Assessing local capacity for community appropriate sustainable energy transitions in northern and remote Indigenous communities

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Abstract

There is a significant growth in community energy across the globe, but many northern and remote Indigenous communities are increasingly vulnerable to energy insecurity. Community energy as a solution to traditional fossil fuel-dominated energy systems is high on the global sustainability agenda, but there is significant risk that northern and Indigenous communities will be left behind in the global energy transition. Ensuring community appropriate sustainable energy solutions in remote communities requires more than building new projects – it requires understanding the local socio-technical capacity to design, implement, and maintain renewable energy projects. Yet, notwithstanding the growing literature on community energy there is limited understanding of the foundational socio-technical capacity needs of northern and remote Indigenous communities to meaningfully engage in energy transitions This paper sets out the fundamental pillars for assessing the capacity needs of northern and remote Indigenous communities to pursue, and sustain, local energy transitions. These pillars are inter-dependent and emphasize the importance of: community energy leadership, supported by local energy champions and inter-local energy networks to enable innovation and capacity building; community values that articulate immediate and longer-term goals for energy transition, including the social, cultural, and economic opportunities to be realized by a more sustainable energy system; community knowledge of local energy resources, technologies, and opportunities, and the embedded skills in a community to support transitions; and the skills innovation to pursue and manage new energy systems coupled with the longer-term engagement of, and capacity building for, local youth as future community energy leaders.

Keywords: energy transition, renewable energy, community energy, remote communities, socio-technical, energy security

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Author contributions

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1. Introduction

Society is facing significant challenges and uncertainties about its energy systems, from global climate change to regional energy injustices (Miller et al., 2013; Rakshit et al., 2018). These challenges and uncertainties will persist until conventional fossil fuel-dominated, centralized energy systems transition toward more decentralized and community-driven sustainable energy (Hewitt et al., 2019; Newell et al., 2017; Pasqualetti et al., 2016). Community renewable energy is high on the agenda for many rural and remote regions, especially in the Circumpolar North (Brewer et al., 2018; Holdmann et al., 2019). Across Canada's North, for example, there are more than 170 remote, Indigenous, diesel-dependent communities that face daily energy security challenges and sustainable development constraints (CER, 2018; Rakshit et al., 2018). Considering past and current energy injustices in many rural and remote regions (Hossain et al., 2016), local communities must be part of the energy transition planning process.

Community energy systems are tightly coupled socio-technical systems that include not only infrastructure and technologies, but also the people who plan for, implement, operate, and maintain community energy projects and use the energy generated (Miller et al., 2015). Community energy places greater control of energy systems in the hands of the community (Jenkins et al., 2018), challenging the sustainability of centralized energy systems that have long shaped social practices (Miller et al., 2013). Sustainable transitions in energy systems require transitions in social systems (Jenkins et al., 2018). However, much of the scholarly focus of community energy research has been on transition theories (Avelino & Wittmayer, 2016), innovations in energy technologies (Quitoras et al., 2020), economic cost-benefit (Bekareva et al., 2018), and state policy and governance instruments (Leonhardt et al., 2021). There has been much less attention to the social dimensions of community socio-technical energy systems, despite sustainable transitions in energy systems requiring considerable social innovation and capacity at the community level (Walker et al., 2021). When social dimensions have been included in energy transitions research, they are often assumed to be static or of secondary importance. There is risk that such an approach may hinder capacity building opportunities to enable and support long-term community energy transition success (Berka et al., 2020; Devine-Wright, 2019).

Building capacity for energy transition starts with people, not technology (Simpson et al., 2003) – this is especially true in rural and remote regions where community energy projects must align with local social and environmental values, resources, 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, sustainability, and control over social, economic, and environmental futures (Littlejohns & Thompson, 2001). Further, for many Indigenous communities, community energy also about 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 sustainable energy transition planning and to community energy sovereignty (Bullock et al., 2018; Hossain et al., 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 understanding the social capacity of remote communities to pursue community centric energy futures (Rakshit et al., 2018).

In this paper we propose a conceptual framework to guide rapid appraisal of community capacity during the pre-planning stages of community energy initiatives. The framework responds to the recognized need for contemporary energy transition planning tools that confront historic energy systems (Miller & Richter, 2014; Miller et al., 2015) and build local capacity to implement, sustain, and derive value from community energy projects (Ikejemba et al., 2017; Karanasios & Parker, 2018). The framework is conceptualized largely based on the energy context of rural and remote Indigenous communities in the North, informed by recent scholarship, and draws on the authors' experiences leading an international community energy partnership program. We also draw on the unique insights of the lead author – an Indigenous scholar working on community capacity for energy transition in Canada's northern Indigenous communities. In the sections that follow we first provide a brief overview of the northern community energy context, followed by the pillars of our conceptual framework. We then venture a number of broader observations for sustainable community energy transition planning.

2. Context and approach

Energy systems across the global North are a mix of centralized grids, regional grids, and off-grid (or micro-grid) systems. Across Canada's territorial North, low population densities limit the viability of large-scale energy infrastructure (Mortensen et al., 2017). Most communities are remote, not connected to a centralized grid, and powered by diesel generators that rely on seasonal fuel delivery (Prieur 2021). Electricity prices in Canada's northern territories are thus significantly higher than the rest of the country – even with government-subsidies. The Canadian average electricity price is approximately CDN $0.12 per KWh. In Nunavut, however, where power generation facilities are diesel-based and homes are heated primarily by fuel oil, subsidized residential rates range from CDN $0.60 per kWh to over CDN $1.15 per kWh. The Qulliq Energy Corporation, which powers 25 communities across Nunavut (38,000 people), requires approximately 55 million litres of diesel annually (Thomson, 2019). The challenge is similar in the Northwest Territories, where 25 of the 33 primarily Indigenous communities powered by the Crown energy provider are off-grid and diesel dependent (GNWT, 2018).

High fuel prices, limited seasonal fuel supplies, and aging and costly energy infrastructure operating at or near capacity, can impose significant social and economic development constraints for many northern and remote Indigenous communities (Cherniak et al., 2015). There is increasing government interest in renewable energy in the North, as illustrated by federal budget commitments to renewable energy infrastructure and pursuit of a low carbon future (Potvin et al., 2017). There is also a growing interest in community renewable energy systems amongst northern and remote communities to improve energy security and ensure access to affordable, reliable, clean energy solutions (Karanasios & Parker, 2018). Renewable energy systems (e.g., solar, wind, biomass) are being deployed to offset diesel-based generation in some regions. For example, in the Northwest Territories, an 85-kW biomass boiler was installed in the community of Fort McPherson in 2013 (Buss et al., 2021), and the Hamlet of Aklavik currently offsets a portion of its diesel dependency with a 52-kW solar system.

Community energy planning is an emerging trend across Canada, where local communities are increasingly becoming involved in planning for their energy future (St. Denis & Parker, 2009). However, most energy planning processes continue to rely on top-down approaches, often without sufficient consideration for the local socio-cultural context and drivers of local energy initiatives (Rakshit et al., 2018). The pursuit, design, and implementation of community energy projects in rural and off-grid settings that fail to incorporate local values and the capacity of communities to transition their energy system are less likely to succeed (Urmee & Md, 2016). Interestingly, there is a growing volume of literature examining Indigenous community involvement in renewable energy development (Hoicka et al., 2021), but only limited attention to community capacity for energy transition in the North – despite the enduring challenges to northern and Indigenous communities' pursuit of sustainable energy futures (Arctic Council & Sustainable Development Working Group, 2019; Cherniak et al., 2015; Mortensen et al., 2017).

2.1 Toward a conceptual framework

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 (GoC, 2021). In the energy sector, Orosz et al. (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 and 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 et al., 2019; Upham & Smith, 2014).

Rapid assessments are evidence-generating exercises that provide the basis for a quick, reliable, and accurate analysis of a situation or intervention. These generally include collecting primary data (quantitative or qualitative, or both), are usually part of an iterative process (involving multiple rounds or subsequent phases), and often employ methodologies that are practical and convenient due to time and resource constraints. Rapid assessments favor simplicity over comprehensiveness in providing a fast and a flexible approach to identifying critical gaps and opportunities in emerging 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.

The foundational pillars to guide rapid assessment of community social capacity for energy transition presented in this paper were conceptualized based on literature from a cross-section of disciplines exploring capacity, including: socio-technical community capacity in developing countries and in the global south (e.g., Middlemiss & Parrish, 2010; Miller & Richter, 2014; Schäfer et al., 2011; Sovacool et al., 2011; Sovacool et al., 2020); energy transition planning and community sustainable development in the Circumpolar North (e.g., Cherniak et al., 2015; Mortensen et al., 2017; Poelzer et al., 2016; Rosenbloom & Meadowcroft, 2014; St. Denis & Parker, 2009), and community energy planning research and planning process guides engaging Indigenous communities (e.g., Karanasios & Parker, 2018; Mercer et al., 2020; Pasqualetti et al., 2016; Rezaei & Dowlatabadi, 2016; Stefanelli et al., 2019). The framework is intended to provide conceptual guidance versus a prescriptive assessment tool, and we acknowledge the importance of economic, political (i.e., governance), infrastructure, and technical factors that also influence community energy transitions and have been addressed elsewhere in the literature (Vallecha et al., 2021).

3. Pillars of community social capacity for assessing socio-technical energy transitions

Eight foundational pillars are proposed as highly relevant to social capacity for energy planning and transition in rural and remote regions. Each pillar provides guidance for the rapid assessment of baseline social capacity as a precursor to formal community energy planning and transition processes (Table 1: Pillars 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.

). These pillars may not be comprehensive of all possible considerations (see Vallecha et al., 2021); however, they represent the necessary community social attributes to initiate, drive, and support community appropriate, sustainable socio-technical energy transitions.

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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 et al., 2020; Martiskainen, 2017; Seyfang et al., 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 in Indigenous communities 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 and Indigenous 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 et al., 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 et al., 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 et al. (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 et al., 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 the *why* 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 et al., 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 et al., 2019; Hossain et al., 2016; Mercer et al., 2020).

For many northern and remote Indigenous communities, community energy is often a means to resolve the immediate pressures of energy poverty by providing access to affordable and reliable energy to meet basic electricity and heating needs. Raphals (2019),for example, describes the energy challenges facing many on-reserve Indigenous peoples in northern Manitoba, Canada, identifying lower than average household 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 represented 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 et al., 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 et al., 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. 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, 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 Canada 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 et al., 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 et al., 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 et al., 2012). Based on energy transitions in rural regions of the Global south, for example, Miller 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. The 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 et al., 2011; Yazdanpanah et al., 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.

4. Discussion

The United Nations Declaration on the Rights of Indigenous Peoples recognizes Indigenous peoples' right to self-determination, including the right to "freely pursue their economic, social and cultural development." Self-determination necessarily implies policy and planning shifts toward greater authority in the institutions that enable Indigenous peoples to pursue such rights (McDonald & Raderschall, 2019). This includes the development and use of land and resources and the delivery of public services and, arguably, the development and ownership of local energy. Hoicka et al. (2021), for example, report that the motivations for Indigenous communities in local energy projects typically include socio-economic development opportunities, and the pursuit of self-sufficiency, autonomy, and self-determination. As such, Stefanelli et al. (2019) argue that many communities are engaging in local, renewable energy development projects and opportunities as a means to assert Indigenous rights and self-determination, and "gain long-term sustainable benefits from economic development projects" as recognized under Canada's Truth and Reconciliation Commission's Calls to Action (TRC, 2015).

Increasing ownership and control of community energy in remote communities across the North holds considerable potential (MacArthur et al. 2020; Mercer et al., 2020), but Hoicka et al. (2021) report that notwithstanding the increase in local renewable energy projects across Canada over the last decade most do not have local community or Indigenous control or shared ownership. We agree with recent scholarship in that the challenges to energy security in remote northern communities are likely to persist until the traditional, top-down, centralized energy planning and development process is reworked in favor of more localized community energy planning processes and distributed energy systems (Hoicka et al. 2021; Mercer et al., 2020; Pasqualetti et al., 2016). However, community energy projects in these regions still depend heavily on capacity provided by state and private sector supports for community energy planning, project development, operation and maintenance, and community training (Creamer et al., 2018; Leonhardt et al., 2021). The energy group of the Arctic Fulbright initiative (Poelzer et al., 2016) reports that northern communities are showing a strong interest in transitioning to renewables and local energy ownership, but they continue to be constrained by the human capacity to develop, deploy, and manage energy at the community level.

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 sustainable 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, then 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).

There has been research on capacity for renewable energy transition, but largely in urban contexts (Middlemiss & Parrish, 2010; Mühlemeier & Binder, 2017; Zhao et al., 2016) or in rural regions of the developing south (Akmalah & Grigg, 2011; Feroz et al., 2011; Miller et al., 2015). Notwithstanding the emerging literature on energy transitions in northern and remote communities (Cherniak et al., 2015; Hoicka et al., 2021), enduring energy poverty, implications of heavy reliance on external resources and capacity supports, and the tightly coupled relationship between local capacity and energy self-determination, there has been limited 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 & Richter, 2014; Miller et al., 2015; Newell et al., 2017).

The conceptual framework presented in this paper sets out the fundamental pillars for understanding the capacity needs of rural and remote Indigenous communities in the North to pursue, and sustain, local energy transitions (Table 1). These pillars are inter-dependent and overlapping, and emphasize the importance of: community energy leadership, supported by local energy champions 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 community energy 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.

5. Conclusion

In conclusion, 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 pillars presented in this paper, including adapting the pillars and indicators to local contexts and applications. As such, we are currently applying the framework in Canada's Northwest Territories, working with remote, off-grid Indigenous communities, to identify local and regional capacity needs for energy transition. The operational value of the framework is supporting the early stages of energy transition planning before communities embark on wholesale energy transition plans or purse specific renewable energy projects or technologies. The framework is not a substitute for community energy planning, but rather a means of making broader needs and uncertainties known (Upham & Smith, 2014). For many remote northern Indigenous communities, understanding current capacity and capacity-building needs in the pursuit of local energy initiatives is essential to the longer-term sustainability goals of energy self-sufficiency and self-determination.

Data Availability

All data generated or analysed during this study are cited in this article.

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