ATTRIBUTES OF SOCIO-TECHNICAL BASELINE CAPACITIES FOR ENERGY TRANSITION IN THE NORTH: OPPORTUNITIES AND CHALLENGES FOR GWICH'IN COMMUNITIES, NORTHWEST TERRITORIES

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By

RHYS MCMASTER

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Dean
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University of Saskatchewan
116 Thorvaldson Building, 110 Science Place
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Abstract

Today's societies confront significant challenges concerning historic energy systems, which are becoming increasingly vulnerable to the threat of climate change. Energy systems need to be adapted to create greater resilience for the future. However, ensuring long-term success in community energy development in the North requires more than building new projects – it requires understanding the local socio-technical capacity to design, implement, and maintain renewable energy projects. Consequently, the design of community-appropriate sustainable energy systems requires a socio-technical understanding of a community's baseline capacity for energy transition. In 2018, through the *2030 Energy Strategy: A Path to More Affordable, Secure, and Sustainable Energy in the Northwest Territories*, the Government of Northwest Territories encouraged local or community level renewable energy development within the territory. Communities in the territory considering their energy futures include the Gwich'in communities of Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic. The challenge, however, is that there is limited research on what a socio-technical baseline capacity profile for a remote northern Indigenous community involves. Therefore, the purpose of my research is to understand the socio-technical baseline capacity for energy transition in Gwich'in communities. The initial objective consisted of developing a conceptual framework for socio-technical baseline capacity profiles. The rapid assessment framework is conceptualized based on the energy context of rural and remote regions in the North and informed by recent energy planning grey literature and scholarship. The conceptual framework was then applied with the four partner communities, based on semi-structured interviews with community members, Gwich'in leaders, intermediary organizations, and energy sector representatives, identifying key strengths, challenges, and regional trends across the partner communities. Results identify several key capacity opportunities and challenges for energy transition, emphasizing the importance of community-to-community capacity building and long-term capacity building within the region. I conclude with a discussion of the research key findings – identifying diverging perspectives, the importance of inter-local energy networks, the intertwined nature of the attributes of the framework, and future research needs.

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Chapter 1 – Introduction

Today's societies confront significant challenges and uncertainties surrounding their energy systems, which are among the most extensive human enterprises, increasingly vulnerable to climate change, and need to be adapted to create greater resilience for the future (Miller, Iles, & Jones, 2013; Miller, O'Leary, Graffy, Stechel, & Dirks, 2015; Verbong & Geels, 2007). Energy systems that are dependent on fossil fuels are rapidly altering Earth's climate and must be fundamentally transformed to reduce global carbon emissions to sustainable levels (Miller, O'Leary, et al., 2015). Many existing, centralized energy systems must also transform and transition in order to ensure reliable and affordable energy for many rural and remote regions (Jenkins, Sovacool, & McCauley, 2018; Rakshit, Shahi, Smith, & Cornwell, 2018). However, due to the historical and legacy characteristics of these large scale and centralized energy systems, sustainable energy transition is faced with complex and multi-faceted challenges – such transformations often require changes not only in infrastructure and technologies, but in the broader social and economic settings that are built around energy production and consumption (Miller et al., 2013; Miller, O'Leary, et al., 2015; Miller & Richter, 2014). The transition toward decentralized and renewable energy systems constitutes a complex socio-technical process (Newell, Sandström, & Söderholm, 2017).

Even more complex are energy transitions in remote Indigenous communities[1], which themselves face unique contemporary and historical circumstances and may require unique considerations and support frameworks for the implementation of new energy initiatives (Beatty, Carriere, & Doraty, 2015; Karanasios & Parker, 2018; Krupa, 2012). Many scholars have said that historically marginalized Indigenous peoples have considerable potential to lead sustainability transitions, and introducing local energy projects could even address many enduring socioeconomic concerns within Indigenous communities (Karanasios & Parker, 2018; Pasqualetti, Jones, Necefer, Scott, & Colombi, 2016). In northern Canada alone, for example, approximately 170 off-grid, diesel-dependent Indigenous communities face the challenges of

[1] An Indigenous community is a distinct cultural group or community of people, who share collective ancestral ties to the lands and natural resources where they live, occupy, or from which they have been displaced. Where the land and natural resources on which they depend are intrinsically linked to their identities, cultures, livelihoods, and physical and spiritual well-being (The World Bank 2022).

energy insecurity – a challenge that affects all aspects of day-to-day life (Cherniak, Dufresne, Keyte, Mallett, & Schott, 2015). Diesel-generated electricity is characterized as responsible for carbon emissions, spills, leakages, poor quality services, and potentially limiting community development opportunities (Karanasios & Parker, 2018). The integration of locally generated or owned and operated renewable energy projects into remote community energy systems may address not only energy insecurity but also socio-economic development concerns (Karanasios & Parker, 2018). However, Miller et al. (2013) emphasize that the design of energy systems that are community appropriate requires careful consideration of a community's socio-technical capacity to transition, coupled with an understanding of the social processes that stimulate and sustain transitions and the longer-term social outcomes of transitions. Ensuring long-term success of renewable energy development in northern or remote regions requires more than building new energy projects – it requires building the local socio-technical capacity to plan for, design, pursue, implement, operate, own, and maintain renewable energy projects (Daley, 2017; Miller, Moore, Altamirano-allende, Irshad, & Biswas, 2018).

Energy systems are socio-technical systems – they are interconnected, integrated systems that link social, economic, and political dynamics to the design and operations of energy systems, including the people who create, develop, manage, and consume the energy (Miller et al., 2013; Miller, Richter, & O'Leary, 2014). The socio-technical capacity of communities is thus an essential component of contemporary energy transitions and subsequent social transitions (Goodman, 2018; Gui & MacGill, 2018; Middlemiss & Parrish, 2010; Miller, Altamirano-Allende, Johnson, & Agyemang, 2015). Energy transitions can stagnate without proper considerations for the socio-technical attributes of communities (Mühlemeier & Binder, 2017). Several authors have identified various factors that comprise socio-technical capacity, including Miller et al. (2013) – who suggest that such factors include financial networks, workforces, and schools required for training within an energy system; and Middlemiss and Parrish (2010), who note that it is critical for personal, organizational, and cultural capacities to be considered when developing and pursuing community energy transition plans.

The challenge, however, is that there is limited research on the necessary and sufficient socio-technical baseline capacities of remote northern Indigenous communities[2] for energy transition. Most research involving energy transition, internationally and in Canada, has focused on southern jurisdictions or urban regions (Leonhardt et al., 2022; Rezaei & Dowlatabadi, 2016; St. Denis & Parker, 2009). Understanding the human baseline capacity to support and sustain community energy transition in northern and Indigenous communities is foundational to initiating, planning for, and achieving energy transitions. This means first tapping into existing community capacities, and second identifying the needs and opportunities for capacity development. Intertwined with community energy transition efforts, is a growing literature speaking to the presence and importance of Indigenous scholars in contemporary energy transitions research (Bullock, Kirchhoff, Mauro, & Boerchers, 2018; Stefanelli et al., 2019). The lens through which I, as a Master of Science candidate, view this research is as a female researcher with an environmental sciences background, who is from the prairie region or south of Canada, and who is Indigenous and a member of Siksika Nation, Alberta.

1.1 Purpose and Objectives

In 2018, through the *2030 Energy Strategy: A Path to More Affordable, Secure, and Sustainable Energy in the Northwest Territories*, the Government of Northwest Territories described their energy supply as highly dependent on fossil fuels (Government of Northwest Territories, 2018). As an effort towards energy transition and a more secure energy future, the government adopted the objective of encouraging local or community-level renewable energy development to shift the present-day dependence on fossil fuels toward more sustainable energy systems (Government of Northwest Territories, 2018). Energy systems in these remote communities involve not only the infrastructure and resources for energy production and consumption, but the people involved in planning for energy transition, whose values will be impacted by new energy sources, and who use and consume energy. Socio-technical baseline capacities in these Gwich'in communities

[2] There are several definitions of a "northern" community, most often defined geographically based on the southern limit of the discontinuous permafrost zone. Similarly, "remoteness" is also variably defined, often concerning a particular context such as no year-round road access. In the context of energy security, remote often means "off-grid"; however, even some northern grid connected communities suffer from similar energy insecurities as off-grid ones.

must be understood and approached as a precondition to successful community energy transitions.

The purpose of this research is to understand the socio-technical baseline capacity for community renewable energy transition in Gwich'in communities in Northwest Territories. The objectives are to:

- Develop a conceptual framework for socio-technical capacity baseline assessments in northern and Indigenous communities;
- Apply the framework, working with partner Gwich'in communities; and
- Identify key capacity opportunities and challenges for energy transition in Gwich'in communities.

This thesis is presented in six chapters, including this introductory chapter. Chapter 2 draws on the literature to develop a conceptual framework for exploring community capacity to engage in energy transitions. The study area and methods for the research, focused on the Gwich'in communities of Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic, are presented in Chapter 3. Results of the framework application are presented in Chapter 4. Chapter 5 discusses the key observations emerging from the research for advancing a socio-technical framework for baseline capacity assessment in northern and Indigenous communities, including implications for Gwich'in communities. Conclusions and recommendations for future research are presented in Chapter 6.

Chapter 2 – Conceptual Framework

Community energy systems are tightly coupled socio-technical systems that include not only the infrastructure and technologies but also the people who plan for, implement, operate, and maintain community energy projects and use the energy generated (Miller, O'Leary, et al., 2015). Community energy places greater control of energy systems in the hands of the community (Jenkins et al., 2018), challenging the dominant centralized approach to energy systems that have long shaped social practices and ways of living (Miller et al., 2013; Sauter & Watson, 2007). Transitions in energy systems thus require transitions in social systems (Jenkins et al., 2018; Miller et al., 2013). A contemporary set of transition management tools are required, as in the face of the challenges fronting historic energy systems, energy transition management, facilitation, and planning must also transition (Miller et al., 2013; Miller & Richter, 2014).

Much of the focus of community energy transition research, however, has been on transition theories (Acosta, Ortega, Bunsen, Koirala, & Ghorbani, 2018; Avelino & Wittmayer, 2016), innovations in energy technologies (Bhattarai & Thompson, 2016; Goodman, 2018; Quitoras, Campana, Rowley, & Crawford, 2020), economic cost-benefit (Bekareva, Meltenisova, & Guerreiro, 2018; Lovekin, Dronkers, & Thibault, 2016), and state policy and governance instruments (Feurtey, Ilinca, Sakout, & Saucier, 2016). There has been much less attention to the social dimension of the community socio-technical energy system, despite energy transitions requiring considerable social innovation and capacity at the community level (Naumann & Rudolph, 2020).When social dimensions are included in energy transitions, they are sometimes assumed to be stagnant or of secondary importance; this may hinder capacity-building opportunities to enable and support long-term community energy transitions (Berka, MacArthur, & Gonnelli, 2020; Devine-Wright et al., 2017). The focus of research and planning is also predominately on urban contexts (Mühlemeier & Binder, 2017; Zhao, Chang, & Chen, 2016), but with a growing literature and attention on rural regions in the global south (Akmalah & Grigg, 2011; Feroz, Moon, Park, Swar, & Rho, 2011; Miller, Altamirano-Allende, et al., 2015).

Building capacity for energy transition starts with people, not technology (Simpson, Wood, & Daws, 2003). This is especially true in rural and remote regions where community energy projects must align with local resources, values, capacities, and opportunities (Mühlemeier &

Binder, 2017; Tozer, 2013). Community capacity is about the collective ability of a community to create and take advantage of opportunities to meet community needs, thus providing for greater self-sufficiency and control over social and economic futures (Smith, Baugh Littlejohns, & Thompson, 2001) and charting a course for self-determination (Rakshit et al., 2018). Understanding the social capacity to pursue, implement, and maintain community energy projects is thus essential to community energy transition planning and energy sovereignty[3] (Bullock et al., 2018; Hossain, Loring, & Marsik, 2016; Jenkins et al., 2018; Rezaei & Dowlatabadi, 2016). The capacity of rural and remote communities to pursue community energy initiatives is grounded in both current and potential social innovation and opportunity (Chino & DeBruyn, 2006). However, notwithstanding the growing literature and practical guidance on community energy planning to assess energy needs, use, infrastructure, and renewable energy technologies, much less attention has been given to assessing the baseline social capacity of communities to pursue "community-centric energy plans" (Rakshit et al., 2018).

The benefits of conceptual frameworks and tools for rapid assessment are noted in scholarship and practice across a diversity of fields. The Government of Canada, for example, uses a rapid evaluation tool as a structured and low-cost approach to assessing government policy and program impacts when time or resources are limited (Government of Canada, 2022). In the energy sector, Orosz, Altes-Buch, Mueller, and Lemort (2018) demonstrate the benefits of rapid rural assessment to explore energy demands and microgrid potential in sub-Saharan African communities. One of the more prominent rapid assessment frameworks, the rapid impact assessment matrix (RIAM) (Pastakia & Jensen, 1998), has been applied in various sectors from hydroelectricity and bioenergy projects to waste disposal project planning and flood mitigation (Gilbuena et al., 2013; Komasi, 2019; Rawal, Rai, & Duggal, 2017; Upham & Smith, 2014).

Rapid assessments are an initial step in a more comprehensive approach. These generally include collecting primary data (quantitative or qualitative, or both), are usually iterative (i.e., involving multiple rounds or phases), and often employ methodologies that are practical and convenient due to time constraints. Rapid assessments are an approach to identifying critical gaps and

[3] Energy sovereignty means enabling Indigenous communities to own and operate energy systems, to use renewable and locally available energy sources, and to have energy independence. Energy sovereignty aligns with Indigenous cultures, knowledge, and land rights, and they increase the resiliency of Indigenous communities that have been negatively impacted by colonialism and capitalist resource extractions (Brown 2019).

opportunities in initial stages of planning processes (Gale et al., 2019). Rapid assessment frameworks are only one part of an evidence-building strategy, complemented by longer-term and more robust research and evaluations, but they are well suited to guide the initial stages of community energy transitions planning, especially in data-sparse regions like northern and remote communities.

In the sections below, a conceptual framework is presented to guide the rapid assessment of community capacity during the pre-planning stages of community energy initiatives (Table 2.1). The framework responds to the recognized need for contemporary energy transition planning tools that confront historic energy systems (Miller, O'Leary, et al., 2015; Miller & Richter, 2014) and build local capacity to implement, sustain, and derive value from community energy projects (Eisler, 2016; Ikejemba, Mpuan, Schuur, & Van Hillegersberg, 2017; Karanasios & Parker, 2018). The framework is conceptualized based on the energy context of rural and remote regions in the North, informed by recent energy planning grey literature and scholarship, but draws on a cross-section literature and a range of disciplines, exploring capacity in such areas as socio-technical capacity indicators from developing countries and the global south (Middlemiss & Parrish, 2010; Miller & Richter, 2014; Schäfer, Kebir, & Neumann, 2011; Sovacool, Agostino, & Bambawale, 2011; Sovacool et al., 2020), energy transition and sustainable development from the circumpolar north (Cherniak et al., 2015; Mortensen, Hansen, & Shestakov, 2017; Poelzer et al., 2016; Rosenbloom & Meadowcroft, 2014; St. Denis & Parker, 2009), and energy transitions from Indigenous communities (Karanasios & Parker, 2018; Mercer, Parker, Hudson, & Martin, 2020; Pasqualetti et al., 2016; Rezaei & Dowlatabadi, 2016; Stefanelli et al., 2019).

The literature was explored to determine what constitutes a socio-technical transition, how social elements are interconnected in transition efforts, and what frameworks, indicators, and perspectives are necessary to comprehend essential characteristics of the transition in northern and Indigenous communities. This led to a cumulation of factors required to understand the baseline capacity for socio-technical transitions, which were culminated into like concepts or foundational attributes, providing guidance for the rapid assessment of baseline local social capacity as a precursor to formal community energy planning processes. These attributes may not be comprehensive of all possible considerations (see Vallecha, Bhattacharjee, Osiri, & Bhola,

2021); however, they represent the necessary community social attributes to initiate, drive, and support community socio-technical energy transitions.

Table 2.1: Attributes for early-stage planning and assessment of community energy transitions.

Community energy champion(s) • There are individual(s) or a group (e.g., energy planner, volunteer group) with an interest and mandate to lead community energy transition. • Sufficient resources are available to lead community energy initiatives (e.g., financial, logistical, managerial).
Inter-local energy networks • Communities have access to a network of professional and technical knowledge about available and emerging energy technology and innovations. • Formal or informal opportunities exist to engage in community-to-community learning and mentorship about opportunities and solutions from energy community frontrunners.
Community energy vision • There is a broadly shared community vision, focused on longer-term goals and aspirations (e.g., self-determination, socio-economic independence). • Community energy is perceived as a pathway to help achieve longer-term goals and aspirations.
Value creation • Community energy is viewed as an opportunity to create new or enhance existing social cultural, or economic opportunities.
Energy literacy • There is a general knowledge about energy use, local energy sources, and alternative energy technologies. • Availability of and access to energy literacy programs.
Embedded skills • Existing energy-related skill sets within the community to operate and maintain local energy systems or technologies. • Existing transferable skill sets (e.g., across sectors – financial, managerial, technical) to support community energy.
Skills development opportunities • Availability of and access to training or mentorship programs across diverse energy related skill sets. • Local workforce capacity and interest to pursue energy-related training and employment.
Next generation leaders • Energy education is embedded in school curriculum. • Youth are actively engaged in youth leadership, community initiatives, or local energy projects and activities.

2.1 Local Energy Champion(s)

Community leadership is foundational to enabling and managing energy transitions in rural and remote communities (St. Denis & Parker, 2009). Local leadership capacity is thus a key condition for low carbon community-based energy projects (Middlemiss & Parrish, 2010), and the vision and leadership of individuals essential to the success of community energy initiatives

(van der Horst, 2008; Walker & Devine-Wright, 2008). Community leadership mobilizes social capital for energy transition, maintains financial and technical resources for energy projects, enables knowledge transfer, and establishes and maintains important energy support networks with external actors (Ghorbani, Nascimento, & Filatova, 2020; Martiskainen, 2017; Seyfang, Hielscher, Hargreaves, Martiskainen, & Smith, 2014). Drawing on community energy systems in the Netherlands, Ghorbani et al. (2020) demonstrate the centrality of leadership, showing that leadership positively impacts the creation of local energy initiatives irrespective of other factors, but cautions that leadership can also be a bottleneck for local energy progress. Notwithstanding the importance of leadership in local energy, there has been only limited research on the topic in the context of community energy transitions (Hoicka & MacArthur, 2018; Martiskainen, 2017), especially in northern and remote contexts.

Community leadership for local energy transitions is not hierarchical in the traditional sense of elected leadership (Onyx & Leonard, 2011), but about building the social capital to collectively enable socio-technical change (Sullivan, 2007). As Martiskainen (2017) explains, community leadership aids processes for voicing expectations about community energy systems and conditions, supports local learning, and facilitates integration with other energy networks and actors while supporting local niche building and innovation. Ghorbani et al. (2020) report that local energy initiatives are more likely to succeed when there are community leaders learning about technology options, translating information for community members, seeking financial and other supports, and actively adjusting expectations about community energy projects. Warburton and Carey (2012) identify local leadership as among the most valued resource for local sustainability projects.

In northern and remote regions, such leadership may be in the form of community energy champions – whether a formal community energy planner or an informal group of community members. Energy champions are critical to transition efforts (Axon et al., 2018); however, Cherniak et al. (2015) note that among the major community-level barriers to energy transitions across northern communities is a lack of community energy champions and a lack of support (e.g., financial, logistical) for those champions. Capacity development opportunities are starting to emerge for Canada's northern and Indigenous communities, through such programs as Natural Resources Canada's Indigenous Off-diesel Initiative to identify and train community clean

energy champions. However, for most northern and remote communities the lack of consistent and sufficiently resourced community energy champions is an enduring barrier to community energy transition (Lovekin et al., 2016).

2.2 Inter-local Energy Networks

Communities are sometimes described as niches in which leadership can help transform energy systems (Raven, Heiskanen, Lovio, Hodson, & Brohmann, 2008), but community energy initiatives are more likely to succeed when supported by a network of actors, collaborations, or partnerships (Juntunen & Hyysalo, 2015; Martiskainen, 2017). The initiation and establishment of community energy projects is often "dependent on collaborations with the private sector for technology provision, and oftentimes maintenance and operation, and on the state for enabling regulation for contracts and capacity building" (Hoicka, Savic, & Campney, 2021). Berka et al. (2020), for example, report on the limits of local or grassroots agency in the pursuit and success of community energy in the New Zealand context, emphasizing the importance of community leadership being embedded in much larger networks to support learning, resource-sharing, and collaborative project development. Onyx and Leonard (2011) similarly note the importance of leadership embedded in both formal and informal networks and operating in an open and engaging system with other communities and energy actors. In the global south, Ulsrud, Rohracher, and Muchunku (2018), illustrate the value in mentorship or *sister community* programs for solar power projects to enable knowledge transfer from India to Kenya.

The embeddedness of community energy leadership in a larger network of actors and inter-local learning is especially critical in the North (Cherniak et al., 2015; Poelzer et al., 2016), where local experiences with energy transition and new technologies may be limited. Inter-local energy networks enable community leadership to learn directly from other communities that have successfully integrated renewables into their energy mix. There are northern and remote communities that have already introduced renewables into their community energy systems. In rural Alaska, for example, several regional grids have been formed, and local utilities have developed systems for supporting regional energy planning and project maintenance (Holdmann, Wies, & Vandermeer, 2019). Alaskan communities have integrated renewables into their diesel-based power grids with more success than perhaps any other region across the Circumpolar

North (Shaw, 2017). In absence of energy networks to support the sharing of success, struggles, and solutions, there are few opportunities to learn from energy innovators and frontrunners (Avelino & Wittmayer, 2016) – a critical factor for the growth and replication of energy innovation (Ghorbani et al., 2020; Poelzer et al., 2016).

2.3 Community Energy Vision

Much of the literature on community energy speaks to the importance of a leadership vision (Arctic Council & Sustainable Development Working Group, 2019; Hossain et al., 2016; Karanasios & Parker, 2018). We agree that local leaders and energy champions must have a vision for how to pursue community energy projects, but why for energy transition must be shaped by community vision for their energy futures. Successful community initiatives are based on a set of collectively achievable goals, beyond merely energy efficiency or conservation (Axon et al., 2018). However, limited attention has been paid to what northern and Indigenous communities want from community energy (Hoicka et al., 2021; Mercer et al., 2020). Externally driven community energy planning efforts in the North have often focused on specific energy technologies rather than larger and longer-term community energy goals and aspirations (Hossain et al., 2016; Rezaei & Dowlatabadi, 2016). Boamah and Rothfuß (2018) make similar observations in rural parts of west Africa, demonstrating an overemphasis on technical and financial considerations, versus community energy visions, in explaining the adoption of decentralized solar energy systems. In China, Zhao et al. (2016) found that inconsistencies between energy visions and a lack of effort to form a shared energy vision were major barriers to local energy transition efforts. Limited attention to a community's energy vision, or contradictory visions that lead to continuously reshaping and reframing the energy visions, are a foremost impediment to community energy transitions (Magnani, Maretti, Salvatore, & Scotti, 2017).

A clear vision for the future is thus important to fostering energy transitions in northern communities (Karanasios & Parker, 2018). This vision must be grounded in community history, needs, and opportunities and is essential to building local community capacity and motivation to pursue new energy futures (Arctic Council & Sustainable Development Working Group, 2019; van der Horst, 2008; Walker & Devine-Wright, 2008). This vision is typically much larger than

the community energy system itself (i.e., mix of projects or energy sources) and is focused on longer-term community futures and outcomes – what might be achieved (socially, culturally, economically) under a sustainable community energy future. As Miller and Richter (2014) note, discussions about energy futures are thus far more than discussions about technologies or the distribution of costs and benefits of a community energy project; they are inherently discussions about what kind(s) of future a community envisions. In the context of northern and Indigenous communities, for example, such visions may be shaped by a desire for self-determination, socio-economic independence, and self-governance (Hoicka et al., 2021; Karanasios & Parker, 2018; Poelzer et al., 2016; Rezaei & Dowlatabadi, 2016). Energy initiatives with ownership models that do not align with those larger visions for the community are unlikely to be successful in sustaining community interest and achieving long-term energy transition (Ghorbani et al., 2020).

2.4 Value Creation

Communities are unlikely to support energy transitions based solely on technological grounds (Urmee & Md, 2016). Community energy options and opportunities must be pursued through a social lens, as energy-related practices are embedded in social systems and shaped by local values, culture, and community support (Fobissie & Inc, 2019; Sovacool et al., 2020). Community values thus determine what is an acceptable local energy project, and in turn, local energy reshapes the social relations embedded in a community's system of energy production, distribution, and use (Veelen, 2017). Pasqualetti et al. (2016) similarly argue that energy developments are often informed more so by cultural and social considerations than by need or accessibility. Cultural and social values play a significant role in shaping energy transition in northern Indigenous communities (Krupa, 2012).

Energy transitions are impactful when communities can derive new or enhance existing value(s) from their energy source(s). These values are often embedded in community context, and shaped by culture and lived experience (Fobissie & Inc, 2019; Hirshberg, 2020). Miller and Richter (2014) report that among north African communities, however, the limited consideration of local values has been a major barrier to successful community energy initiatives. The challenge is similar across many northern and Indigenous communities in Canada (Hoicka et al., 2021; Krupa, 2012), where energy projects are sometimes imposed on communities based on external

interests and do not necessarily align with, or enhance, local community-centric values (Rakshit et al., 2018). It should not be assumed that technological interests or responding to global climate are the primary values driving energy transitions in northern and remote communities (Hanna, Mcguigan, Noble, & Parkins, 2016; Hossain et al., 2016; Mercer et al., 2020).

For many northern or remote Indigenous communities, community energy is often a means to resolve the immediate pressures of energy poverty by proving access to affordable and reliable energy to meet basic electricity and heating needs. Raphals (2019),for example, reports that the energy challenges facing many on-reserve Indigenous peoples in northern Manitoba, Canada, are lower than average incomes coupled with home heating costs that are 80% higher than households in urban areas (Raphals, 2019). The shift to biomass energy in the remote community of Galena, Alaska, for example, similarly represents a local need to shift from expensive and unreliable imported diesel fuel for the Galena Learning Academy – the community's economic driving force (Kalke, 2015). Simply put, local energy initiatives that do not reflect local values often falter (Ikejemba et al., 2017). Mercer et al. (2020) reports that for off-grid Indigenous communities in eastern Labrador, Canada, energy sources that do not align with local, traditional land uses and values are not seen as advancing quality of life and less likely to be accepted. Thus, when approaching community energy planning processes, attention must be given identifying and understanding the socio-cultural values and value creation opportunities that shape a community's interest in, and acceptance of, local energy developments and transition processes (Devine-Wright et al., 2017).

2.5 Energy Literacy

A community's existing knowledge about energy resources and technologies, and the socio-technical capacity to pursue energy initiatives, are foundational to successful transitions (Cherniak et al., 2015; Krupa, 2012). If a community's energy leaders or decision-makers lack foundational energy knowledge and socio-technical supports, or if widespread misinformation about local energy exists, it can deter the social value of local energy developments (Lovekin et al., 2016; Mercer, Sabau, & Klinke, 2017). Initiating technical or planning solutions without first establishing a community's existing knowledge and socio-technical capacity "will not sustainably advance innovation within local energy systems" (Advanced Energy Centre, 2015).

Community energy literacy is thus a catalyst to energy transition. A community's understanding of and familiarity with energy resources and technologies is key to meaningful engagement in, and acceptance of, energy planning and local energy projects (Cherniak et al., 2015; McDonald & Pearce, 2012). Limited understanding of energy sources and options, or misunderstandings about energy technologies, can deter the social acceptance of energy transitions (Iyamu, Anda, & Ho, 2017; Mercer et al., 2017). Amongst remote Indigenous communities in Labrador, for example, Mercer et al. (2020) report that emerging technologies such as biomass, wave, and tidal power, as well as energy storage options like batteries and pumped hydro were resisted as community members did not fully understand their risks and benefits (p. 25). In contrast, when energy literacy is strong it can help drive bottom-up change even in the absence of government support for energy programming (Advanced Energy Centre, 2015; Cherniak et al., 2015; Mortensen et al., 2017). Reflecting on the success of energy transitions in remote Alaskan communities, for example, Holdmann et al. (2019) emphasize the necessity of energy literacy programs in helping community members understand energy systems and how the community can derive new benefits from an alternative energy future. Gauging initial community understandings of energy sources and technologies, and identifying the availability of energy literacy programming, is thus a necessary starting point for any community energy transition planning process.

2.6 Embedded Socio-technical Skills

Community energy transitions require community members with the knowledge, experience, and skills to be able to participate in local energy planning and projects (Haggett & Aitken, 2015). Literature suggests that many remote communities across the North have limited capacity to organize, operate, maintain, and manage local energy initiatives (Advanced Energy Centre, 2015; Knowles, 2016; Mortensen et al., 2017), or are challenged by high turnover of human resources – especially for long-term initiatives such as energy transitions (Cherniak et al., 2015; Mühlemeier & Binder, 2017). Energy systems and technology-specific skills are essential to successful, long-term energy transitions. However, too often energy planning, like other sectors (Stevenson & Perreault, 2008), adopts a capacity deficit approach, focusing only on the technology-specific skill sets that are absent with little attention to existing and embedded skills.

Financial, managerial, and technical capacity are routinely-cited barriers to energy transition in many remote or Indigenous communities (Bhattarai & Thompson, 2016; Boute, 2016; Cherniak et al., 2015; Mortensen et al., 2017; Pasqualetti et al., 2016); yet, transferable and potential skill sets that already exist within a community are often overlooked. For example, The National Indigenous Economic Development Board (2019) notes the significant growth in Indigenous entrepreneurial leadership and business success in comparison to non-Indigenous business start-ups. For many communities with diesel dependency, existing technical skills applied to the operations and maintenance of diesel generators may be transferable to alternative energy technologies. Capacity can also be found in retired assets or in part-time or seasonal workers engaged in other sectors, contributing the financial, managerial, or technical skills and capacity to support local energy planning initiatives (Arctic Council & Sustainable Development Working Group, 2019; Cherniak et al., 2015; Hirshberg, 2020). At the early stages of planning for energy transition, it is important to clearly identify the existing capacity strengths in the community, including those reflected in transferable skills and retired assets, and their ability to reorganize and support local energy initiatives.

2.7 Skills Innovation

Compared to "non-green" jobs, "green jobs," such as those in the renewable energy sector, require higher levels of non-routine, creative problem-solving-type analytical skills (Consoli, Marin, Marzucchi, & Vona, 2016). Consideration of a community's access to innovative skills training and mentorship programs across a diversity of energy skillsets, from technical to managerial, is a requisite for local energy transitions. The community energy literature emphasizes that an essential benefit of local energy development is stimulation of the local economy via direct job creation in the renewables sector, coupled with new economic opportunities created because of access to secure, affordable, and sustainable energy (Brummer, 2018; Rosenbloom, Berton, & Meadowcroft, 2016). This suggests that maximizing the added value of energy transitions at the local level also requires access complementary skills training, such as those related to community development, legal, administrative, and entrepreneurial professions (Ortiz, Dienst, & Terrapon-pfaff, 2012). Based on energy transitions in rural regions of the Global south, for example, Miller, Altamirano-Allende, et al. (2015) argue that the design of energy systems must be symbiotic with the design of capacity-building or training programs to

support the diverse set of skills needed for the long-term transition of energy systems. Assembly of First Nations (2010) and Beatty et al. (2015) emphasize the importance of access to education and skills training across northern and Indigenous communities; not only to meet individual aspirations, but also to ensure longer-term community capacity building. An enduring challenge, however, is that not all northern and Indigenous communities have the same readiness or resources to access energy training and skills development programs (Cherniak et al., 2015; Mercer et al., 2017; NCCAH, 2017), and there is limited Indigenous representation in general post-secondary training programs to develop the skills required for local energy planning, implementation, and management (Advanced Energy Centre, 2015; Krupa, 2012). Access to skills development and training programs does simply mean that such programs are available – they must also be accessible. Accessible often means locally accessible, within the community or region (Arctic Council & Sustainable Development Working Group, 2019), or that sufficient financial or infrastructure (e.g., high-speed internet) supports are available to ensure access to non-local programs and skills-development opportunities (Assembly of First Nations, 2010). An important consideration when planning for local energy developments, and a requisite to longer-term energy transition, is thus the availability and accessibility of tailored educational and skills development programs to enable communities to develop and maintain energy projects and to build the long-term capacity to realize the added value of local energy transitions.

2.8 Next Generation Leaders

The Seventh Generation Principle means that the decisions made today about energy and resources should result in a sustainable world seven generations into the future. This generational thinking underscores the importance of youth engagement in community energy initiatives – the next generation of local energy leaders. (Nelson, 2019) argues that community leadership, governments, and the business community must embrace this concept of generational sustainability to ensure long-term community well-being. This means that youth must be active participants in sustainability initiatives and empowered with both capacity and opportunity to drive change (Billimoria, 2016), an argument reflected in the UN policy for youth, which targets youth engagement in the implementation of the global sustainable development goals. However, the majority of literature and guidance on youth in community energy tends to focus on assessing youth knowledge of renewable energy (Halder, Havu-Nuutinen, Pietarinen, & Pelkonen, 2011;

Yazdanpanah, Komendantova, Shirazi, & Bayer, 2015) rather than on the opportunities for youth to shape community energy futures.

Youth engagement is critical for the resilience of any socio-technical system in northern or Indigenous communities (Cherniak et al., 2015). As Beatty et al. (2015) explain, programs and pathways for engaging youth in community development are not only important for youth themselves, but to longer-term sustainability. Literature focusing on northern energy systems in particular emphasizes that youth are a critical catalyst for renewable energy (Arctic Council & Sustainable Development Working Group, 2019; Cherniak et al., 2015). (McCarthy & Morrison, 2020) argue that "this generation of Indigenous youth should be equipped to lead a clean energy army that would bring their energy, talent and, eventually, expertise to the challenges and opportunities that confront us." Youth engagement, training and development leads to youth leadership (Singh & Panackal, 2017), strengthening local ownership and longer-term capacity for maximizing the value of community energy projects. Identifying formal youth energy-related programs or initiatives within the community, or existing youth engagement within broader community development and social programs, is an important foundation for understanding the potential for youth engagement in local energy planning initiatives and goals-setting.

2.9 Summary

The conceptual framework above sets out the fundamental attributes for exploring current capacity and the capacity needs of rural and remote Indigenous communities in the north to pursue and sustain long-term local energy transitions. The conceptual framework and fundamental attributes are proposed for rapid assessments to guide the initial stages of community energy planning. These attributes are inter-dependent and overlapping, and emphasize the importance of: local energy champions and inter-local energy networks to enable knowledge sharing, innovation, and capacity building and inter-local energy networks to enable knowledge sharing, innovation, and capacity building across communities; articulation of community values and longer-term and overarching goals of energy transition, including the desirable cultural, social, or economic values and opportunities to be supported or created by a more sustainable energy system; community knowledge, including not only a community's understanding of their energy resources, technologies, and opportunities, but also the technical,

managerial and other embedded skills in the community to support energy transitions; and considerations of community futures, specifically, the skills innovation required to pursue and manage new energy systems coupled with the longer-term engagement of, and capacity building for, local youth – the next generation of community energy leaders. The framework presented in this paper is not meant to be predictive of energy transition success or explanatory of why some community energy projects succeed while others fail; rather, it offers conceptual guidance to the exploration of fundamental baseline capacities of a community prior to embarking on local energy initiatives. There is an opportunity for further indicator development to accompany the attributes presented in the framework, including adapting the framework to local contexts and applications.

Chapter 3 – Methods

3.1 Study Area

Gwich'in are one of the most northern Indigenous peoples on the North American continent, with traditional lands encompassed by the Richardson Mountains to the west and the Mackenzie Delta to the north (Gwich'in Tribal Council, 2022b). The Gwich'in people in the settlement area are represented by the Gwich'in Tribal Council (GTC). The GTC operates under the Gwich'in Comprehensive Land Claim Agreement, signed in 1992 (Gwich'in Tribal Council, 2022a). Many Gwich'in community members maintain summer and winter camps for hunting, trapping, and fishing – which remains culturally and economically significant for the communities (Gwich'in Tribal Council, 2022b). The vision statement of GTC is – "*the Gwich'in are a culturally vibrant and independent Nation that is environmentally responsible and socially, economically and politically self-reliant*" (Gwich'in Tribal Council, 2022c).

The community energy landscape varies across the North, but the study region reflects a typical setting in northern Canada in that the communities are off-grid and served by a government-owned energy utility. Inuvik, being the larger of the four communities and with a commercial airport, is more easily accessible than Aklavik, Fort McPherson, and Tsiigehtchic, which are served by seasonal road access from Inuvik. Each of the communities have different levels of investment in community-based energy projects, again reflecting the diverse energy landscape across the North and allowing valuable lessons to be learned for community energy in other northern and remote regions. Therefore, the focus of this research is the four communities of Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic, located within the Gwich'in Settlement Area (Figure 3.1). All four communities are members of the Community Appropriate Sustainable Energy Security Partnership, an initiative led by the University of Saskatchewan in partnership with northern and Indigenous communities, public and private sector enterprise, and researchers from Canada, Alaska, Sweden and Norway (see https://renewableenergy.usask.ca/Projects/CASES.php). All four communities are also off-grid communities. The Northwest Territories Power Corporation (NTPC), a crown corporation of the Government of Northwest Territories (GNWT), generates and distributes electricity in all four off-grid partner communities. NTPC supports over 30 communities across the Northwest Territories, most of which are dependent on diesel generators as the primary energy source.

Electricity rates in Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic are highly subsidized, with residential subsidized electricity rates at $0.306/kilowatt-hours for the first 1,000 kilowatt-hours per month from September to March, and for the first 600 kilowatt-hours per month from April to August. Unsubsidized rates are $0.684/kilowatt-hours (NTPC, 2022d, 2022b, 2022a, 2022f, 2022e, 2022g, 2022c).

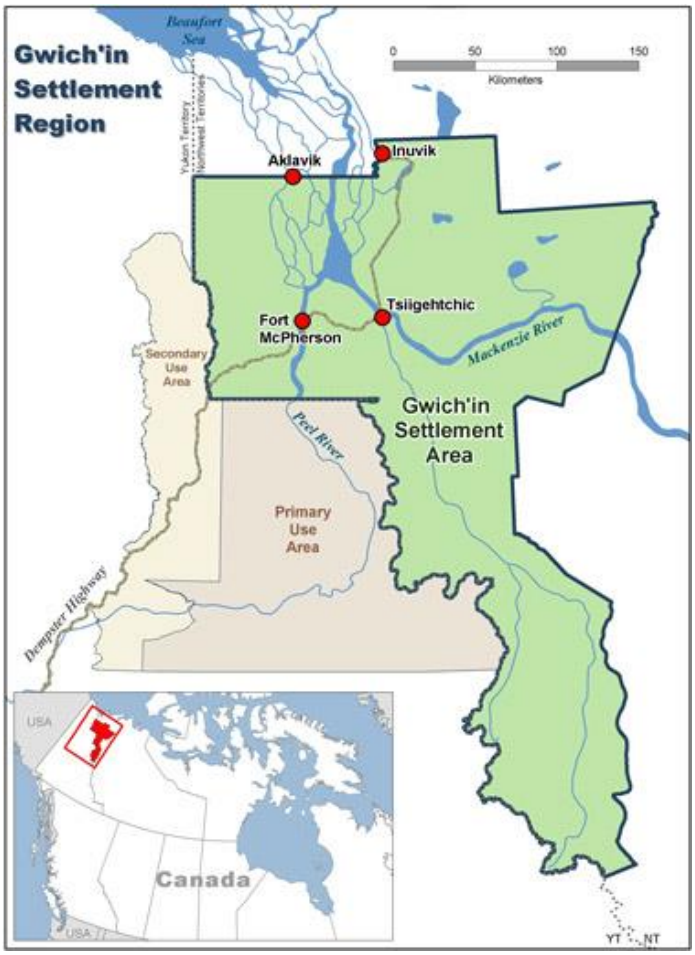

Figure 3.1: Gwich'in Settlement Area (Gwich'in Renewable Resources Board, 2022).

Aklavik is powered by variable-speed diesel-based generators, delivering electricity to approximately 300 households and other (e.g., commercial, school, recreational complex) buildings, and an integrated 55-kilowatt solar photovoltaic system – installed in 2017 (Table 3.1). Local solar initiatives include a solar water heater for the hamlet's swimming pool and solar

electricity systems on the recreation complex, staff residence, and local bed and breakfast. Residential heating is primarily heating oil supplemented by firewood (Arctic Energy Alliance, 2020a). Approximately 51% of annual energy use in Aklavik is for heating, primarily heating oil, followed by electricity (31%) and transport (19%) (Arctic Energy Alliance, 2020a). Aklavik has a community energy plan, emphasizing the importance of providing residents with the information they need to make wise choices about their energy use, the need to use energy and water in harmony with the land, and to make clean, affordable, and reliable energy the everyday norm (Arctic Energy Alliance, 2020a; Arctic Energy Alliance, Natural Resources Canada, & Hamlet of Aklavik, 2017). Sustainable energy futures and encouraging youth involvement in energy planning, and training for skills and development opportunities for community members are among the hamlet's key energy goals and priorities (Arctic Energy Alliance, Natural Resources Canada, & Hamlet of Aklavik, 2017).

Table 3.1: Community socio-economic and energy profiles: Aklavik, Fort McPherson, Tsiigehtchic, Inuvik.

Community	Socio-economic profile	Energy profile
Aklavik	Population (2021): 684 • 164 < 15 years; 95 > 60 years Employment (2019): 41.2% • mean family income (2019): $92,467 Residential tenure (2019): 222	Diesel-based generation • four 320 kw generators 55 kw solar PV system Residential heating: heating oil, firewood 4.2% of community's total energy in 2018 was renewables • 4% firewood (190 cords) • 0.2 % (59,900 kilowatts-hours) solar PV
Fort McPherson	Population (2021): 737, • 113 < 15 years; 162 > 60 years Employment (2019): 39.5% • mean family income (2019): $81,700 Residential tenure (2019): 242	Diesel-based generation • 1.83 MW plant Biomass district heating: 85 kw facility for community buildings Residential heating: heating oil, firewood 4.01% of the community's total energy in 2018 was renewables • 2% (236 tonnes) wood pellets • 2% (196 cords) firewood • 0.01% (4,100 kilowatt-hours) solar PV Waste heat recovery system: 1,160,000 MJ
Tsiigehtchic	Population (2021): 190 • 31 < 15 years; 28 > 60 years Employment (2019): 53.4%	Diesel-based generation • three diesel units, totaling 510 kw Residential heating: heating oil, firewood 5% of the community's total energy in 2018 was renewables

	• mean family income (2019): $110,500 Residential tenure (2019): 60	• 100% firewood (68 cords)
Inuvik	Population (2021): 3,303 • 730 < 15 years; 473 > 60 years Employment (2019): 68.3% • mean family income (2019): $126,832 Residential tenure (2019): 1,180	Diesel-based generation • installed capacity of 6.2 megawatts Gas power plant • 3 LNG-fueled generators (7.7 MW) • trucked-in LNG fuel 3.4% of the community's total energy in 2018 was renewables • 2% (787) cords from firewood • 1.3% (600) tonnes from wood pellets • 0.1% (180,000 kilowatt-hours) solar PV Waste heat recovery system: 2,510,000 MJ

Sources: (Arctic Energy Alliance, 2020a, 2020b, 2020c, 2020d; Cherniak et al., 2015; NTPC, 2022a, 2022b, 2022d, 2022f; NWT Bureau of Statistics, 2022a, 2022b, 2022c, 2022d).

Fort McPherson is also powered by diesel-based generation, coupled with a waste heat recovery system that gathers 1,160,000 Megajoules off of the diesel generator, and an 85 kilowatt biomass project (Arctic Energy Alliance, 2020b; Cherniak et al., 2015). The biomass project was installed in 2013 to heat the Band office and community health centre with a district heat system – the boiler is able to burn cordwood, wood pellets, and wood chips. The project in intended to ultimately only burn wood chips from locally harvested willows, creating additional employment opportunities within the community (Cherniak et al., 2015). Transportation comprises the majority of annual energy use in Aklavik (55%), followed by heating (29%) and electricity (17%) (Arctic Energy Alliance, 2020b). Home heating is primarily heating oil supplemented with firewood. Fort McPherson does not have an energy plan. The community engaged in a climate change adaptation planning project in 2011, funded by Indian and Northern Affairs Canada. Included in that plan is a vision that, by 2050, the community will be "a resilient, self-sufficient community that celebrates and practices its culture and promotes renewable economic development within its traditional lands" (Ecology North, 2011).

Diesel-based generation is the primary source of electricity in Tsiigehtchic, with heating comprised mostly of heating oil supplemented with firewood. Approximately 47% of annual energy use in for heating, followed by electricity (32%) and transportation (22%) (Arctic Energy Alliance, 2020d). Tsiigehtchic has a climate change adaptation plan, developed in 2010 under the

same Indian and Northern Affairs Canada program as Fort McPherson, and shared the same vision for community resiliency and self-sufficiency by 2050 (Ecology North, 2010).

The primary energy sources in Inuvik are synthetic natural gas and diesel-based generation. Inuvik, the largest of the four communities, has a gas power plant comprised of three gas-fueled generators with a total installed capacity of 7.7 MW. Liquefied natural gas powering the generators is trucked in from southern Canada. The community's diesel power plant has a total installed capacity of 6.2 megawatts. Other known energy investments in Inuvik include solar photovoltaic projects on the Aurora research institute, Gwich'in centre, the town hall, the recreation complex, and two housing units at approximately 28.2 kilowatts in size (Cherniak et al., 2015). Additionally, there is a waste recovery unit on the power plant's natural gas-fired generator that gathers 2,510,000 Megajoules. Approximately 40% of annual energy use in Inuvik is for heating, followed by transportation (32%) and electricity (29%) (Arctic Energy Alliance, 2020c). Inuvik has a community energy plan, established in 2010, which outlines five long term goals, including increasing spatial efficiency of the community, improving the health, safety, and energy efficiency of buildings, promoting alternative modes of transportation within the community, increasing opportunities for renewable energy supply, and pursuing energy efficiency and conservation within the broader context of sustainability (Kavik-AXYS, 2010).

3.2 Data Collection

Data collection occurred through semi-structured interviews with community members from the four respective partner communities, Gwich'in leadership, and representatives of the energy sector and intermediary organizations. Interview-based research allows the researcher to conduct in-depth exploratory interviews, where the individual is allowed to talk openly about a structured topic (Cresswell, 2008). Interviews were audio-recorded, lasted up to 60 minutes, and were completed in collaboration with the CASES Northwest Territories (NWT) team. For the energy sector and intermediary organization representatives, the intent was to conduct interviews at the representative's place of work or by phone. For the community member and Gwich'in leadership interviews, the intent was to host two community workshops in each community to present on energy data and host discussions groups. Following the workshops, it was also planned to conduct in-person semi-structured interviews with community members and community

leadership. However, data collection plans were tremendously impacted due to the COVID-19 pandemic, given travel restrictions to northern communities.

Planned interviews at the various key informants and community leaders' places of work were no longer possible; consequently, the CASES NWT team conducted interviews over the telephone or through online videoconference. Due to the pandemic, the community member and community leadership workshops were also no longer possible. The revised strategy for the community member interviews consisted of hiring and training Indigenous youth researchers living in each respective community in collaboration with Gwich'in Tribal Council. The youth researchers conducted the interviews in person and over the phone with the community members.

The selection of participants for the key informant interviews occurred in collaboration with the CASES NWT team through the initial identification of those with relationships with the project leaders and project partners. From there, a snowball sampling design was used to identify others to interview. This occurred by asking interviewees if they could think of anyone who would like to participate or who might have an interest in community energy. Community member interviewees were also selected by a snowball-type sample design led by the youth researchers. The CASES researchers completed 21 Gwich'in leadership, energy sector representatives, and intermediary organization representatives' interviews, while the youth researchers conducted 74 community member interviews. The distribution of the interviewees across the five participant groups is shown in Table 3.2.

Table 3.2: Research participants.

Participant Group	Participants	Number of Participants
Aklavik	Community members	14
Fort McPherson	Community members	20
Inuvik	Community members	25
Tsiigehtchic	Community members	15
Gwich'in Leadership	Gwich'in Tribal Council leadership	10
Energy Sector	Utility representatives	2
Intermediaries	Intermediary organizations	8
	Total participants	**94**

Questions were designed by the CASES research team and explored several themes, including questions about: the importance of energy for everyday life in the community; local leadership and resources to pursue energy initiatives; relationships between communities and between communities and utilities and intermediaries in terms of supports for local energy initiatives; community energy needs and future opportunities from secure and sustainable energy systems; the types of local investments required to ensure a secure energy future; knowledge about the community's energy supply and energy security; training, human resources, skill sets, expertise, and support programs to develop local energy and sustain energy transition over the long-term. Because this research was part of a larger project, additional interview questions were asked about regulations, energy consumption patterns, and historical changes in energy systems that extended beyond the specific scope of this thesis. Research ethics approval was received under the umbrella of the CASES project from the University of Saskatchewan Behavioural Research Ethics Board and a northern research license secured from the NWT research licensing board. All interviews were recorded and transcribed verbatim.

3.3 Analysis

Analysis of interview data was informed by the conceptual framework presented in

Table 2.1. Using the conceptual framework as guidance, interviews were first coded in NVivo 12 based on the defining attributes of community baseline capacity for energy transition and identifying whether each attribute, if discussed by the participant, was referred to as an existing strength or capacity challenge or limitation in the community or region. The number of participants who identified a given attribute was recorded across all interviews. This allowed the data to be analyzed to represent the frequency of occurrence across all participants versus the repetitive frequency within conversations.

The subthemes were then explored further based on the respective participant groups (Table 3.2) by community and rolled up to capture a regional perspective whilst being sensitive to participant group and community nuances. Understanding the regional perspective, comprising community members, community leadership, intermediary, and energy sector conversations,

provided for a holistic understanding of patterns of opportunities and challenges for energy transition across the Gwich'in region.

Finally, since the conceptual framework guiding the analysis was derived based on global academic literature and guidance, it should not be assumed that these attributes adequately capture local conversations about socio-technical baseline capacities for communities in the North. Therefore, an additional round of coding was done for all 94 interviews in an effort to identify any emergent and recurring themes that did not align with, or map to, the attributes identified in Table 2.1.

3.4 Constraints

There were external constraints to this research, the most significant of which was the COVID-19 pandemic. Due to travel restrictions implemented just before planned community research, the CASES researchers could not visit the partner communities. Consequently, all efforts CASES researchers made had to be done remotely. Therefore, we relied on local youth researchers to collect data and represent the research through the CASES partnership. The youth researchers were a significant component of the successes of the remote research, especially in reference to resolving limitations of participants' eagerness to participate.

A concern identified in the initial research design was whether community members would be willing to openly discuss their experiences and thoughts related to specific topics with outside researchers, even though a formal partnership with Gwich'in Tribal Council had been established. Relying on youth researchers to conduct the interviews in person or over the phone with community members in their own community alleviated some of this concern. At the same time, however, the youth researchers did not probe as deeply into some interview responses with follow-up questions as may have been the case with graduate student researchers. For community leaders and key informant interviews, being conducted remotely was a challenge to securing their participation, despite providing ample information of what the research and conversation would be used for in the future.

An additional external constraint came shortly after the research began, in the form of a Gwich'in leadership election. This added an additional time constraint as a relationship had to be built with the new point of contact at Gwich'in Tribal Council to redevelop relationships with

GTC leadership to further the research. The COVID-19 pandemic restricting access to communities for field researchers, coupled with a change in Gwich'in leadership, caused delays to the research process and limited the ability to interact with community members to build stronger relationships.

Chapter 4 - Results

"I think what you're doing is a really good thing, because you're asking our opinions" [Interviewee, Tsiigehtchic]

This Chapter presents results of the socio-technical capacity assessment for energy transition across the four Gwich'in communities. Results are presented holistically for each attribute as a Gwich'in region – identifying strengths and challenges across the four communities. Across the region, *community energy values* was the most frequently discussed attribute by interviewees, raised by 96% of participants and across all participant groups (Table 4.1). This was followed closely by *embedded energy skills*, identified by 83% of interviewees, and *skills development*, discussed by 77% of participants. In sharp contrast, less than one-third of participants discussed topics related to *inter-local energy networks* and *energy champions* – essential aspects of community energy leadership and local capacity to transition energy systems. The largest proportion of interviewees who raised these two attributes were those representing GTC leadership, followed by those from intermediary organizations. These attributes were also raised by participants from the energy sector and from each the four communities, but at a lesser scale.

Table 4.1: Social capacity attributes as a strength vs challenge, across the four study communities, to support community energy transition.

Social Capacity Attributes	**Perspectives on current capacity**[1]	
	strength	*challenge*
Local energy champion(s)	*6*	*12*
Inter-local energy networks	*9*	*20*
Community energy vision	*7*	*4*
Community energy value	*83*	*25*
Energy literacy	*14*	*38*
Embedded skills	*59*	*29*
Skills development	*19*	*62*
Next generation leaders	*13*	*4*

[1] Number of interviewees who identified current capacity strengths or challenges. Numbers for any given combination of 'strengths' and/or 'challenges' (rows and/or columns) do not add to the total (n = 94) because not all interviewees addressed every attribute. For a given attribute, some individuals identified *both* strengths and challenges.

Based on the ratio of strengths to limitations as identified by study participants when speaking to the various attributes of community energy capacity, several important observations emerged that illustrate key strengths and key challenges to energy transition (Figure 4.1). At the aggregate scale, across the four communities, the presence of community vision to guide energy transitions, and shared community energy values, were identified as essential and existing strengths. This was often expressed as values seen through the lens of cultural considerations, community considerations, or social and economic considerations. An additional strength identified by participants was the presence of next generation leadership to facilitate long-term community energy transitions and ensure long-term socio-technical capacity. This was often discussed in terms of the importance of youth and youth involvement in community initiatives in general, but also in terms of youth interest in energy transition or through energy-based curriculum within the school system. A final existing strength identified was embedded skillsets, as part of a community's existing energy knowledge. These embedded skillsets consider energy-relevant skillsets, such as technical, managerial, or financial skillsets. It also includes skillsets among retired community members and the resilience of skills in terms of people's ability to adapt skillsets to new technologies or opportunities.

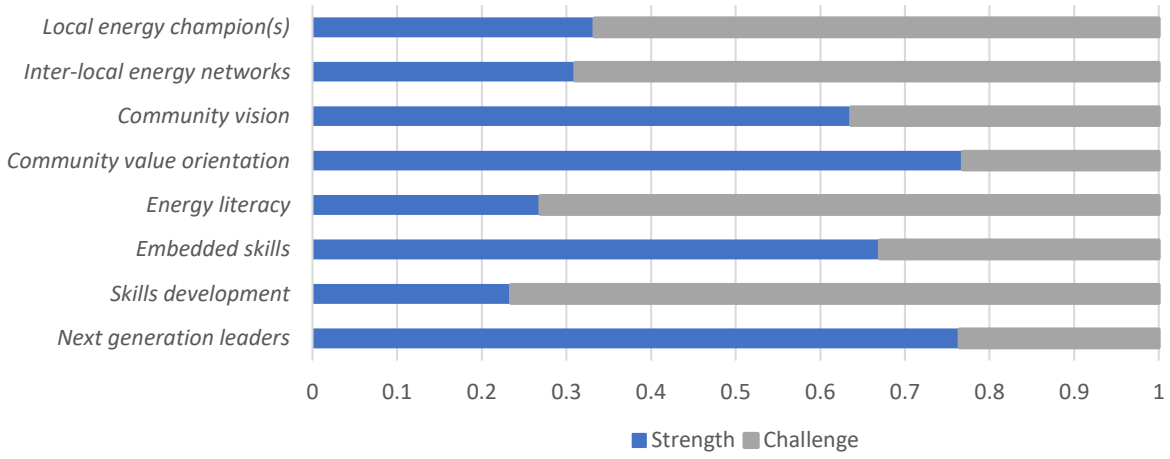

Figure 4.1: Ratio of baseline community capacity strengths to limitations for the study region as derived from interview data.

Note: Ratio is based on total number of interviewees identifying strengths vs. limitations related to each attribute of community capacity.

The two most definitive capacity challenges identified by participants were intertwined - the first was energy literacy; the second was opportunities for skills development (Figure 4.1). Energy literacy considers both existing energy literacy within the partner communities and the access community members have to energy literacy training, workshops, and education opportunities. Skills development considers opportunities for training and capacity development, such as access to training, workshops, and education to develop skillsets relevant for energy planning and transition efforts. At the most fundamental level, these two identified challenges represent a lack of local access to education and training opportunities, whether for enhancing and developing energy literacy or for specific skills development in areas of expertise such as technical, financial, or managerial skillsets. Closely following these two main challenges were those associated with limited development of inter-local energy networks to facilitate knowledge sharing and support across communities and with communities in other regions, and the lack of capacity to support local energy champions to drive community energy initiatives (Figure 4.1).

However, the *regional* picture is complex, with different communities exhibiting different strengths and challenges across different attributes. But, as a region, results indicate that the four Gwich'in communities have many opportunities, collectively, and exciting prospects to support each other's challenges and share each other's possibilities to further the region's energy planning, transitions, and developments through regional energy networks and support systems. A more nuanced analysis of results, exploring perspectives on each attribute across participant groups and communities, is presented in the following sections.

4.1 Local Energy Champion(s)

When interviewees discussed the role of local energy champion(s), most referred to current challenges. The dominant concern was the lack of people resources to provide energy leadership at the local level. Interviewees from Tsiigehtchic, Aklavik, and Fort McPherson explained that not having designated energy champions or sufficiently resourced ones at the local level means missed opportunities for communities to pursue renewable energy initiatives. For example, as explained by a community member of Tsiigehtchic: "*there's lots of pots of money out there for energy sources, but we don't have anybody in our office that can utilize those funding pots to get started, to get studies and reports done, and to get that money*." GTC leadership indicated that

these challenges are known, and there is ongoing consideration of how to improve this dimension, explaining: "*I'm really pushing my self-government negotiation to learn more about project management… trying to develop that skill amongst those that really need it or at least going forward*." The overall sentiment, as captured by an interviewee from GTC leadership, is the current challenges to community energy leadership are more so capacity-related than the lack of prioritization of local energy, noting that "*we're* [Gwich'in Tribal Council] just *a much smaller organization…we just don't have the people and enough manpower to be able to move projects forward always or even go after all the grants that we would like to*."

The scenario was quite different in Inuvik; however, the largest of the four communities, where the existing presence of local energy champions, specifically the Arctic Energy Alliance (AEA), was considered a key strength for advancing local energy initiatives. For example, an Inuvik community member explained, "*they have a staff of four or five in that Arctic Energy Alliance office, locally… those are the key people who deal with those particular issues*." Interestingly, although AEA's mandate is to support all communities in the NWT (Arctic Energy Alliance, 2022) with an office in Inuvik, the AEA did not emerge in discussions about local energy champions outside Inuvik, in the three smaller Gwich'in communities.

Despite these challenges, it should not be assumed that the communities have no local leadership to advance community energy. From the perspective of Gwich'in leadership, there are energy champions in each community. These individuals may not carry an official title, but they are described as energy champions through their traditional way of life:

> "*I believe there's a lot of folks in each of the communities who are energy champions in their own way…I mean that in the perspective of the traditional way of life and …what they're doing in the local level, just naturally. They're not stepping out or being highlighted as they are the energy champion, but you just know, in the communities, who sets the example. Who's taking the initiative to lead peaceful protest walks and rallies and those sorts of things that focus on environment and protection and energy and that sort of thing are those or those who are just demonstrating recycling, reducing, that sort of way of energy champions.*"

A community member in Tsiigehtchic shared a similar perspective about the presence of local energy champions embedded in the community way of life. The interviewee expressed concern about imposed leadership from outside the community, specifically the federal government, indicating that "*the federal government still treats us like we're in Residential School…its like, "We know what's best for you," even though [they] live in Ottawa… haven't come to our community... haven't seen the geography or the terrain and you haven't spoken to our Elders, you haven't spoken to our youth…".* Referring to the potential for biomass energy development, the interviewee explained that "*our experts are Elders that have been burning wood for years, that know--they know how fast willows grow and know the terrain. They know all those things and it's just put into a proposal and ask for money to make things better, so that the community grows and the community saves and the community prospers, but when the funders question all that, it's not good."*

4.2 Inter-local Energy Networks

Inter-local energy networks, inclusive of communities' access to regional resources and collaborations, were described as a significant challenge by 20 interviewees, whereas nine spoke to existing strengths. Those who spoke to strengths referred more so to the recognized desire for the stronger community to community or regional collaborations as opposed to existing, formal networks and opportunities per se.

An interviewee from an intermediary organization suggested that sister communities or community energy networks do not exist across the region, explaining that "*the only time that there's sort of connection in sister communities is really, for instance, if Fort McPherson and Tsiigehtchic, who are brother-sister communities – one of them gets solar panels and the other one will be like, "Well, I wanna take part in that too."* The interviewee described this not as a network per se but rather an *"if it works here, it'll work there"* approach. This perspective was echoed by a community member of Fort McPherson, emphasizing the desire for greater collaboration and support networks across communities but the limited resources for doing so. The interviewee suggested, "*we would love to share our knowledge, but a lot of times, too, you get bogged down in your own business … to connect with another community would take more time and more effort."* Drawing on the community's existing biomass project, the interviewee

connected the challenges to collaboration with the constraints to resourcing local energy champions, noting that *"if we had a whole department just on biomass and all of the aspects of biomass, then that department could focus on getting the community running as well as it can in sustainable energy and then, sharing that, eventually sharing that, with the other communities."*

Similar perspectives were shared by GTC leadership, noting that "*we haven't had too much of that time to really collaborate and do exchanges."* Tribal Council capacity was said to be a significant obstacle to facilitating such networks, in that the GTC doesn't have a staff member whose main role is to coordinate such projects and advance these innovations, and that the absence of such a regional coordinator role is "*…probably one of the main reasons that things haven't had the big focus and exchanges that they should*." Another interviewee from GTC leadership acknowledged this concerns constraint. Still, he noted the complexity of working across communities to establish such regional networks, explaining that because community energy goals and projects are locally defined, "*that level of collaboration looks a little bit different… it would look different in communities like Aklavik, which is a shared community with Gwich'in and Inuvialuit, as well as Inuvik."* The interviewee emphasized room for more collaboration but that no person or organization exists to drive and facilitate it.

Interestingly, from the perspective of local community member interviewees, there is a shared need and desire to participate in such inter-regional networks and an opportunity for such networks to be developed based on existing energy experience and knowledge available in other communities. For example, a community member in Tsiigehtchic emphasized the importance of collaborations and learning across communities, noting, "*that's something we could certainly learn if we visit the two communities of Colville Lake or Old Crow, where they have solar energy projects. And we can certainly find out from them what kind of funding it took to get to that stage, what kind of training they offer their people … those two projects, those are the two immediate ones I can think of right now that are close by."* The participant emphasized the opportunities gained from learning about the opportunities and solutions from community frontrunners, noting that it would be beneficial to inform and support local energy projects.

Finally, some participants also raised the need for improved networks between governments, not only communities, to enable community-to-community learning and share resources,

innovations, and expertise. As explained by an Inuvik community member, "*we have to seek partnership out of our – not only in the – community; maybe out of the country, as well."* This illustrated the need for government-to-government energy networks, "*not only our territorial government, but between the Inuvialuit and the Gwich'in…to work together to mutually be beneficial, rather than what we see a lot of, now, is one government sort of against each other."*

4.3 Community Energy Vision

When interviewees discussed the role of a community's energy vision, most referred to the strengths of their community's existing vision for an energy future. Across all communities, energy cost savings was raised as a primary concern. For example, an interviewee from Fort McPherson spoke to viable opportunities that could come from local energy development, particularly a biomass, explaining that a small biomass operation for heating the community's grocery/supply store could reduce the current fuel-based heating bill from *"15 to 20,000 a month from November to April every year…down to about seven to 10,000"* noting *"that's major savings for us, it really is, That's 50 to 60% savings."* The acknowledged the up-front financial investment costs but explained that "*ten years down the road it's gonna be well worth it; it really is."* Similar drivers of community energy vision were identified by interviewees from Tsiigehtchic and Aklavik, typically emphasizing immediate cost savings. As explained by an interviewee from GTC leadership "*if you talked to the ordinary person on the street, that's what they're going to be concerned about – paying their bills. The rest of it is important and it is a motivator, yes, but cost is going to be the primary driver."* Another interviewee from GTC leadership, however, suggested that cost savings and energy independence are not separate, explaining that self-determination or energy independence is the primary driver of energy visions in the region, and "*everything else flows from that; if you have energy control locally, you can make better decisions about how you spend that energy, and what you do with it."*

Limitations or challenges to community energy visions were identified *only* by interviewees from the energy sector and intermediary organizations, who emphasized a lack of energy vision in the region and a lack of cohesion. When an energy sector interviewee was asked about community energy vision within the partner communities, the participant highlighted that the challenges of energy transitions are rooted in energy vision challenges, where a cohesive

collective vision is lacking: *" it comes back to that vision, that's exactly what I would like to see., as I've said, even with the GTC, we're not seeing a cohesive group."* One intermediary interviewee identified the benefits of a strong community energy vision, from energy sustainability and security to improved health, but emphasized the *"encouraged dependency"* that exists a result of colonization, explaining that *"healthy ways of working through that are happening, but its taking time…it's going to take a while to get into a better state."* The interviewee suggested that to expect a community to articulate a clear energy vision is not realistic at the present time, explaining:

> *"People have been encouraged to be powerless, and dependency has been the system in place for quite a while. To suddenly expect people to turn around and become independent and, you know whatever, is not realistic. It takes time. And there's a lot of anger and things that need to be worked through."*

4.4 Community Energy Value

Community values, inclusive of a community's social and cultural values, were raised by 83 interviewees as a significant factor in driving energy transitions, whereas 25 individuals spoke to existing challenges of energy options in supporting community values. Environmental values, reinvesting in the community, independence, and preserving cultural values and practices were the dominant topics of conversation around community values in relation to energy. For example, as explained by an interviewee from GTC leadership, most community members are environmentally concerned, they "*want things done with climate change and global warming, just being stewards of the land… they want to see cleaner sources of fuel that we're using to heat our homes and drive our vehicles and everything."* But, for most community member participants, a dominant theme was the added value to local communities from having a secure and affordable energy support and ensuring that the benefits of local energy developments accrue to the entire community. For example, a community interviewee from Inuvik stressed the importance of the whole community needing to benefit from local energy, and that if a community had greater access to and control over local energy, "*it'd be a lot of money going back into the economy and into the schools and into everything…there'd be programs and money to fund programs... for the community.*

An additional participant from Inuvik similarly emphasized that for daycares, schools, and recreational centers – all of which are highly-valued community services – "*if you could lower their operating costs, they could deliver more programs/services, so there's benefit there if you can do something…[if] you have gas, or you have wind, solar, and battery bank."* An interviewee from GTC leadership echoed these comments, noting the value that local energy developments could bring to the communities, but emphasized the larger opportunities it would create – specifically, supporting greater self-determination and breaking the *"long history of colonial policies and colonial approaches telling us how we need to do things."* In this context, the participant spoke to the importance of local knowledge holders in the communities, who understand the land, shape local value, and can provide guidance to those that make important decisions about community futures.

Closely related, participants across all four communities emphasized preserving the land and maintaining cultural values as prominent factors when discussing community values toward energy – values that need to be supported under any energy mix. For example, an interviewee in Fort McPherson explained that wood is important for home heating, because sometimes some people don't have jobs and can't afford the fuel oil. However, even community members who use wood for a heat source still need fossil fuels – they still need affordable fuel for their skidoos to harvest that wood, or for generators at cabins or when out on the land. The participant also raised the importance of fossil fuels for Elders within the communities, noting that *"diesel is important, especially for people that are Elders and people that and need heat and…for people that don't have stoves, they need that diesel."* That said, the affordability of fuel to support local way of life and access to the land was a concern raised across all communities. A participant from Inuvik spoke to the effects of energy costs on hunters and trappers, noting that "*a lot of our hunters and trappers can't go hunting and that because the cost of gasoline is too high. I've got a boat, but I don't use it as much as I used to because the price of gas is quite costly. I know a lot of our elderly hunters and trappers that want to get out there, they can't afford to. It's just too expensive."*

Of those who spoke to challenges, 21 of the 25 participants were community members, 2 participants were representatives of intermediary organizations, and 1 participant was from GTC leadership and the energy sector respectively. Of the community members who commented on

the challenges of community energy value, most suggested that the community's energy situation does not currently impact traditional practices within the communities. For example, from the perspective of an interviewee from Tsiigehtchic, when asked if the current energy profile impacts traditional practices, *"I don't think so… 'cause if you're gonna be going hunting, trapping, or fishing, the only energy you're using is your snowmobile, your boat, which is not really energy."* This may reflect how participants understand energy security in their communities, disassociating energy for electricity and heating, and the costs of energy, from energy sources used for other purposes. All interviewees from Tsiigehtchic, Fort McPherson, and Inuvik who commented on the challenges of community energy value described negligible impacts, positive or negative, of energy transition on traditional practices.

Interestingly, Aklavik participants who commented on energy values offered only a lukewarm perspective on the value of energy transitions. One participant, for example, referenced previous investments in renewable energy developments, indicating "*they setup solar panels a while ago, haven't seen much change though."* This relates to a perspective presented by an intermediary organization, who suggested that some community members were upset after the solar farm development and referring also to an abandoned wind farm proposal in a neighbouring community. The participant went on to explain, however, that this may have more to do with planning processes and consultation than local values about renewables, in that *"the community has to live with it, they need to know about it, they need to want it, they need to approve it or else it's just not right."*

4.5 Energy Literacy

Energy literacy, inclusive of communities' existing energy literacy and access to energy literacy programs, was described as a challenge by 38 interviewees, whereas 14 spoke to existing strengths. Interestingly, those who spoke to strengths were representatives of either GTC leadership, intermediary organizations, or the energy sector – but even those participants were conservative about the level of energy literacy that existed in the communities. An interviewee from GTC leadership explained that most community members understand that diesel is a main fuel source for community heating, but beyond that most would not understand the details of how the system actually worked. The participant explained: "*if you were to go ask people what*

does the Aadrii Joint Venture do, I don't think many people in Fort McPherson would actually know that...this joint venture is taking heat from the diesel system and circulating it other areas of McPherson, mainly the school." An additional interviewee of GTC leadership provided a similar illustration for Aklavik, noting the community's *variable speed generator and solar system, in that "both things were installed and no one knows what they are", identifying* an overall lack of understanding of the energy supply chain from source to home.

The deficit of energy literacy programming across the communities was identified as a major challenge. A GTC leader identified only the efforts of the AEA on raising awareness about energy use and emissions, but no broad-scale community energy literacy efforts. Similar concerns were evident from community interviews in Aklavik, Fort McPherson, and Tsiigehtchic. A participant in Tsiigehtchic, for example, emphasized *"we can't keep relying on non-renewable energy like oil and gas, it's not good for the planet, it's not good for the environment"* and went on to note that greater efforts are needed to improve energy literacy in the community, specifically: *"if we could start having our kids thinking of those, maybe we can not only cut down on the climate change, but I think we could really have a community that thinks energy efficient."* Similar concerns about energy literacy were also voiced by an interviewee in Fort McPherson, who also expressed the need for more community education on how *"it will save them money and how it will save the environment."* Responses were slightly different in Inuvik, where community participants indicated that there has been a lot of prior work on energy literacy programming. This may suggest an imbalance across the Gwich'in communities in terms of access to energy literacy development opportunities; as one interviewee noted: "*they've done a lot of workshops. But I just don't think the message is getting out there*."

Overall, across all participants, when speaking about the need for improved energy literacy a dominant focus of community interviewees was on enabling a better understanding of energy efficiency, as opposed to understanding energy production, distribution, use, and opportunities more broadly. This was reinforced by a participant from an outside intermediary organization:

> *"A lot of the energy literacy…tends to focus on how to conserve energy in your house, changing the LED lights, that kind of thing. And that kind of energy literacy is good of course, because you're reducing your energy consumption which is good. But it really doesn't help people understand how electric power systems work in the first place."*

4.6 Embedded Skills

When interviewees referred to the embedded skillsets within the communities, most referred to the strengths. When challenges were raised, they were raised primarily by interviewees from intermediary organizations. For example, one interviewee stated that their organization could provide the technical resources for communities, suggesting that communities do not have the skills needed to support energy transition – a perspective that does not align with the community perspective presented by multiple community members.

In Aklavik, Fort McPherson, and Tsiigehtchic, multiple interviewees raised specific skillsets within the community, such as technical, managerial, or retired skillsets that could support local energy initiatives. In Tsiigehtchic, multiple interviewees mentioned how one community member had taken solar panel installation training. An interviewee from Aklavik spoke to the resilience of technical skillsets within the community, especially for the community's variable speed generator, in that "w*e have everything in house…we have our own techs.*" The interviewee explained that it's not necessary to have such skillsets in every community, and that *"it's only on special stuff that we bring in people…like to do the generator re-windings - that goes out every 3 or 4 years, so it just wouldn't make sense to hire someone to stay there."*

An interviewee in Fort McPherson brought up existing technical skills within the community related to biomass (e.g., training on the woodchipper) but emphasized the lack of business development skillsets, explaining "*let's say we wanna do a proposal, then we'd have to get the consultants to help do that."* Interestingly, however, another community member provided an opposite perspective, indicating uncertainty as to whether the community had sufficient technical skill sets but emphasized existing and retired business skill sets: "*there are many people that have managed businesses, and lots of people that have qualifications and training to help with that"*

Participants in Inuvik offered similar observations, with participants identifying retired individuals with electrical and other trades who could provide the skills for simple solar installations: "*from kids and Elders who have certain trade skills, that or even just Elders-people who have retired but have certain trade skills like electrical… that would be useful for doing stuff simple as setting up solar panels at a cabin, for instance*." Another interviewee

focused on transferable skills, especially in the mining and oil and gas sector, explaining "*there are a lot of people with a lot of really good skills here that they've developed for heavy equipment operators or drilling and things like that, that are very easily transferable and then, they could be retrained into working in renewable energy."* The participant also spoke to the impact these community members could have on long-term energy transitions within the community, indicating that these existing skill sets *"would go a long way towards really making a solid, redundant energy infrastructure that is sustainable up here… they just need the training to transfer over.* However, Inuvik was unique from the other communities, as there were references to a broader range of embedded skill sets within the community, versus pinpointing one strong skill set. That said, participants still identified the limitations to existing skill sets for local energy, and the need to still bring in specialized skills from outside the region when needed to resolve new challenges or to address new technologies or complex problems.

Across the region, a dominant perspective was the availability of existing, potentially transferrable skill sets to support local energy developments. As summarized by an interviewee from GTC leadership:

> *"There's definitely people who I think have the ability to be able to be trained very quickly. We have a unique group of older men specifically who have worked in the oil and gas field and probably dropped out of school when they were about 15 for oil and gas money because why would you not do that. To work on the oil rigs. And then when oil left, there was no jobs. So, there's definitely a lot people who have passed experience in more technical kind of jobs who I think those skills could just be upgraded."*

4.7 Skills Development

Interviewees from all four communities spoke to the importance of and need for greater access to training opportunities, from how to maintain biomass boilers, to solar designs and installations, to wind, waterpower, electrical and other skill sets. In addition to technical skills, participants identified the need for access to financial and business skills development to assist in securing and managing energy development projects. Explained by an interviewee from Inuvik, *"we also need the training on the finances to maintain that and to budget and to invest… our Band have struggled with in the past with our business deals…I just think that we need to invest in ourselves and we need to know how to invest in ourselves."*

The accessibility of training programs within the communities, however, was a significant challenge raised by most all participants. Interviewees from all four communities commented on a lack of access to training opportunities, especially locally. For example, an interviewee from Inuvik explained that there are limited training opportunities in the region. There are individuals from outside the region, such as solar installers, who will help train local people during installs to help with maintenance, and *"they will help find funding for them to go down south to be more well-versed."* However, a community member from Tsiigehtchic raised a sharp contrast in terms of local access to skills development training in their community versus the opportunities available to the larger town of Inuvik:

> *" They've just sent us a little poster that we post up. There's nobody that comes into the community or even has phoned our office and said, "We're based in Inuvik." Or "We're based in Yellowknife, and we're taking care of your community, and we want you to know that we have so much money in our budget for your community, and is there people that we can be talking to, to access this program?" Nobody does that training."*

Interestingly, an interviewee from an intermediary organization indicated *"there are programs that exist"* such as through the Arctic Energy Alliance and Indigenous Clean Energy Network. The interviewee indicated that GTC has partnered with these organizations on energy education and outreach, but "the challenge has been that communities typically don't have the resources to do that, for having people in the community that manage energy and energy efficiency." For an interview from GTC leadership, however, a major constraint was that most formal skills development programs that do exist require a background educational level that makes the programs largely inaccessible to local community members. As described by the interviewee, "*the educational incentives are at a much higher degree …incentives for studying at a master's level when we don't have anyone,"* noting that few to no opportunities or incentives seem to be available for people to train technically on specific energy at any level other than masters. The participant went on to explain that what is needed is local access to diploma-based training or technical certification: "*We just don't have very many people who are getting to the Masters level and if they are, then they're not really interested in coming back here."*

In Aklavik, Fort McPherson, and Tsiigehtchic, however, community interviewees often identified opportunities to support skills development by way of more informal training and local mentorship – specifically, community members being trained by other community members who have received formal training. For example, an interviewee in Fort McPherson referred to an individual trained to operate the woodchipper for biomass energy, and the opportunity to provide hands-on training to other community members, especially youth, noting that "*the training part is not in the youth's mind right now, but once they get going, it'll flow*."

4.8 Next Generation Leaders

Few interviewees focused specifically on the role youth in their community regarding energy futures. However, in the conversations where the topic did emerge the majority referred to next generation leaders as a current strength within the communities. However, four interviewees referred to the challenges of next generation leaders. Three of which were presented by community members from Tsiigehtchic and Inuvik – which focused on social challenges within the school systems and the need to develop energy education curriculum within the school systems. One was presented by GTC leadership, who suggested that energy education existed in the school systems, but that it is it not at the level that it should be.

The strengths of future leaders were identified by participants from each of the communities, intermediary organizations, and Gwich'in leadership. From the perspective of an intermediary participant, the renewable energy sector is growing in the North; referring to Aklavik's solar energy installation: "if you are a student and you've never seen a solar system and all of the sudden you get one, and it peaks your interest, it might encourage you to follow that as a career." Gwich'in leadership participants also spoke to the value of having an example of an energy development accessible to the students in terms of sparking their interest to pursue energy-related careers. One participant referred to the high school in Fort MacPherson, which is heated by biomass, noting "that's an example right where they are where renewable energy is happening right in their community."

Gwich'in leadership participants also spoke to existing opportunities within communities to engage youth in renewable energy and energy efficiency, noting existing STEM projects taking

place in the schools, from the ages of preschool to high school. One participant noted the work of GTC leadership to help recruit youth into careers the energy sector, by providing scholarships and bursaries to be trained as engineers and more technical positions to office-based positions. Another interviewee commented on a recent initiative with the Northwest Territories Power Corporation, to *"provide for more apprentice type training positions for those right out of high school."*

The regional Gwich'in youth council, which has a youth representative from each community, was identified as an example of next generation leadership capacity. A Gwich'in leader explained that the youth council members attend academic conferences each year, and they have a high success rate of youth council members then attending post-secondary education. The initiative targets youth who have recently graduated high school but haven't attended post-secondary. After the first four years of the program, 83% of participating youth have gone to a post-secondary program, an internship, or some sort of education or training. As explained by an interviewee from GTC leadership, investment in next generation leaders is "helping young people be aware of their responsibility especially as Indigenous people and specifically Gwich'in." The participant explained "We were all taught a very deep responsibility to be a part of our communities and to give back, and if you have the ability to do so, then it's your responsibility to do so."

4.9 Energy Technologies – An Emergent Theme

An additional, recurrent theme that emerged from the interviews that did not map to the conceptual framework was energy source or technology preference. Over 80% of participants discussed various energy preferences during the interview process, often discussing a preference for what type of energy technologies the communities should pursue. This may reflect the individual's energy vision. A commonality between all partner communities was specific, intentional, technology preferences dependent upon geographical considerations and the location of the respective community.

Of the 74 total community participants, 70 discussed energy technology preferences. The technology that was raised most frequently was solar, followed by biomass and wind, and then

hydro developments. In Tsiigehtchic, for example, an interviewee expressed the importance of hydroelectric and wind developments for their community's energy future, due to the geographic location of the community:

> *We're right up on a hill if you look at the map. The two rivers come – this is a river coming and then this is the Mackenzie going. So, we're in between the rivers and on a hilltop. So, the winds are always coming and blowing, and we can make good use of that wind energy. And our 24-hour sunlight in the summer.*

Of the other interviewees expressing technology preference, 6 interviewees from GTC leadership raised interest in biomass, wind, and solar developments; 1 participant from the energy sector commented on the potential for hydro development; 4 participants representing intermediary organizations expressed technology preferences based on biomass, wind, hydro, and solar. Several of these interviewees also raised consideration of community members' preferences, in that communities' support for a development can make or break the project, noting there's always risk that development driven by outside preferences can mean that a project *"just turns out to be a dud because the community didn't want that…there's a risk of upsetting the community if you don't do the sort of pre-commissioning work and get the feedback.*" As summarized by an additional intermediary interviewee, "*ultimately, it's always going to depend on the community…there's never a one size fits all."*

Chapter 5 - Discussion

This research identified several baseline socio-technical capacity strengths and challenges for Gwich'in communities. Results indicate several attributes where a strong baseline capacity for energy transition exists, such as community energy values, inclusive of community vision; or the embedded skillsets of the communities, coupled with opportunities for strengthening community energy knowledge and next generation leaders. In turn, there were areas where significant capacity building may be required for community energy transition, such as supports for local energy champion(s) and enabling inter-local energy networks.

Results also show that the foundational attributes of social capacity for energy transition in northern communities are interconnected, and strengths or challenges in one area often reflect strengths or challenges in another. For example, successful energy transitions often hinge on community's identifying value-added in energy planning or in specific energy developments, which may hinge on available and sufficiently resourced local community energy champions (Hoicka et al., 2021; Krupa, 2012) – a noted capacity deficit among study communities in this research. In turn, however, if communities have not articulated or understand the potential value-added of community energy or alternative energy systems, beyond energy conservation measures, it may be difficult to identify passionate leaders from within the community to drive transitions (Middlemiss & Parrish, 2010; St. Denis & Parker, 2009; van der Horst, 2008; Walker & Devine-Wright, 2008).

Similarly, noted deficiencies in energy literacy (e.g., education, programming) and skills development opportunities (e.g., technical skills training) appear tightly coupled. At the most fundamental level, these two capacity deficits reflect limited local access to education and training opportunities, whether for enhancing and developing basic community energy literacy or for specific technical skills development. In terms of which of the two attributes is the catalyst to the challenges identified, one could argue that the challenges in either one reflects or cause deficits in the other. Without relevant skills development opportunities for training and capacity development related to energy transitions, it is challenging to develop strong energy literacy programs in communities (Arctic Council & Sustainable Development Working Group, 2019; Mercer et al., 2017; Rosenbloom et al., 2016); without energy literacy programs, education, and

workshops, it is challenging to nurture energy-relevant skills development opportunities to support transitions (Holdmann et al., 2019; Lovekin et al., 2016; McDonald & Pearce, 2012). Unfortunately, deficits in energy literacy programming and skills development opportunities, may cause deficiencies in the future embedded skill sets of a community (Bhattarai & Thompson, 2016; Mortensen et al., 2017; Pasqualetti et al., 2016; Stevenson & Perreault, 2008) and in next generation leaders to maintain community energy projects and energy transitions in the longer-term (McCarthy & Morrison, 2020; Nelson, 2019; Yazdanpanah et al., 2015).

Reflecting on these relative opportunities, strengths, and actor perspectives, this Chapter presents several key observations regarding the capacity for long-term socio-technical energy transitions in communities and across the Gwich'in territory, alignment of current energy transitions literature with a northern perspective, and the merits of the conceptual framework used in the research.

5.1 Capacity Building that Aligns with Community Needs and Aspirations

There are often diverging perspectives between community members and other interests, including intermediaries, about community energy transition capacity opportunities and challenges. Two examples in particular that emerged from this research, where the views of local community participants differed from those of other participants regarding different capacity attributes, opportunities, and needs – specifically local access to energy literacy and training programs, and also the skills development and training opportunities needed to pursue community energy. If communities lack knowledge about energy or if widespread misinformation exists, it can obstruct transitions and diminish their social value (Mercer et al., 2017). Through successful transitions in Alaskan communities, for example, energy literacy programs were seen as essential for helping community members understand energy systems and how they can reduce costs (Holdmann et al., 2019). Interestingly, in this research, the need for improved energy literacy was noted across all participants, but specific challenges related to energy literacy were primarily raised by Gwich'in community members, usually referring to the lack of locally accessible energy literacy education and workshop opportunities. Similar capacity building constraints were identified by community members regarding training opportunities, indicating the need for local access to energy training opportunities in the forms of energy

systems maintenance, operations, and installations, and the need for hands-on training and mentorship from individuals in other communities who have found successes with energy transition efforts. This deficit in energy literacy programming and training opportunities often contrasted with the perspectives of other participants including intermediary organizations, and sometimes GTC leadership, who spoke of the variety of programs and their availability and accessibility across the Gwich'in communities.

Part of the reason for the divergence may be a misalignment between the types of energy literacy and skills development programs available versus what communities are interested in for their energy future. For example, intermediaries and GTC leadership often spoke of energy efficiency and energy use education and training, but community members tended to emphasize the need for more knowledge and training about energy production, distribution, use, and opportunities more broadly related to pursuing new energy projects or alternative energy systems as opposed to using less energy or energy efficiencies per se. Similar challenges may be the source of divergence regarding training opportunities, whereby energy efficiency workshops or new opportunities for university-level training may not align with the community's desires for their energy system, with current education levels in the community to pursue university-related training , or with actual community energy training needs. Cherniak et al. (2015) and Mercer et al. (2017) indicate that limited access to energy literacy education in the North, coupled with limited access to energy skills training and development opportunities, poses significant barriers to community energy development. This research shown that equally important to access is that the literacy programs and training opportunities that are available are community appropriate and align with community needs, values and aspirations.

The above points may speak to much larger capacity challenges facing northern and Indigenous communities to pursue local energy projects, but more importantly they may also reflect a more significant and underlying challenge faced by Indigenous communities. In absence of local capacity, energy projects can be implanted and values attempted to be reshaped by other interests, resulting in energy futures or priorities that may not succeed in the long term or serve to enhance community values (Ikejemba et al., 2017; Tenenbaum, Greacen, Siyambalapitiya, & Knuckles, 2014). In this research, interviewees from the smaller communities of Aklavik, Fort McPherson, and Tsiigehtchic, but not necessarily the larger center of Inuvik, often spoke of

energy intermediaries or the federal government as ‘outsiders’ to the community. This notion that those agencies or organizations supporting communities in energy efforts may have different perspectives or values to that of community members was emphasized by an interviewee from Tsiigehtchic, who expressed that Indigenous communities are often still treated like they are in Residential Schools – outside interests often claim to know what is best for the community. Thus, there are significant, and broader implications for the difference in perspectives identified in this research related to local energy capacity and capacity building needs. However, across the country, it should not be astonishing that these difference of opinions and values exist. Canada’s history reflects systemic differences of values, priorities and often a divide between what Indigenous communities want versus what external interests believe is *bes*t for Indigenous communities. Focusing on community-appropriate capacity building is needed, aligning with the values and interests of the communities and Elders, those who know the geography and terrain, know where the willows grow and how fast they grow, and who know where the wind blows – is essential for a successful, long-term sustainable socio-technical energy transition.

5.2 Sister Communities for Capacity Building

Strengthening sister community relationships between communities within and external to the Gwich’in region may be a solution to many local capacity challenges across multiple attributes. There are numerous examples in the literature of the opportunities that can emerge from inter-local regional networks. In five years in Germany, for example, over 450 energy cooperatives surfaced that played an essential role in supporting local energy grids (Juntunen & Hyysalo, 2015). In Wales and Scotland, energy cooperative programs have been most successful in networks of close-knit rural communities (Strand, 2018). In Alaska, several regional grids have been developed, and utilities have developed systems for supporting regional energy planning and project maintenance across otherwise remote (Holdmann et al., 2019). In the global south, research has shown the value in community-to-community mentorship programs for developing solar power projects in rural areas, and providing a network for knowledge transfer from India to Kenya (Ulsrud et al., 2018). In the circumpolar region, research has emphasized that mentorship programs are critically important; as they are a way to provide support and enable communities to share success stories and lessons learned of energy transition efforts across the North (Cherniak et al., 2015).

Results from this research indicate that there is limited networking and knowledge transfer among the four communities regarding community energy planning or energy transition opportunities. A strong inter-local energy network among communities may allow for capacity deficits in one community to be leveled out by the collective capacity strengths of the network of communities (Berka et al., 2020; Onyx & Leonard, 2011; Poelzer et al., 2016; Shaw, 2017). For example, if Aklavik does not have a locally resourced community energy champion, they may leverage the strengths of the other partner Gwich'in communities. Similarly, if Fort McPherson implements a robust new energy literacy curriculum, it could be shared with the other partner communities to strengthen the energy literacy of the network via GTC leadership. As the larger of the four communities, if Inuvik has certain embedded energy technology skill sets, there is an opportunity for knowledge transfer and training to build similar skillsets in Tsiigehtchic. However, perhaps some of the reason for the limited energy networking and knowledge transfer among the four communities is simply because they are at similar stages of energy transition – thus emphasizing the importance of sister community relationships that extend beyond the Gwich'in territory.

Results show a cohesive regional interest held by community members, Gwich'in leadership, and representatives of intermediary organizations and the energy sector in developing partnerships and knowledge-sharing platforms, and a shared interest in future inter-local energy networks. Such interests included partnerships between the four communities and other northern communities, partnerships between different First Nations governments, and partnerships among First Nation governments and territorial, municipal, and federal governments. The concept of inter-local learning is defined as learning between specific socio-technical experiences in different geographical contexts, where practical projects with technology innovations are piloted and lessons and new skill sets transferred to other settings (Ulsrud et al., 2018). In this research, many community interviewees spoke of the desire to learn from other communities in the Northwest Territories that have embarked on local energy initiatives, and especially the opportunity to learn from neighbouring Alaskan communities who are recognized as leaders in community energy transition solutions. Such networks could build local capacity through community-to-community learning, even in absence of more formal training programs locally, and support more collaborative energy planning, technology transfer, resource sharing, and transition opportunities across the territory.

5.3 Northern Context in Contrast to Community Energy Scholarship

There has been research on capacity for energy systems development, but largely in urban contexts (Middlemiss & Parrish, 2010; Mühlemeier & Binder, 2017; Zhao et al., 2016) or in rural regions of the global south (Akmalah & Grigg, 2011; Feroz et al., 2011; Miller, O'Leary, et al., 2015); there has been much less attention to the baseline capacity and capacity-building needs for northern communities to embark on such complex socio-technical transitions. Throughout the literature, an underlying notion is that energy transitions are accompanied by social shifts; therefore, energy policy and planning must expand into understanding local capacity to recognize, pursue, incorporate, and governing such complex and dynamic social transitions (Feurtey et al., 2016; Miller, O'Leary, et al., 2015; Miller & Richter, 2014; Newell et al., 2017). Arguably, however, recent scholarly literature regarding local capacity for community energy does not always tightly align with, or reflect the nuances of, energy transition in northern and Indigenous communities.

For example, literature has emphasized the importance of leadership in community energy planning and transition initiatives, emphasizing that the lack of local energy champions can pose barriers to community energy support and is among the most significant challenges to energy transition in the North (Axon et al., 2018; Cherniak et al., 2015). It is true that community leadership is important to maintain financial and technical resources for energy projects, enable knowledge transfer, and establish and maintain important energy support networks with external actors (Ghorbani et al., 2020; Martiskainen, 2017). This often requires a set of formal professional, technical, and managerial skills and attributes. However, the lack of formally designated community energy leadership is constraining but it should not be assumed that the communities have no local leadership to advance community energy. As emphasized by participants in this research, there are energy champions in each community that may not carry an official title but are energy champions through their traditional way of life – promoting community well being, environmental and cultural awareness, and thus mobilizing the social capital necessary for transitions. This understanding of energy champion(s) as community social and cultural leaders should be considered when approaching energy leadership in communities in the North, in addition to more formalized understandings of community energy leadership.

Second, recognizing the social value of energy is critical to transition efforts (Jenkins et al., 2018). The dominant focus of much of the community energy literacy however, including energy policy and the efforts of energy intermediaries, is often on energy efficiency and emissions reduction (Government of Canada, 2016; Hossain et al., 2016). In this regard, energy transitions are often conceptualized based on top-down values (Stefanelli et al., 2019). However, an overarching emphasis in the conversations had with community members in this research was the importance of energy for the entire community, generating broader community value and generating new resources or energy savings that could go back into programming and services, schools, lower energy costs, or daycares. Cultural and social values play a significant role in shaping energy transition in northern Indigenous communities (Krupa, 2012).

Third, literature often focuses on the capacity deficits of northern and Indigenous communities (Stevenson & Perreault, 2008), focusing on the specific skill sets that are missing rather than also focusing on the resilience of existing skills and experiences in the community. Literature will often talk about professional skills and training programs and the lack of skills, or skill deficiencies in the communities as barriers to energy transition (Advanced Energy Centre, 2015; Cherniak et al., 2015; Mortensen et al., 2017). But in this research, participants discussed the value of hands-on learning and existing and retired skillsets, passing their knowledge on to others in the communities, as important embedded skills and an overarching strength across the partner communities. Of particular importance in assessing social capacity is the resilience of skillsets in a community to adapt and be transferred to new types of energy systems and transition efforts.

5.4 Framework Improvement

The conceptual framework presented in this paper sets out the attributes for rapid assessment of the capacity needs of rural and remote Indigenous communities in the North to pursue, and sustain, local energy transitions. These attributes emphasize the importance of: local energy champions and inter-local energy networks to enable knowledge sharing, innovation, and capacity building and inter-local energy networks to enable knowledge sharing, innovation, and capacity building across communities; articulation of community values and longer-term and overarching goals of energy transition, including the desirable cultural, social, or economic

values and opportunities to be supported or created by a more sustainable energy system; community knowledge, including not only a community's understanding of their energy resources, technologies, and opportunities, but also the technical, managerial and other embedded skills in the community to support energy transitions; and considerations of community futures, specifically, the skills innovation required to pursue and manage new energy systems coupled with the longer-term engagement of, and capacity building for, local youth – the next generation of community energy leaders.

These attributes are not predictive of energy transition success, or explanatory of why some community energy projects succeed while others fail; rather, they offer conceptual guidance to the exploration of fundamental baseline capacities of a community prior to embarking on local energy initiatives. No single framework or suite of attributes may be comprehensive of all local issues or opportunities—context matters – but rapid assessment frameworks are valuable tools in community energy transitions planning. A rapid assessment framework can provide fast, sufficiently accurate, and flexible ways of understanding a community's baseline capacity to engage in energy systems planning (Daryabeigi Zand, Vaezi Heir, & Hoveidi, 2019; Gilbuena et al., 2013). However, it is acknowledge that a rapid assessment tool is not a substitute for other forms of detailed assessment and community engagement; rather it is a means for making broader uncertainties, opportunities, and capacity needs known (Upham & Smith, 2014).

There is an opportunity for further development to accompany the attributes presented in the framework, including adapting the framework to local contexts and applications and integrating new factors and considerations. For example, as discussed above, energy technology preferences continued to emerge during the interviews, with participants routinely couching their conversation in terms of what type of energy technologies communities should pursue. Thus, a communities' preference for an energy technology, their knowledge about that technology, and understanding what or who helped shaped energy technology knowledge and preference, may be important context when assessing capacity for socio-technical transition efforts move forward in the North, as in all of the partner communities, intentional preferences for technology pursuits existed. This may influence how individuals address or respond to certain capacity issues, should they be addressing those issues with a particular technology in mind (e.g. Mercer et al., 2020). Treating the application of the framework in this research as pilot testing with the partner

communities, and considering the key lessons emerging as discussed above, will allow future researchers to improve, curate, extend, and continue to improve socio-technical baseline capacity rapid assessments tailored for communities in the North.

Chapter 6 – Conclusion

Fully realizing the long-term community benefits of renewable energy development in northern and remote regions requires more than building new energy projects – it requires developing the local socio-technical capacity to design, implement, and maintain renewable energy projects (Daley, 2017). Community capacity is an important pre-requisite to energy transition and to the development of community renewable energy projects, but increased community capacity is also a longer-term outcome of investment in local energy. If advancements in community energy across the North are to meet the longer-term goals of socio-economic development, energy self-sufficiency, and greater self-determination over energy futures, the planning, design, and implementation of remote energy systems that are community-appropriate requires a much improved socio-technical understanding of a community's fundamental capacity to transition, the social processes that stimulate and manage transitions, and the social outcomes of transitions (Miller et al., 2013).

This research aimed to understand the socio-technical baseline capacity for renewable energy transition in Gwich'in communities in Northwest Territories, specifically Aklavik, Fort McPherson, Inuvik, and Tsiigehtchic. The results paint a complex regional picture of multiple strengths and challenges across communities and attributes. Across the region, community vision to guide energy transitions and shared community energy values, often expressed through the lens of cultural, community, or shared social and economic considerations, were identified as essential and existing strengths. These strengths were coupled with the importance and presence of next generation leadership to ensure long-term socio-technical capacity, and the resilience of embedded skillsets in the community to support local energy planning and project implementation and management. That said, challenges were also noted including resourcing for local energy champions, inter-local energy networks, and access to community appropriate skills development programs.

The results of the research yielded several important observations, The first observation concerns the interconnectedness of many capacity attributes for energy transition in northern communities, whereby strengths or challenges in one area often reflect strengths or challenges in another. Second, the perspectives of community members and intermediary organization representatives

sometimes diverged, particularly on community energy literacy, and appropriateness of skills development opportunities. Equally important to access is that the literacy programs and training opportunities are community appropriate and align with community needs, values and aspirations. This perhaps speaks to a more significant systematic divergence between community interests in energy transition and the interests of 'outsider' interests. Third, strengthening sister community relationships within the region and with communities external to the region may be an opportunity to address many local capacity challenges across multiple attributes. A collective interest in developing such networks was expressed by community members, community leadership, and representatives of the energy sector and intermediary organizations, allowing for mentorship and educational opportunities through building off and sharing of existing skills and resources of sister communities. Fourth, this research demonstrated, at times, conflicting perspectives between community members and recent scholarly literature on community energy. Specifically, recent scholarly literature on local leadership for community energy does not always tightly align with, or reflect the nuances of, energy transition leadership in northern and Indigenous communities, namely the important role of cultural leadership in mobilizing the social capital necessary for transitions. Further, literature, dominant policy, and energy intermediary interests in energy efficiency and emissions reduction does not necessarily support community interests in more substantive energy transitions allow access to renewable energy for the entire community, in a way that generated new social and cultural value through energy planning, transitions and project developments.

Finally, there may be no single framework or set of attributes for assessing social capacity that is comprehensive of all local issues or opportunities related to community energy transition across northern communities. However, building on the literature, and drawing on the lessons from on-the-ground application, the conceptual framework advanced in this research provided a rich insight into socio-technical baseline capacity challenges and strengths across the partner communities for initial energy planning guidance. In doing so, the research will help advance knowledge and create opportunities for all other northern and Indigenous communities to inform the exploration and assessment of their own baselines, energy futures and opportunities for energy transitions. Perhaps more significant to the context of this research, however, are the capacity opportunities and needs of the four Gwich'in communities to support each other's challenges and share each other's possibilities to further the region's energy planning, transition,

and development efforts through interdependent energy networks and support systems. Arguably, this is the most important contribution of this research– a snapshot of community socio-technical capacity to assist in opening up prospects for long-term capacity building in the partner communities to make informed energy planning decisions for their respective sovereign energy futures.

This most important contribution, a snapshot of community social technical capacity, would not have been possible without the successful community youth engagement. The youth researchers in each of the respective partner communities tremendously enhanced the research, they conducted 71 of the 94 interviews. Perhaps this is an additional contribution of the research, and the greatest lesson for future researchers, that true community youth engagement can truly enhance research and community youth engagement is the path forward for community energy research. As this research would not have been possible without them.

In conclusion, community capacity is about the collective ability of a community to create and seize opportunities to meet community needs, thus providing for greater self-sufficiency and control over social and economic futures (Smith et al., 2001) – and for many Indigenous communities, charting a course for self-determination (Rakshit et al., 2018). Understanding the social capacity to pursue, implement, and maintain community energy projects is thus important to community energy transition planning and to energy sovereignty (Bullock et al., 2018; Hossain et al., 2016). Building capacity for energy transition starts with people, not technology (Simpson et al., 2003) – especially in rural and remote regions where community energy opportunities must align with local resources, values, aspirations, and current and future capacities.

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