the interviews and content analysis of the archival materials. What follows is a thematic (as opposed to a numeric) presentation of these four themes. The first theme, access of available renewable resources to offset extraordinarily high diesel fuel costs was initially thought of as two separate themes, but upon closer evaluation of the findings and participant responses we soon realized that without the availability of the resource the project is not viable. While the goal is to offset high fuel costs, the action step to accomplish that goal rests in the ability to access a resource that simultaneously does not put the project at odds with the community's resources, for example certain desired wood species, and is accessible within a reasonable distance from the village.

The second theme, creation and development of economic opportunity is a by-product or positive feed-back of this project. Participants thought of this as a chance to partially address the nearly stagnate economic development in Fort Yukon. Participants and archival documents

agreed in thinking of the project as a prime opportunity to offset fuel costs and the monetary gains to be made coupled with offsetting fuel costs, which seemed to only strengthen the need. The third theme, movement away from fossil fuel and fossil fuel systems and towards self-determining energy opportunities seems a much broader discussion, but in consideration of how financially tied fuel miles[11], for example, are to the overall cost of fuel in Fort Yukon, participants identified this as a real possibility to intentionally reshape their relationship with fuel. For participants, the project created a chance to not only move away from these systems but define energy on their own terms. Being an off-grid community, it seemed to make sense to the participants that they would, at least in part, produce their own energy and not fully rely on costly outside sources.

The fourth theme, cultural significance and connection to burning wood speaks to millennia of Gwich'in observations and experiences within this landscape. Gwich'in people have been a part of the environment in interior Alaska for the better part of 30,000 years (Bodley 2006), having adapted their societies to what the environment provided in order to thrive. Today, part of the adaptation demonstrates an ability to manage forest ecosystems for heating and building materials. With modern technology and a concerted effort to remain environmentally friendly, the participants realize the project reimagines this very old and very established relationship with wood/forests, and minimizes their carbon input through the use of new technology. Additionally, part of this relationship increases Fort Yukon's ability to enhance habitat and suppress fire in these forest ecosystems.

[11] Fuel miles refers to the actual cost of transporting the fuel to Fort Yukon, which is added on to the already expensive gas prices.

The first theme access of available renewable resources to offset extraordinarily high diesel fuel costs speaks directly to the need to think about what renewable resources Fort Yukon has access to given land title issues. What resources are available and can be developed as a means to create an alternative energy structure that is sustainable, and developed while protecting the longevity of the resource; with the goal of offsetting the high diesel fuel costs? In all of the interviews, participants clearly stated that high diesel fuel costs played a role in the conception of the project. Participants shared that long before interest in the project began, the village of Fort Yukon was well aware that the current infrastructure built around diesel fuel was unsustainable, as documented in the one-year heating fuel cost agreements for remote villages.[12] Participant 3 shared "And I think the thing that is driving a lot of villagers to start seriously identifying these kind of projects is the cost of fuel as well as the transportation of getting the fuel they need in their village to run their power plants, and everything comes from an urban area and it's very costly." Participant 2 stated "…it seems fuel costs in Ft. Yukon have always fluctuated but what has been consistent is that cost is always high, so it fluctuates at high dollar amounts, you're paying for the fuel to be flown or barged in, so that cost tacked onto the actual fuel cost itself." Ft. Yukon paid over $6.00 per gallon of diesel heating fuel in 2007 (some villages paid more) with 40% of the cost accounting for transportation, storage, and retailer markup due to their rural location, not including taxes (Wilson et al. 2008). As of this writing in 2016, the cost of diesel fuel in Fort Yukon was $6.18 a gallon. Meanwhile the average diesel fuel consumer in the lower 48 states paid $2.18 per gallon in April of 2016. Such constraints make

[12] One-year heating fuel cost agreements are common fuel costs agreements between villages and heating companies that deliver to the village fuel for heat. At times, and in the content analysis of archival materials, officials from either party the consumer or the distributor will comment on the price of the fuel or their concerns. In this case it was documented that officials of the village recognized that the cost of fuel was too high and unsustainable.

this project a top priority for the community. The project's 2013 Environmental Impact Statement predicts that the biomass system will offset nearly 550,000 liters of diesel fuel annually, amounting to approximately US $4,080,000 (2013, 15).

The second theme creation and development of economic opportunity recognizes the need to stimulate the local economy by providing jobs and freeing up money that would otherwise have been spent to purchase diesel fuel. Economic development in the context of job creation has been slow, availability of local jobs is minimal, as most employment opportunities are with tribal, state, or federal agencies, and much of that work is seasonal in nature. For Ft. Yukon the challenge of creating jobs and keeping employees is consistent, so the only real option for longevity of this project is to invest in community members as employees. Participant 3 elaborates, "…we want to see people willing to see this thing from whatever it takes from harvesting to maintenance of the boilers, to every part this whole operation…when we run and get this project off the ground and it's operational, then we really have to concentrate on who was in the community can really help us and we really got to give them an attractive contract with incentives to keep them on board." Participant 1 considered how the income rate (salary) of this job compared to what normal pay on other labor skills jobs would be "…yeah, it's good pay." Participant 5 spoke directly to the need for Gwich'in driven economic development, "it's the only way this community can self-sustain, is by their own hand." Participant 4's perspective resonates with other participants, "…we live off the land and just self-sustaining." The project would create, "local jobs for the underserved minority community of Fort Yukon" (EA 2013). Respectfully, the interviews and archival documents both agree with each other, this story is common throughout, as interviews and documents often demonstrated a very succinct message spanning nearly eight years (2007-2015). In concert with observed or anecdotal evidence

community members alike recognize that the cost of fuel is not sustainable and comment regularly on the hope that the combined heating facility comes to fruition sooner rather than later. Accordingly, of the nearly 250 archival documents, job creation and competitive recruitment of employees was consistent.

The third theme movement away from fossil fuel and fossil fuel systems and towards self-determining energy opportunities pulls from a more community oriented ideology implementing this project with the intent of reclaiming and further defining how the Gwich'in of Ft. Yukon will pursue a new energy future, by moving away from fossil fuel dependence towards energy sovereignty. Participant 2 shared "…the idea that this community was really taking the lead on such a cool thing really made me excited" in relation to a community led energy initiative in interior Alaska. Participant 3 gave a very poignant explanation of what this project and the people of Ft. Yukon are working towards:

> Our elders, I know, look back at the land and say that's what's going to sustain you. If your shelves in the store are empty you'll be able to set a snare, you'll be able to fish, you'll be able to do this but you gotta be there before you ever get to that time because you got to protect it. You know, we're fighting a lot of battles everywhere on mining and everything, and then now we're also dealing with climate change up here. Climate change don't happen overnight but it'll happen way after I'm gone. So you know it's the people behind me that, that's the younger people. My kids and all them are all probably going to see things that are talked about today. That's why we got to look at everything and we got to talk about, you know, how to use what we have locally—the resources, you know, which is biomass. Other areas it's different things, there's solar, you know, wind

generators. You know but that won't work as well in the flats as it would out there in the coast...

Community member support as both employees and advocates will help realize multiple benefits from the project, such as "energy costs…[that will] help maintain the cost of education and health care in Fort Yukon" and minimize "measurable impacts on traditional use and subsistence hunting and fishing" (EA 2013).

The fourth and final theme, cultural significance and connection to burning wood relates to the cultural practices of using wood for energy, or heating and building materials. The only documented and observed uses of cottonwood in Fort Yukon were to build structures and as a smoking agent to cure wild-game. While Gwich'in forestry practices have a long and highly developed system in interior Alaska, the relationship to preferred species of wood have remained consistent. Participants recognized the growing relationship to cottonwood, and literally built in a new management of cottonwood stands to maintain a sustainable harvest, to create new forestry practices, which will ultimately enhance their already well established forestry practices. For example, with the use of the proposed technology to produce heat and distribute heat to the identified locations cottonwood can play a much larger role in the community. Beyond distribution the carbon dioxide that comes from burning wood will be substantially suppressed in the boilers, therefore further minimizing environmental impact. Each participant acknowledged and archival documents were consistent that the need for cottonwood could then potentially drive a new wood market in Fort Yukon, which will then in turn create a community consciousness around cottonwood. Participants agreed that burning wood for energy or heating purposes is something that Gwich'in people have been doing for a very long time. Participant 5 added,

"burning wood is culturally relevant." Participant 3 followed by sharing "using wood as their by-product for the boilers… It's not a new concept."

Discussion

We initiate this discussion by highlighting what may seem like an obvious limitation of this study. The geography of Fort Yukon represents a very unique part of the world and the Arctic in general, therefore the geography can seem to limit the broader application of the findings. On the other hand, depending on the need for alternative energy options for small rural, or off grid communities throughout the world, this study can potentially inform those who may fit or partially fit this demographic.

We have organized the discussion into sections that replicate the "Findings" section in order to maintain clarity and give respect/attention to the themes. Although the themes are presented as separate esthetically, we realize now the inception of the biomass project is possible via a concerted effort. Therefore, the themes are separate for the purposes of disseminating the results of this article; however, they are not necessarily separate in the minds of interview participants or archival materials.

Taking a step back and looking at this from a broader context, the longevity of this project will ultimately be tied to land tenure status (Karekesi 2011). Though land title is complex, in and around Fort Yukon the available woody biomass resources to support this project are in abundance. The research shows the delivery of this project will hinge on the access to the resource, which will depend on a number of variables[13] present in this project as can be highlighted in the international literature (Howitt 2012; Godoy et al. 2005; and Finley-Brook and

[13] Such as remoteness, access to land, management of land, climate change, and environment to name a few.

Thomas 2007). For example, environmental change is part of this broader picture; while GZC has access to 215,000 acres (EA 2013) of heavily wooded bottomland, wildfires have been a "wicked" problem around Fort Yukon (Chapin 2008). The land title issues can potentially be problematic in a larger land management scenario where GZC can actively manage one area, and adjacent to that area is a piece of land not under GZC management (Case and Voluck 2012). Ideally, offsetting high diesel fuel costs is a requirement of this project, however, land title limitations have forced GZC to think about the long-term availability of cottonwood on lands that are accessible but also subject to adjacent non-GZC lands. This particular land title scenario reminds us that while remoteness might provide opportunity, the political and legal status of remote lands can act as both an antagonist in the support of fossil fuel and a road block in the promotion of alternative energy initiatives (Howitt 2012). Therefore, the longevity of this project seems theoretically viable, but in reality subject to a complex land tenure status regime and a changing environment.

The creation of economic opportunity through the development of alternative energy seems to be an obvious need. Carefully evaluating how Fort Yukon came to these economic cross-roads (Ganapathy 2011) is paramount in consideration of the larger Alaskan or global economy. Fort Yukon, like many Alaskan Native villages participates in the fossil fuel "game," which is an infrastructure built around fossil fuel without many economic incentives (Isherwood et al. 2000) in exchange for participation. This research shows that in Fort Yukon technology is providing opportunities to reevaluate what this relationship can look like. In juxtaposition to a one-way relationship that defines the fossil fuel industry, this new relationship would focus more on reciprocity, as this project is dependent on a heating source that is renewable, sustainable, and

cultural significant, but does require active management (Chapman 2010; Chapman 2013; and Aslan 2012).

The decision to move away from fossil fuel and the drivers of the fossil fuel industry echoes the interests of other, more global, Indigenous communities (Stewart et al. 2011; Wachsman and Tolmasquim 2002). As Brewer recognizes, the ability to self-determine energy choices is not about asking for permission to make an energy choice, it is in fact a reflection or exercise of the sovereign status of Alaskan Native people collectively to *support the ability to choose* (emphasis added) (Brewer forthcoming). Additionally, it's not the choice itself, but the inherent right to make a choice, therefore the deeply inherent sovereign rights of GZC shareholders are also the deeply inherent sovereign rights of all Alaskan Natives (Brewer forthcoming).

The right to decide is a continuation of the relationship Gwich'in have maintained with their environment over millennia, to think of wood as energy. The newly forming relationship to technology broadens the opportunity to eliminate carbon input, which is developed on protocols of reciprocity (Whyte et al. 2015). Accordingly, the international literature suggests that when Indigenous communities have a choice about their relationship to energy they are choosing more sustainable directions (Krupa 2012). Indigenous people want to move away from extractionist economies that wreak havoc on the environment, and towards energy systems that maintain the human-environment relationship (Robyn 2003).

Conclusion

This research explored the key factors motivating Gwichyaa Zhee Corporation to pursue a woody biomass boiler system as a renewable and alternative energy source. The results of this research demonstrate GZC's desire to move beyond a dependence on outside industries that have

imposed fuel systems (i.e., purchasing, delivery and consumption) that are unsustainable economic practices on the community; a move towards energy sovereignty. All things considered, GZC, CATG, and Gwichyaa Gwich'in's motivations speak to the growing field of energy sovereignty scholars who have suggested more local dependence on access to energy potential (Royster 2012).

While key historic events have produced dramatic social and economic transitions in Fort Yukon in recent decades, the one common denominator always present is the high financial costs associated with these transitions, such as diesel fuel for heat and electricity. These are adjustments the community continually makes. Although transitions create issues, issues of high fuels costs have created an opportunity to reconsider and reclaim their sovereign right to decide what energy options they want to pursue.

One thing is certain, the pursuit alone opens up a number of known and unknown economic development, environmental, and community opportunities. For example, creating a boarder wood market where CATG or the corporation can pay wood-vendors, and therefore circulate money in the community, will ultimately broaden the availability of the resource as individual land owners would have access to other cottonwood stands the corporation, the tribe, or CATG does not. There is actually the possibility that this rural/remote village can show the world, and Alaska how to move away from fossil fuels, and how to invest in community, how to work around land tenure/title issues, and maybe more importantly make their own choices to move away from the destructionist behaviors of the Anthropocene. The clear example Fort Yukon is setting for Alaska, the Arctic, and the world is the move away from fossil fuels, the challenge but importance of investing in community resilience, how to work around complex land tenure/title issues in the interior of Alaska, and how to develop such projects with a small

workforce. Within Alaska, other remote communities are learning significant lessons as this remote, Indigenous community creates innovative solutions for their fossil fuel dependence. In Fort Yukon, the biomass project seems to hinge on the incorporation of new practices, which in turn opens up new possibilities for Gwich'in people to lessening their environmental footprint and reshape forestry practices on their traditional homeland. For the foreseeable future in Alaska, change will always be a part of the political, legal, and environmental landscape. At multiple scales, we can learn to manage or even mitigate all of these changes by including Indigenous ways of knowing and doing into the management of all Alaskan lands.

Chapter IV: Discussion

The transformation of the people of Ft. Yukon's traditional and customary lifestyles into its current state has been remarkable and devastating. In just two centuries, a small fur-trading outpost was transformed into a more established village in interior Alaska. Along with that a major shift in traditional practices used to harvest for example wild game by locals in this Native village that once knew no borders in accessing these foods for their livelihood's nor the necessity to adapt their practices to current living situations (Kofinas 2010). The village continues to be impacted by major fishing industries and other local hunters and fisherman in search of the same seasonal foods that are native to this region of Alaska (Berardi 1998; Wolfe & Walker 1987). Rivers continue to morph and change, favored wild game dwindles in numbers lost to overhunting and climate change, fish species fight to swim up rivers to spawn without first being fished at towns and villages along the way or being affected by the warming temperature of waters (Chapin et al 2008; Wertheimer 1997; and Taylor 2008). In spite of these issues, the forests surrounding the village remain almost unchanged except for wildfires that have burned a part of corporation owned forests. In 2015 alone 5,144,880 acres of Alaskan forests were burned with 585,442.6 acres being Native Corporation land, a record high for the state (DOF 2015). Fortunately there is still an abundance of biomass to be used by the community to relieve some financial stress stemming from high fuel cost purchases. This has triggered the Gwitchyaa Zhee Corporation (GZC) and CATG to initiate projects to mitigate and improve on the surrounding forest and rivers (Chapin et al 2008). For example a moose management plan has been put into effect to explore and apply forest land management practices that could aid in increasing the moose population in the area which has no effect on the biomass project. This effort in addition to the woody biomass project led by GZC, represents the villages' historic and current

motivations to constantly maintain their social, economic, and environmental well-being in such a way there is little reliance on needs beyond their rural community.

A constant theme occurring throughout the project is the economics. Where will the money come from? How much money will be saved once the project is going? How much will need to be invested? How much does the community already spend? Questions like these impact every aspect of the project. One such is the income this project can bring into the community. As mentioned previously, 18.5% of the community lives at or below the poverty line. These numbers merely show that a percentage of the community meets state standards for what is considered "poverty." What is not shown is how the rural location and high costs of living help in that equation. As expressed throughout the paper, jobs are difficult to come by, mixed subsistence is a way to meet daily needs, and costs of imported goods are extremely high. We see this unfold particularly with regard to food options. The village primarily relies on collecting food indigenous to the area but there is always a level of uncertainty. For example, when a family is unable to hunt a moose, due to state or federal restrictions, that provides at least 800 pounds of meat that translates into approximately $4,000 in added food expenses (AVI 2007). The cost accounts for nearly a third of an annual poverty level income of $14,500 (ASPE 2015). For a few village members some income will come from the woody biomass project.

The project intends to help a handful of the village members by providing "4-6 half-time jobs and one full-time" (AEA 2009). Such jobs include harvesting the wood, a duty that includes tasks such as operating heavy harvest equipment, decking and chipping the wood, and transporting the resource. If the project intends to harvest 2,000 tons annually engineers propose this would take 89 working days. This does not include additional days to move equipment to harvest sites, maintaining equipment, or other unanticipated tasks. These tasks together are

expected to provide at least four months of guaranteed work (AEA 2009). This expected time of employment depends highly on the climate of the region.

A combination of the rural location and the climate of the region, timing is everything in Ft. Yukon. Every aspect of the project had to be organized so as to align with the climate of the region and anticipated applications and permits to be approved in a timely manner. For example, the heavy equipment needed for the project needed to be barged in on the river before winter freeze up but that task depended on whether a grant was awarded and funds were disbursed on time to purchase the equipment. Such a time sensitive tasked would have set back the project a whole winter harvest season if the funds were not in place. As expressed in a harvest operation document, "scheduling of each step is dictated principally by weather and ice conditions suitable for safe movement, given the necessity of over water transport to and from some designated harvest sites. Summer months will allow for barge transportation of machinery, enabling harvest during both summer and winter periods (AEA 2008)." Furthermore these cold months dictate the hours of operation for the harvesters. Unlike woody biomass projects outside of the Alaskan interior, Ft. Yukon has temperatures that drop well below -30 degrees Fahrenheit. For the harvesters, an analyst working closely with the village expressed a safe cut off temperature at -25 degrees Farenheit (Champagne n.d. p. 5). Last but not the least of time sensitive tasks is the drying time of wood chips. First the trees need to be decked and chipped then allowed to reach a favorable moisture content of 25% which takes approximately one year (AVI 2009). The time required for curing the wood impacts the overall costs of the project. It is unlikely lower 48 biomass projects have to regard their time with so much caution but for this village it is always a task at hand, as seen from the above examples.

Also considered is the decisions made in determining the most cost effective boiler loop system. Unlike calculating oil fuel consumption costs which are upfront and do not require significant analysis, the central heat and power system had to consider the upfront costs of the project and appropriate boiler system, calculating all the heat losses and gains, parts, and labor. An analysis identified that a woodchip system (not sticks, as it was not feasible for such a large amount of buildings being served) would prove to be more profitable than diesel fuel for heat (AVI 2010). This was done by using a net simple payback formula, a formula used because a substantial amount of the start-up money was not personal equity of the village, rather funding from grants (ibid.). To determine the appropriate boiler loop, five scenarios were proposed, it was determined having a main system connecting the clustered commercial buildings and have two stand-alone boiler systems at the clinic and vocational school was best. This analysis did not calculate connecting residential homes to the loop though it is a future consideration. The loop that was selected was based on finding the right set up that ensured the same amount of BTU's were being supplied to the buildings as if by diesel fuel (AEA 2008).[14]

Although a significant amount of fuel will be displaced there will still be a need for diesel fuel during every harvest. During the first year's harvest in 2013, harvesters calculated the heavy equipment to have "burned roughly through 2,250 gallons in one month" as such four months of operation in the harvest areas will require at the least 10,000 gallons of fuel (Champagne n.d. p. 5). Additionally, as explained in chapter three, the boiler system will still be able to use diesel fuel, as it will be a back-up source during the "shoulder" months when there is not a great demand or during times when woodchips are not available (AVI 2008). Unfortunately, ties with diesel fuel cannot be completely broken but it provides the village the ability to retain energy

[14] BTU's are discussed in chapter three

sovereignty in ways not feasible by other means with so many public buildings requiring heat throughout the long Arctic winter.

Although not a bad thing but a deeply considered proponent of the project for some current biomass project personnel is GZC's use of Federal funding for the project. While the state does have programs that help fund renewable energy projects across Alaska like the Renewable Energy Fund guided by Alaska Energy Authority (2016). What this means for a sovereign entity like the village is that accepting grants has its award dates, timeline for spending funds, and following guidelines as stipulated in awards that creates an additional set of time sensitive tasks to align with the entire project. Participant three in the interviews mirrored this view. It is an unavoidable situation as the village does not have the means to cover the project themselves, looking beyond this several biomass employees believe this will be worked through by focusing on the purpose of this project, to, "become a great example in natural resource development that many others will look to in the future as a way to better a people's self-sufficiency and a community's independence from big business…[and] positively affect each person in Ft. Yukon in many ways not yet realized" (Champagne, n.d., p. 7).

The project thus far continues to face new scenarios needing adjustment but many positive affects as well. For example, the harvest team has realized efficient methods for decking and chipping the biomass in winter conditions, this has taken one harvesting season to work through. Much of this has been realized through local knowledge of the area which was only possible by local villagers. Additionally, local knowledge helped harvesters understand the limitations of heavy equipment operating in arctic temperatures. Such knowledge is not readily available outside the community. GZC plans to turn their experiences into a sort of "lessons learned" manual. A manual they hope can assist other interior villages. When we think of how

Ft. Yukon wants their journey towards renewable and sustainable energy to be that of other communities, it should indicate how important this case study is to others globally.

Future Considerations/ Work

While I used documents available to me along with my co-authors and other project participants to determine why Gwitchyaa Zhee Corporation (GZC) has made the choice to pursue this project, there are other things still left unsaid that could be explored. One suggestion is to explore challenges faced by colder regions, like interior Alaska, that requires retrofitting equipment in order for it to withstand arctic weather conditions. The same goes for exploring how the woody biomass when decked stands up to arctic conditions, especially during harvest. Observations like this can help assist another village or equally cold region to understand the weathers effect on the trees tolerance to being handled by heavy equipment, specifically the physiology of cottonwoods, which is an understudied species in this region. This would be an optimal topic to explore because undertaking a project similar to GZCs should mean a smoother process and less of a trial and error run when another community has already interacted with these challenges.

A second topic that could be explored is looking at how employing local people benefit this renewable energy project and the advice that could be taken from this decision that GZC employed. Because GZC is working with such a local renewable resource the idea to employ locals who understand the geography of the area has eliminated or lessened the need to further train biomass workers about understanding interior Alaskan climate effects on everyday decisions in a harvest area. Or the benefit of having local workers help in organizing time sensitive plans regarding importing products that could easily be affected by climate conditions. Doing such work on this can help other communities understand the importance of local hiring

for it is the community members that understand the geography of a region, which proves helpful when non-locals are hired onto these sorts of projects. More importantly, ensures the longevity of a project when it is locals taking responsibility of their energy sovereignty.

Another step that could be taken with this research is to look at the projects' success and influence on villages in the Yukon Flats region. While this depends on what happens once the project is no longer in the pilot stages and well into years of harvesting and operation this is still a worthy topic to endeavor. Looking at this shift in energy use could open up further the discussion of interior villages adopting new practices into their tradition as it aligns with a legacy of sustainable environmental practices. Such inquiry can also let us see the improvement in practices applied to getting a biomass project started and going from village to village.

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