ARCTIC
VOL. 75, NO. 2 (JUNE 2022) P. 149–160
https://doi.org/10.14430/arctic75055

Empowering Churchill: Exploring Energy Security in Northern Manitoba

Michael Kvern,[1,2] Patricia Fitzpatrick[1] and LeeAnn Fishback[1,3]

(*Received 21 January 2021; accepted in revised form 30 August 2021*)

ABSTRACT. To those living in Churchill, Manitoba, having power means much more than being able to turn on the lights. Using Churchill as a case study, we examine how local context can improve the suitability of energy security definitions for communities in northern Canada. Churchill is an isolated northern municipality with no road access but is connected to the electrical grid. Energy consumption data were collected from utility providers and organized into a community energy profile. Semi-structured interviews (n = 23) and a community workshop (n = 12) identified challenges, opportunities, and a vision for Churchill's energy system. High per capita energy consumption, especially of transportation (jet fuel) and heat (electricity and propane) sources dominate Churchill's energy profile. The reliance on air travel and need for heating are realities that define energy systems in the North. Participants expressed desire for increased use of renewables and improved energy efficiency. Churchill is reliant on external sources of power and there is a need for agency and local decision making. Jurisdictional realities and the community's desire for consideration of local context mean energy security definitions should take a regional approach. Recognizing these findings, we propose a new definition of energy security that fits the circumstances and desires of Churchill and the North.

Key words: energy security; community energy planning; Churchill, Manitoba; efficiency; agency; northern Canada; remote communities

RÉSUMÉ. Pour les gens de Churchill, au Manitoba, avoir de l'énergie ne signifie pas seulement être capable d'allumer les lumières. En nous appuyant sur une étude de cas au sujet de Churchill, nous examinons en quoi le contexte local peut permettre d'améliorer le caractère approprié des définitions de la sécurité énergétique pour les communautés du Nord canadien. Churchill est une municipalité nordique isolée sans accès routier, mais elle est reliée au réseau électrique. Des données sur la consommation d'énergie ont été recueillies auprès de fournisseurs de ce service public et organisées en un profil énergétique communautaire. Des entrevues semi-structurées (n = 23) et un atelier communautaire (n = 12) ont permis de cerner les défis, les possibilités et une vision pour le système énergétique de Churchill. La consommation d'énergie par habitant est élevée, surtout en ce qui a trait aux sources énergétiques destinées au transport (carburéacteur) et à la chaleur (électricité et propane) qui dominent le profil énergétique de Churchill. Le recours prononcé au transport aérien et les besoins en chauffage sont des réalités qui définissent les systèmes énergétiques du Nord. Les participants ont exprimé le désir d'une utilisation accrue d'énergies renouvelables et d'une meilleure efficacité énergétique. Churchill dépend de sources d'énergie externes, et il faudrait que les décisions soient prises à l'échelle locale, par une agence. Les réalités juridictionnelles et le désir de cette municipalité de prendre le contexte local en considération signifient que les définitions de la sécurité énergétique devraient prendre une approche régionale. À la lumière de ces constatations, nous proposons une nouvelle définition de la sécurité énergétique, définition qui cadre avec les circonstances et les désirs de Churchill et du Nord.

Mots clés : sécurité énergétique; planification de l'énergie communautaire; Churchill, Manitoba; efficacité; agence; Nord canadien; communautés éloignées

Traduit pour la revue *Arctic* par Nicole Giguère.

INTRODUCTION

Global concern about sustainability and social justice are bringing new context and relevance to issues surrounding energy security (Kruyt et al., 2009; Sovacool, 2011; Karanasios and Parker, 2018; Nyman, 2018). Mounting pressures related to climate change and equity are contributing to this increasing interest in energy security. This is especially true in northern Canada, where energy systems tend be less secure (Mcdonald and Pearce, 2012; Rezaei and Dowlatabadi, 2016; Karanasios and Parker, 2018; Brosemer et al., 2020).

Traditional definitions of energy security are geopolitical and focus on the supply of fossil fuels because energy production is dependent on natural resources and modern sociopolitical structures (Kruyt et al., 2009; Sovacool and

[1] University of Winnipeg, 515 Portage Ave., Winnipeg, Manitoba R3B 2E9, Canada
[2] Corresponding author: kvern.michael@gmail.com
[3] Churchill Northern Studies Centre, PO Box 610, Churchill, Manitoba R0B 0E0, Canada
© The Arctic Institute of North America

Mukherjee, 2011; Cherp and Jewell, 2014; Nyman, 2018). As a result, environmental and social considerations of energy systems are largely excluded from these definitions (Kruyt et al., 2009; Chester, 2010; Ang et al., 2015; Wang and Zhou, 2017). The present geopolitical nature of energy security fails to conceptualize energy security as it applies to individuals and communities.

The COVID-19 pandemic highlighted the energy insecurity and existing vulnerabilities of remote and northern communities (Brosemer et al., 2020; Henry et al., 2020; Stammler, 2020). Energy security is becoming increasingly relevant at the local level as there may be an increased need to develop localized power sources in support of efforts to reach isolated communities (Rasolt, 2020; Graff and Carley, 2020; Riley, 2020). Remote communities are also seeing a compounding of crises, as the present health crisis further stresses already susceptible energy systems (Brosemer et al., 2020; Rasolt, 2020; Riley, 2020). This rising awareness of energy justice along with regard for sustainability and increasing interest in redefining energy security are resulting in the introduction of more holistic definitions (Chester, 2010; Sovacool, 2011; Ang et al., 2015; Karanasios and Parker, 2018; Ayoo, 2020).

One foundational definition is the four As of energy security (availability, accessibility, affordability, and acceptability), which were created in the context of ensuring sufficient supplies of fossil fuels to nation states (APERC, 2007). The four As allow for assessment of a given energy systems' security. This article explores the unique aspects of energy security in remote northern communities, utilizing Churchill, Manitoba, Canada, as a case study. It works to understand to what degree conventional energy security definitions like the four As apply to remote northern communities. Ensuring energy security definitions are appropriate for the unique circumstances of remote communities is an important step in the reconceptualization and definition of energy security.

BACKGROUND

Energy security is concerned with the systems and sources that provide electrical, heat, and transportation energy to people on a large-scale basis. Among the numerous definitions and conceptualizations of energy security, there is a dominant focus on securing the supply of energy sources (Kruyt et al., 2009; Chester, 2010; Ang et al., 2015). Nearly all definitions include availability of natural resources for energy generation, and infrastructure and technology for transport of energy (Ang et al., 2015; Wang and Zhou, 2017). These considerations are structural forces concerned with fuel supply and the security of infrastructure against attack or disruption. Similarly, the reduction of risk to national fuel supply chains is found to be the guiding notion behind energy security definitions (Winzer, 2012). These definitions focus on security of energy and fuel supply but fail to consider demand-side energy security or how energy is used by people. Rather, these definitions conceptualize demand simply as energy's end use and not as something necessary for individuals and communities.

However, conceptualizations of energy security are beginning to expand beyond the availability of an energy source. As fossil fuel use declines in favour of renewable resources, the definition of energy security is evolving (Ang et al., 2015; Jewell et al., 2016; Proskuryakova, 2018). In emerging definitions, price, environmental sustainability, governance, and efficiency are becoming components of energy security (Ang et al., 2015; Hossain et al., 2016). The complex and multidimensional nature of energy security as identified by Chester (2010) can be beneficial in this changing environment. As conditions in which energy security are conceptualized change, definitions and conceptualizations can also change, leading to expanding views of energy security.

A common definition of energy security that encompasses many of these structural considerations is the four As: availability, accessibility, affordability, and acceptability (APERC, 2007). Each "A" addresses a specific aspect of energy security (APERC, 2007; Kruyt et al., 2009):

- *availability* refers to the physical presence of the energy source within the environment;
- *accessibility* addresses geopolitical factors, technology, and the workforce;
- *affordability* refers to the cost of production and generation of energy; and
- *acceptability* comprises environmental and social concerns.

The four As define energy security as a steady supply of reasonably priced energy that is acceptable to extract and generate (APERC, 2007; Kruyt et al., 2009; Cherp and Jewell, 2014). The paradigm of the four As has been directly and indirectly assessed and utilized by many scholars to consider energy security (Hughes, 2009; Kruyt et al., 2009; Chester, 2010; Sovacool and Mukherjee, 2011; Winzer, 2012; Cherp and Jewell, 2014). The four As provide a strong starting point for energy security, as they include the social considerations of energy acceptability. However, their application to subnational systems or northern regions is limited, and applying them in a northern setting is novel. Hossain et al. (2016) proposed a framework for northern energy security based on research conducted in Alaska. However, the Arctic and Subarctic are incredibly unique heterogenous environments that face a variety of energy challenges and require a multifaceted approach to assessing energy security (Hossain et al., 2016; Gjorv, 2017). The framework and definition proposed by Hossain et al. (2016) is explicitly place-based, and they stress the need for localized definitions of energy security in remote and isolated regions. The fours As are a useful basis to begin examining energy security within the unique contexts of

Churchill and Manitoba. Utilizing the four As allows for the multifaceted, place-based approach required in the North and aids in further understanding the diverse needs of remote northern communities.

Case Setting

Churchill, Manitoba, a subarctic community on the western shore of Hudson Bay, is approximately 1000 km from Winnipeg, Manitoba. With no road access, it relies on rail, air, and sea transportation. Churchill's population is just under 900 people; approximately 67% identify as Indigenous, with 44% First Nations, 19% Metis, and 5% are Inuit (Statistics Canada, 2017). Unusually for the North, Churchill is a municipality (Manitoba Government, 1996), which places it under provincial jurisdiction for its municipal administration, land-use planning, and energy. In contrast, other northern communities with high First Nations and Metis populations are largely under federal jurisdiction. Churchill is the northernmost community in Manitoba, but the only one north of 57° with an electrical grid connection. The communities of Brochet, Lac Brochet, and Tadoule Lake are all at a similar latitude to Churchill but are dependent on diesel generators for their electricity (Natural Resources Canada, 2018a). Churchill's isolated northern location and high First Nations, Inuit, and Metis population make it similar to many other northern communities, but its connection to the North American electrical grid and its status as a municipality make it unique in the North.

Tourism and the Port of Churchill are the primary employers in this community (Statistics Canada, 2017). Tourism is foundational to its economy with 16 tour operators and 15 hotels (Churchill Chamber of Commerce, 2020; Travel Manitoba, 2020). Churchill is often referred to as a "last chance tourism" destination, marketed as an exceptional site for viewing disappearing natural environments and wildlife (Dawson et al., 2010; Lemelin and Whipp, 2019). An estimated 6000 to 15,000 tourists annually visit Churchill, the majority arriving by air (Dawson et al., 2010; Groulx et al., 2016; Huddart and Stott, 2020).

Natural resources, including those used in the generation of energy, are a provincial jurisdiction in Canada, which creates a regionalized approach to energy management, as each province has different natural resource, demographics, economics, and legislative frameworks that influence their energy system (Eaton, 2015). Manitoba is unusual in that a state-owned monopoly, Manitoba Hydro, controls and delivers electricity in the province. Manitoba Hydro's offices and board are located in the provincial capital of Winnipeg, nearly 1000 km away from Churchill. As a result, local decision making about electricity is almost nonexistent. Further, hydroelectric development by Manitoba Hydro in the 1960s and 1970s diverted flow of the Churchill River, which has its mouth adjacent to the community (Province of Manitoba, n.d.). This diversion decreased river levels near Churchill, which negatively impacted fishing and recreation. The Churchill River Diversion has created lasting tensions and mistrust towards Manitoba Hydro within the community.

Work on understanding the energy needs of Churchill began with a student-led research project in 2017. Lucas et al. (2018) found that energy reliability, as judged by the community, was low. Importantly, this preliminary research was conducted during a period of vulnerability. Between May 2017 and October 2018, the rail line to Churchill was not functional, which made fuel supplies uncertain (CBC, 2018). Because of the rail outage, prices of external supplies, including propane, gasoline, diesel, and jet fuel, increased as a result of the supply chain accessibility challenges.

The energy system in Churchill is reliant on sources from outside the community. Nonelectrical energy, primarily propane, gasoline, diesel, and jet fuel are delivered by rail. As in other northern communities, costs for transportation fuels (gasoline, diesel, jet fuel) are considered very high by community members (Lucas et al., 2018). Historically, diesel generators were used to produce electricity from 1961 until 1987 when an approximately 400 km transmission line from Gillam, Manitoba, was built to deliver hydroelectricity directly to the community (Manitoba Hydro, 2003). Building age and condition were deemed crucial to the energy profile by community members. Interestingly, the Province of Manitoba, through Manitoba Housing, owns and operates a majority the housing stock in Churchill (Distasio et al., 2011). The community is presently in a time of energy transition as the Manitoba government seeks to electrify heating in provincially owned housing in order to reduce costs and emissions associated with propane heat (Manitoba Sustainable Development, 2017).

Being a subarctic coastal community, Churchill faces unique and increased threats from climate change including changing permafrost conditions that pose a substantial threat to the current hydroelectric transmission line, which is Churchill's sole source of electrical energy (Burke and Stephens, 2018; Karanasios and Parker, 2018). The community has expressed desires to explore alternative and renewable energy sources, both through previous research and the 2011 Churchill Sustainability Planning Framework (Distasio et al., 2011; Lucas et al., 2018). In the planning framework, energy planning and visioning are explicitly mentioned as priority areas (Distasio et al., 2011). Because of Churchill's current energy challenges, increasing vulnerability to climate change, and desire to undertake energy planning, the community is ideally suited for this energy security case study.

METHODS

This research employed a case study design to capture data on Churchill's energy system in a holistic manner. Case studies use multiple data collection methods to obtain a range of perspectives into the case and are best suited

to situations where it is difficult to separate the research subject from its context, such as analyses of communities (Merriam, 1988; Berg, 2007; Taylor, 2016). Case studies are also useful when examining uncommon situations that merit further investigation (Taylor, 2016). A community energy consumption profile explored energy use; semi-structured, snowball key participant interviews and a community workshop identified residents' criteria for a future energy system.

Data on Churchill's consumption of electricity, propane, gasoline, diesel, and jet fuel were gathered from utility providers. Despite the interruption to the rail line, 2018 consumption was confirmed as being consistent with past years through key sources and 10-year electricity consumption records. To tabulate the energy profile, 2018 consumption data for electricity, propane, gasoline, diesel, and jet fuel were entered in a Microsoft Excel spreadsheet and converted into kilowatt hours. Using records from the Town of Churchill, the Province of Manitoba, and Manitoba Hydro, electricity consumption was divided by land use zone and by square footage (Webster, 2016) and then visualized in a series of maps produced in ArcMap 10.6.1 (Evenson et al., 2013; ESRI, 2018).

Semi-structured interviews were conducted with 20 residents of Churchill and three with energy industry experts. The interview guide was informed by previous priorities identified by Lucas et al. (2018) and by an extensive review of energy security, resilience, and the energy-planning literature. Interviews explored energy usage, strengths and limitations of the system, and priorities for energy moving forward. Participants were asked specifically to identify challenges in the present system and their long-term vision for it. Interview notes and recordings were transcribed and imported into Nvivo12 for analysis, along with workshop discussion group notes and vision statement element cue cards (QSR International, 2018). The coding structure was informed by a literature review of energy security and resilience and by systematic process (Cope and Kurtz, 2016).

A community workshop presented preliminary vision themes from the interviews to participants (n = 12). These findings were then discussed in two small groups, and participants added their own ideas to identify elements they considered important for an energy plan vision statement. Participants wrote their elements on cue cards, grouped them by theme, and ranked and prioritized elements using a dotocracy ranking, which is a facilitation method where participants vote for their preferred outcome using coloured dots (Wates, 2014).

RESULTS

The community energy profile presented in Figure 1 illustrates Churchill's energy consumption for 2018. The greatest source of energy was fossil fuels, at nearly 9 million litres of fuel: 5.4 million litres of jet fuel, which accounts for 51% of total energy; 2 million litres of propane (11%), 900,000 litres of gasoline (8%), and 660,000 litres of diesel (6%) (Fig. 1A). The town also used just over 27 million kilowatt hours of hydroelectricity (25%). When jet fuel is excluded from the community's energy profile, the primary source of energy is electricity at 50% (Fig. 1B).

Churchill consumes proportionately more fossil fuels than Manitoba, and slightly less than the nation, as shown in Figure 2. On a per capita basis, the average Canadian consumes approximately 2.5×10^{-4} petajoules (PJ) of fossil fuels annually, whereas the average Churchillian consumes 3.35×10^{-4} PJ, nearly 35% more (Canada Energy Regulator, 2019; Statistics Canada, 2019). While the Canadian and Manitoban energy consumption amounts include jet fuel, it is important to note that Churchill's proportion of jet fuel use is exceedingly high. As a semi-remote community, air transportation is a vital linkage for the North. The fact that this linkage is not a necessity for most Canadian or Manitobans is reflected in consumption patterns.

Electricity consumption is also greater in Churchill than at the provincial or national level, both as a proportion of total energy consumption and per capita consumption. Residents of Churchill consumed approximately 1.11×10^{-4} PJ of electricity in 2018, whereas the Canadian average is 5.45×10^{-5} PJ, an order of magnitude less than Churchill (Canada Energy Regulator, 2019; Statistics Canada, 2019).

Findings from the semi-structured interviews and community workshop present a variety of themes. Interviewees expressed concerns about the high costs of the energy system, a desire to reduce fossil fuel consumption, and an interest in locally generated energy. Workshop participants echoed many of the interview themes but placed particular emphasis on the desire for self-sufficiency and local decision making as a way to achieve sustainability. Overall, participants are not satisfied with their current energy system and seek to restructure how energy is generated, transported, and consumed.

Availability

There is limited energy generation in Churchill; most power generation is external to the community resulting in low availability. Three participants noted the use of off-grid trapping cabins outside of the community that were powered by wind and solar and heated by wood stoves. However, all primary sources of energy for the community come from hundreds or thousands of kilometers away, either by rail, sea, or hydroelectric transmission line. Churchill's reliance on external systems is perceived by community members as a barrier to local self-sufficiency:

> With the tenuous nature of having a single hydro line that comes into the town, you know, and there is no sort of plan B like if something serious were to happen to that power supply.
>
> (Participant 16)

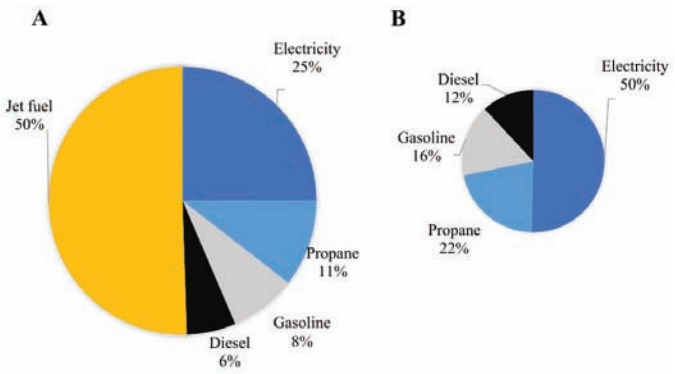

FIG. 1. Churchill's 2018 energy consumption. A) total energy consumption including jet fuel 0.402 PJ. B) community consumption excluding jet fuel, 0.199 PJ.

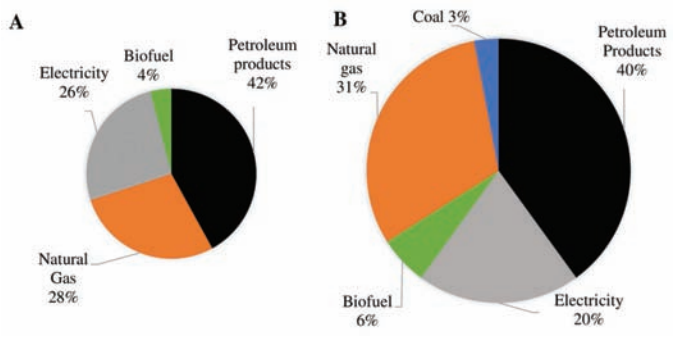

FIG. 2. Energy consumption in 2018. A) Manitoba, 323 PJ (Canada Energy Regulator, 2019). B) Canada, 9013 PJ (Natural Resources Canada, 2018b).

> Well, what I'd like to have is I'd like it to be self-sufficient. Realistically, I would like to see us look at renewables a little stronger to supplement the grid and be able to provide that backup system if required even to a point of a limited time.
>
> (Participant 14)

Backup systems in the form of diesel generators exist for key community infrastructure like the hospital and water treatment plant, but reliance is primarily on tenuous connections to the grid and fossil fuel supply chains. The reliance on grid connection was deemed particularly concerning by 18 participants, as the Province of Manitoba is moving towards electrifying heat (Manitoba Sustainable Development, 2017). This proposal made participants nervous that heat might not be available if storms or thawing permafrost impacted the grid connection, creating life safety concerns. The community's dependency on external sources and little in situ generation capacity greatly impacts how residents perceive energy availability.

The lack of locally available energy and the dependence on external systems are perceived as barriers to self-sufficiency and disaster preparedness by 18 interviewees. There are concerns among 12 interviewees and both workshop groups that the present energy system is unable to manage large disruptions or emergencies in its current state. Nine interview participants expressed anxiety that the energy supply was vulnerable to disruption of the rail or hydro line. Should a disruption occur, there are emergency short-term backups, but these are not sustainable or resilient. These worries are exacerbated by a recent 18-month rail outage in 2017 and 2018 that impacted the supply of propane, gasoline, and diesel to the community. Nine participants consider a self-sufficient energy system as key to disaster management. However, the rail outage did significantly impact residents' perceptions of energy security, especially of propane, gasoline, and diesel, and these perceptions are reflected in the energy plan vision statement.

Accessibility

Six participants envisioned increased accessibility of Churchill to the outside markets and technology as key to improved and reimagined energy security. Innovative solutions that position Churchill as a leader in renewable energy generation and energy efficiency were sought by four workshop participants. Three interview participants noted that the reactivation of the port provided a strong economic spur for the community and that a new energy system should aim to do the same thing.

> [To increase energy security], I think economic investment and development is needed, like [the conservation organization] Polar Bears International.
>
> (Participant 6)

"Foster new partnerships" was also given on a workshop vision theme cue card. Opportunities for partnership with business, research, and other communities to share knowledge and increase opportunities for technological advancement were considered by three participants. Churchill's subarctic geography and accessible wildlife makes it a globally desirable destination, attracting thousands of visitors a year (Dawson et al., 2010; Groulx et al., 2016; Huddart and Stott, 2020). Tourists are significant users of air transport and thus jet fuel, and tourism is a crucial component of the local economy. Increased accessibility to markets beyond tourism was seen by four participants to provide an economic development strategy for Churchill's future that included improved energy systems. The lack of higher education and skilled trades in the community was also identified by six participants as a barrier to the maintenance of the current energy system, and the adoption of a future, more sustainable system. Increasing the accessibility of Churchill's energy system is seen by some participants as key to creating new, more secure, energy systems.

Affordability

Churchillians are acutely aware of affordability in their energy system. Nine interview participants linked the lack of affordability to the community's high per capita energy

consumption. Affordability of energy is one of the most prevalent concerns regarding updating and improving the community's energy system. According to six participants, security improvements and technologies that are affordable and that can be maintained and repaired by the community are key to successful implementation.

> My primary concern is the high costs of energy and the cost to repair and maintain our present energy systems.
>
> (Participant 21)

The high cost of upgrading or retrofitting buildings and the capital costs associated with sustainable or renewable energy projects were noted by 16 interviewees and in the workshop discussion notes as some of the largest affordability challenges. Affordability is seen as a barrier to the implementation of renewable energy technologies. Cost is consistently mentioned by participants as a key barrier to improving the efficiency and sustainability of the energy system.

Affordability of energy is also a barrier to the present system. Fourteen interview participants and the workshop groups directly mentioned the high cost and poor affordability as primary challenges facing Churchill's energy system. Most often, concern about high cost relates to hydroelectricity and propane, but also extends to gasoline and diesel.

> Cost to diversify [is high] … and that all across the board, that's propane, that's heat, that's hydro. And to do any upgrades, the cost is prohibitive.
>
> (Participant 17)

In July 2019, gasoline cost approximately Can$2.25/L, and propane cost approximately $1/L. Participants who pay for electric heat in their homes state that in the coldest months their hydroelectricity bills are often over $300 a month. In comparison, the average cost for electric baseboard heat in Manitoba is approximately $100 a month (Manitoba Hydro, n.d.). The high costs of gasoline or diesel fuel for cars is more accepted than the high costs of propane or hydroelectricity for heat within the community. Only three participants directly mentioned the high cost of gasoline or diesel as a barrier. The remainder focused solely on propane and hydro-electricity, and only one participant mentioned the cost of jet fuel. The affordability of transporting people or goods to and from the community is seen as less related to energy but more to the cost of travel. Churchill's reliance on air transport for people and goods is environmentally damaging and unaffordable. In 2019, round trip airfare between Churchill and Winnipeg was over Can$1700 per person, limiting the mobility and agency of community members. That said, Churchill does have passenger rail service provided by Via Rail, which is a less expensive but more time-consuming transportation option. But, like air travel, rail was not often discussed by participants in the context of energy. The affordability of energy is one of the most prevalent concerns about the present energy system, especially the cost of propane and hydroelectricity.

Acceptability

When asked to reflect on the acceptability of Churchill's energy system, participants spoke of a range of potential environmental impacts associated with energy, including the production of greenhouse gases and the risk of spills related to the storage and transportation of fuel. Twelve interview participants and the workshop discussion notes directly connected acceptability with sustainability and environmental considerations. A strong theme articulated by 21 interview participants and all workshop participants was the desire for renewable energy. There is a strong focus on renewable and carbon-neutral energy production using technologies like wind, solar, or tidal.

> Churchill becomes a leader in alternate energy sources—100% zero net carbon, 100% off grid.
>
> (Workshop participant)

Associated with the environmental dimensions of acceptability, Churchillians expressed concerns about consumption patterns. High consumption decreases acceptability of Churchill's energy system but can be mitigated through efficiency and the use of renewable energy generation.

Agency and Efficiency

In addition to the findings related to the four As, two additional important themes emerged from the results: 1) the need for control over Churchill's energy system by, with, and for the community and 2) the need to decrease the community's energy consumption to reduce emissions and costs. We express these two themes as agency and efficiency.

The desire for a more socially acceptable energy system is further expressed by participants' interest in achieving greater local agency. All workshop discussion groups and 14 interviewees discussed the fact that Churchill's energy system is completely dependent upon the far-removed southern Manitoba systems and how the community lacks control over the supply and distribution of energy. Most of the decision making is done outside of the community by large government bureaucracies like Manitoba Housing or Manitoba Hydro. The supply of most energy comes from the south, without local benefit or generation options.

> It seems as if major companies have a monopoly on the energy source[s] that are in communities and towns and cities. It's just a shame we can't use what's given to us naturally to help communities and populations and people.
>
> (Participant 12)

> I think in [10 years] maybe instead of having a provincial body making decisions on energy for an entire province, maybe you bring it more down to the regional level and you have local energy co-ops for example.
>
> (Participant 5)

A local system would strive to be renewable and use resources closer to the community, relying less on the main grid (Workshop participants). The presence of a utility monopoly and the lack of local skilled trades results in very little community decision making, leading to a lack of social acceptability and agency.

As a remedy to the lack of agency and acceptability, 18 interview and all workshop participants mentioned a desire for an energy system specific to Churchill. Frustrated with the lack of control the community has over its energy system, three participants envisioned a totally local, not grid-connected, self-sufficient energy generation and distribution system. The notion of energy sovereignty was discussed by one interviewee and within the workshop discussion groups. Local generation of energy is seen as key to a sustainable, renewable, local energy system. Local energy generation would require both the technology and skill to repair and maintain the system in the community.

> I would love the independence. I'm sure there's ways we could do that and not be reliant on sources from the south.
>
> (Participant 13)

> [That] Churchill's energy is produced in Churchill—energy sovereignty.
>
> (Workshop participant)

This local energy system envisioned by the community integrates renewable technology and efficiency upgrades to reduce consumption and emissions. In situ generation would also centralize decision making in the community, providing greater agency by reducing dependency on southern systems.

High consumption of energy, especially fossil fuels, is of substantial concern to community members. Thirteen participants mentioned infrastructure age, poor building conditions, wasteful behaviours or the lack of incentives to retrofit create significant unneeded energy consumption. Fewer participants (n = 7) noted the decline of provincially run energy efficiency programs for home retrofits and upgrades as a barrier to modernization and efficiency in the community. For example, Participant 7 noted, "wasting energy is the biggest issue in this town." To address these issues, 14 participants suggested broad improvements to efficiency such as educational programs in schools or in the broader community to promote conservation behaviour. The barriers to acceptability can be partially mitigated through efficiency and utilizing renewable energy generation technologies, something strongly desired by nearly every participant. Environmental acceptability of energy goes beyond the impacts of generation for the community; it includes considerations of consumption by institutions, companies, and individuals. Interviewees and workshop participants were enthused to promote energy savings programs to increase efficiency.

DISCUSSION

The themes that emerged from the interviews and workshop generally align with the four As and the work of energy security scholars, as summarized in Table 1 (APERC, 2007; Kruyt et al., 2009; Cherp and Jewell, 2014). Energy is available and accessible to the community through rail and hydroelectric transmission line. Given Churchill's remoteness, in cases of previous rail disruptions, sea lift was used to ensure accessibility and supply fuel. Affordability could be increased, as many community members cited concerns about their ability to pay for present energy and any future changes. Acceptability of the energy system could also be increased, as residents desire greater use of renewable sources, increased efficiency, local control, and self-sufficiency through local generation.

The prominence of the themes of agency (control over decisions) and efficiency (a desire to reduce consumption at all levels) suggest their importance to energy security in the North. While the desire for improved efficiency is related to the social acceptability and the affordability of Churchill's energy system, efficiency includes the specific desire to use less energy while taking local actions to improve the energy system. The role of action and reduced consumption are not fully accounted for within the concepts of acceptability or affordability. The desire for increased agency is also linked to acceptability, but the current framework of the four As does not consider the role of self-sufficiency or community-level direct action. We view the elements of agency and efficiency as important elements of energy security that are not currently included in historical, mainstream definitions of energy security. Scholars note that definitions like the four As historically fail to consider social, environmental, and community-level issues in any significant or holistic manner (Winzer, 2012; Ang et al., 2015; Hossain et al., 2016). To create a more holistic and representative definition, we propose adding the elements of efficiency and agency to the four As, resulting in A5E1 (acceptability, affordability, availability, accessibility, agency, and efficiency). This conceptualization redefines energy security to incorporate the specific needs of northern communities in a holistic way that achieves sustainable, local energy management.

Agency is incredibly important for communities that are far removed from their energy sources. Many of the participants' criticisms relate to the fact that Churchill is reliant on shipping and external decision making. The capacity of the community to improve the present system is limited and frustrating for residents. This frustration is expressed within the interviews and workshop as the

TABLE 1. Overview of energy security aspects and their manifestation in the Churchill case study.

Aspect	Considerations	Churchill
Availability	The existence of a useable energy source.	• Hydroelectric transmission line. • Rail line for delivery of fuel.
Accessibility	The equipment, knowledge, labour, and market forces needed to produce and consume energy.	• Community desire for economic development partnerships to innovate and develop energy solutions. • Lack of skilled trades to repair or upgrade energy infrastructure.
Affordability	The economic impact of production, generation, and consumption of energy.	• High cost of transportation fuels. • High cost of heat, electricity, and propane. • Cost as a barrier to energy upgrades or new technologies.
Acceptability	Social, cultural, and environmental concerns surrounding energy production and use.	• Desire for reduced emissions and greater protection from fuel spills. • Desire for use of renewable energy technologies.
Agency	Self-sufficiency gained from involvement and influence in decision making regarding energy.	• Desire for control and self-sufficiency. • Energy sovereignty. • No in situ generation. • Little local decision making regarding energy.
Efficiency	Reducing consumption and wasting of energy.	• Desire for reduced consumption and costs. • Need to update and retrofit energy system.

desire for self-sufficiency, local control, education, and skills training. Churchillians feel that they lack agency in their current system because of its high cost, the lack of consultation or decision-making power, and lack of in situ generation.

The four As focus on macroscale accessibility and availability of energy delivered by centralized national energy systems and the security of fossil fuel supplies and infrastructure (Kruyt et al., 2009). Churchill does not fit well within the centralized grid given its isolation and tenuous connection to it. The loss of Churchill's rail in 2017 and 2018 is a pertinent demonstration of how centralized energy systems are tenuously connected to northern communities and how their disruption can jeopardize the accessibility and availability of energy. Churchill replaced local diesel generation, which much of the North currently possesses, in the 1980s. While connection to hydroelectricity allows the community to reduce costs and emissions, the hydroelectric line is vulnerable and is governed by external decision makers. The external provision of energy, while impacted by tenuous availability and accessibility, is a matter of agency. Redressing Churchill's need for local generation and reliable energy can be achieved through increased agency and a local energy system as opposed to a centralized grid.

Given Churchill's status as a municipality, decisions surrounding community planning and energy planning are largely made at the provincial level. Manitoba Hydro, a provincially owned, centralized energy generator and distributor, controls much of the energy-related decision making and infrastructure. Residents feel that they are subject to the system rather than a part of it. This perception is compounded by the fact that a significant portion of housing in Churchill is also government owned and managed, meaning tenants cannot install their own energy efficiency upgrades or makes choices about their energy. Further, no Manitoba Housing tenants in Churchill pay for utilities, which led some residents to speculate if a lack of financial incentive leads to unnecessary consumption. There is a lack of any direct agency in Churchill's present energy system.

Agency is needed to bring about the desired new energy system in Churchill. Government ownership of housing, energy monopolies, and private utilities limit agency in the present system and thus Churchill's ability to take independent action for its future. The community lacks the funds and skilled trades people to effectively transition to renewable and local energy generation. Increased agency requires that Churchill be able to explore and implement the necessary changes to ensure energy security. Participants expressed the desire to simply live at the same standards as Southerners—to have affordable, reliable, acceptable energy that they have a say in.

The four As of energy security take into consideration the availability of fuel, but not the need for improved efficiency. Increased energy consumption is typical of northern communities, which impacts the affordability and acceptability of energy systems (McDonald and Pearce, 2013; Karanasios and Parker, 2018). Churchill exemplifies this with its higher-than-average per capita consumption of electricity and fossil fuels, which results in disproportionate emissions. On the forefront of climate change, northern communities are the most likely to be impacted severely with the least capacity to adapt (St. Denis and Parker, 2009; Karanasios and Parker, 2018). To reduce overall consumption and emissions of greenhouse gases, efficiency is crucial to acceptability. High consumption also increases costs. In the North, energy can be three to 10 times as expensive as in southern Canada (National Energy Board, 2016; Rezaei and Dowlatabadi, 2016). Including efficiency in energy security definitions has cross-cutting implications that can improve affordability

and acceptability. Considering efficiency in the energy system is an important step identified by the community to mitigate these challenges and make the four As more robust and applicable to northern communities.

Managing energy at the local level is crucial for long-term sustainability and requires new components of energy security (Canada Mortgage and Housing Corporation, 2003; Hossain et al., 2016). The local management of energy keeps social and economic benefits within the region, while increasing local resilience and decreasing fossil fuel use (Alanne and Saari, 2006; Burke and Stephens, 2018). The COVID-19 pandemic highlights the crucial need for local energy security and the exceptional challenges faced by remote northern communities (Brosemer et al., 2020; Rasolt, 2020; Graff and Carley, 2020). Local control and self-sufficiency as desired by Churchill are necessary for long-term sustainability but are not completely captured by the four As. The addition of agency to the four As more completely reflects the realities of energy security in the North.

Modern energy systems and definitions of energy security do not adequately provide energy to the North. Communities in the Canadian North like Churchill experience particular energy challenges, including a lack of reliable and affordable energy and disproportionate use of fossil fuels, and often bear the burdens of large-scale energy production. Southern paradigms do not apply well to northern communities and need to be personalized to the unique conditions of the North. Assessing energy security in Churchill can be done more robustly by including the elements of agency and efficiency into the four As. Utilizing A5E1 includes the strengths of the four As definition and adds essential elements to strengthen energy security as identified by community members in Churchill. A5E1 more effectively captures the needs of the community and provides a more accurate reflection of Churchill's energy system and how it is perceived by the community.

A Churchill-specific definition of energy security assists the community in beginning to redefine its energy system. In the diverse regions of the North, context and place are important. Place-based definitions can better consider the resources and geopolitical context of existing and potential energy systems. This research provides a localized definition and the data needed to identify a vision for a future community energy plan. With an established energy profile and community vision, the foundation now exists for future planning and implementation of a renewable energy system in Churchill. It is the first step the community is taking to reverse its energy-related vulnerabilities and increase energy security.

While this research was limited to a singular case study, it adds northern Manitoban experiences of energy security to the literature. This case is supported by a broader network of research through the Community Appropriate Sustainable Energy Security (CASES) partnership. The CASES partnership is a joint venture between industry, government, and northern and Indigenous communities to "reimagine energy security … by co-creating and brokering the knowledge, understanding, and capacity to design, implement and manage renewable energy systems that support and enhance social and economic values" (CASES, n.d.). The partnership seeks to frame energy security for the unique and specific needs of northern and Indigenous communities and jointly establish local energy systems that improve community benefit. The findings from this case study will be shared and applied to other northern communities in Canada and internationally.

CONCLUSION

A key observation in the energy security literature has been the contextual and changing nature of energy security (Chester, 2010; Sovacool, 2011; Winzer, 2012; Ang et al., 2015). Past definitions of energy security are being phased out because they were only fuel and supply oriented and are no longer applicable to holistic energy systems. Future definitions of energy security that consider long-term sustainability with carbon-free renewable sources will be just as important in shaping future energy systems as past definitions have been for past systems. Under traditional definitions of energy security, northern communities were considered secure since they had a source of fuel, but a more nuanced, holistic approach reveals the gaps left by traditional definitions.

Ultimately, considerations of energy security are imprecise and subjective. Many energy security concerns within Churchill are multifaceted and do not fit neatly into one category. There is substantial overlap in the needs and desires of the community among numerous elements and conceptualizations of energy security.

That being said, the four As of energy security do not completely address the unique needs of northern and remote communities but can provide a framework for building a better structure. Through creating a profile of Churchill's energy system and understanding the criteria for alternatives as presented by community members, an alternative framing of energy security for the North is contemplated. A5E1 (availability, accessibility, affordability, acceptability, agency, and efficiency) incorporates the elements of efficiency and agency into the existing four As of the energy security definition to better reflect the requirements for energy security in northern Canada. Reframing energy security as A5E1 is in line with the subjective nature of energy security and better defines it for the circumstances in Churchill.

ACKNOWLEDGEMENTS

The authors acknowledge that Churchill is within the adhesion to Treaty 5 home of the Cree, Dene, Inuit, and Metis Peoples. The University of Winnipeg is located in Treaty 1, the territory of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene Peoples, and

the homeland of the Metis Peoples. The water we drink comes from Treaty 3 and the power we use comes from Treaty 5 and beyond. The authors would like to thank the participants for their invaluable insights; this article would not be possible without them. The authors also extend thanks to the anonymous reviewers of this paper for their constructive feedback. This research was supported by the University of Winnipeg, the Northern Research Fund, the Northern Scientific Training Program, the Geography and Environmental Students' Association, the Social Sciences and Humanities Research Council of Canada through the CASES partnership grant, and the Manitoba Public Interest Law Centre. Funders had no involvement in study design, data collection, analysis, interpretation, writing, or submission to publication.

REFERENCES

Alanne, K., and Saari, A. 2006. Distributed energy generation and sustainable development. Renewable and Sustainable Energy Reviews 10(6):539–558. https://doi.org/10.1016/j.rser.2004.11.004

Ang, B.W., Choong, W.L., and Ng, T.S. 2015. Energy security: Definitions, dimensions and indexes. Renewable and Sustainable Energy Reviews 42:1077–1093. https://doi.org/10.1016/j.rser.2014.10.064

APERC (Asia Pacific Energy Research Centre). 2007. A quest for energy security in the 21st century: Resources and constraints. Tokyo: APERC. https://aperc.or.jp/file/2010/9/26/APERC_2007_A_Quest_for_Energy_Security.pdf

Ayoo, C. 2020. Towards energy security for the twenty-first century. In: Taner, T., ed. Energy policy. London: IntechOpen Ltd. https://doi.org/10.5772/intechopen.90872

Berg, B.L. 2007. Qualitative research methods for the social sciences, 6th ed. Boston: Pearson.

Brosemer, K., Schelly, C., Gagnon, V., Arola, K.L., Pearce, J.M., Bessette, D., and Schmitt Olabisi, L. 2020. The energy crises revealed by COVID: Intersections of Indigeneity, inequity, and health. Energy Research & Social Science 68: 101661. https://doi.org/10.1016/j.erss.2020.101661

Burke, M.J., and Stephens, J.C. 2018. Political power and renewable energy futures: A critical review. Energy Research & Social Science 35:78–93. https://doi.org/10.1016/j.erss.2017.10.018

Canada Energy Regulator. 2019. Provincial and territorial energy profiles – Manitoba. Ottawa: Government of Canada.

Canada Mortgage and Housing Corporation. 2003. Community energy management: Foundation paper. Technical Series 02-112. Ottawa: Government of Canada. https://publications.gc.ca/site/eng/474303/publication.html

CASES (Community Appropriate Sustainable Energy Security Partnership). n.d. Renewable energy homepage. Saskatoon: University of Saskatchewan. https://renewableenergy.usask.ca/Projects/CASES.php

CBC (Canadian Broadcasting Corporation). 2018. Propane shipment heading to Churchill after residents ordered to ration use. *CBC News*, July 6.

Cherp, A., and Jewell, J. 2014. The concept of energy security: Beyond the four As. Energy Policy 75:415–421. https://doi.org/10.1016/J.ENPOL.2014.09.005

Chester, L. 2010. Conceptualising energy security and making explicit its polysemic nature. Energy Policy 38(2):887–895. https://doi.org/10.1016/j.enpol.2009.10.039

Churchill Chamber of Commerce. 2020. Tours / Travel agencies. https://www.churchillchamber.ca/tours-travel-agencies-churchill-chamber-of-commerce

Cope, M., and Kurtz, H. 2016. Organizing, coding, analyzing qualitative data. In: Clifford, N., Cope, M., Gillespie, T., and French, S., eds. Key methods in geography, 3rd ed. Thousand Oaks, California: Sage. 647–664.

Dawson, J., Stewart, E.J., Lemelin, H., and Scott, D. 2010. The carbon cost of polar bear viewing tourism in Churchill, Canada. Journal of Sustainable Tourism 18(3):319–336. https://doi.org/10.1080/09669580903215147

Distasio, J., Dudley, M., and Moradzadeh, F. 2011. Churchill sustainability planning framework. Winnipeg: The Institute of Urban Studies, University of Winnipeg. https://winnspace.uwinnipeg.ca/handle/10680/806

Eaton, E. 2015. Managing energy resources for environmental and social sustainability. In: Mitchell, B., ed. Resource and environmental management in Canada: Addressing conflict and uncertainty, 5th ed. Don Mills: Oxford University Press. 370–401.

ESRI (Environmental Systems Research Institute). 2018. ArcGIS 10.6.1.

Evenson, J., Margerm, K., and McDonough, A. 2013. Advancing integrated community energy planning in Ontario: A primer. Toronto: Canadian Urban Institute.

Gjorv, G.H. 2017. Tensions between environmental, economic and energy security in the Arctic. In: Fondahl, G., and Wilson, G.N., eds. Northern sustainabilities: Understanding and addressing change in the circumpolar world. Cham, Switzerland: Springer. 35–46. https://doi.org/10.1007/978-3-319-46150-2

Graff, M., and Carley, S. 2020. COVID-19 assistance needs to target energy insecurity. Nature Energy 5:352–354. https://doi.org/10.1038/s41560-020-0620-y

Groulx, M., Lemieux, C., Dawson, J., Stewart, E., and Yudina, O. 2016. Motivations to engage in last chance tourism in the Churchill Wildlife Management Area and Wapusk National Park: The role of place identity and nature relatedness. Journal of Sustainable Tourism 24(11):1523–1540. https://doi.org/10.1080/09669582.2015.1134556

Henry, M.S., Bazilian, M.D., and Markuson, C. 2020. Just transitions: Histories and futures in a post-COVID world. Energy Research & Social Science 68: 101668. https://doi.org/10.1016/j.erss.2020.101668

Hossain, Y., Loring, P.A., and Marsik, T. 2016. Defining energy security in the rural North—Historical and contemporary perspectives from Alaska. Energy Research & Social Science 16:89–97. https://doi.org/10.1016/J.ERSS.2016.03.014

Huddart, D., and Stott, T. 2020. Adventure tourism: Environmental impacts and management. Cham, Switzerland: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-18623-4

Hughes, L. 2009. The four 'R's of energy security. Energy Policy 37(6):2459–2461. https://doi.org/10.1016/j.enpol.2009.02.038

Jewell, J., Vinichenko, V., McCollum, D., Bauer, N., Riahi, K., Aboumahboub, T., Fricko, O., et al. 2016. Comparison and interactions between the long-term pursuit of energy independence and climate policies. Nature Energy 1: 16073. https://doi.org/10.1038/nenergy.2016.73

Karanasios, K., and Parker, P. 2018. Tracking the transition to renewable electricity in remote Indigenous communities in Canada. Energy Policy 118:169–181. https://doi.org/10.1016/j.enpol.2018.03.032

Kruyt, B., van Vuuren, D.P., de Vries, H.J.M., and Groenenberg, H. 2009. Indicators for energy security. Energy Policy 37(6):2166–2181. https://doi.org/10.1016/J.ENPOL.2009.02.006

Lemelin, H., and Whipp, P. 2019. Last chance tourism: A decade in review. In: Timothy, D.J., ed. Handbook of globalisation and tourism. Cheltenham: Edward Elgar Publishing. 316–322. https://doi.org/10.4337/9781786431295.00039

Lucas, A., Robb, K., Sewell, K., Velo, A.M., and Villebrun-Normand, K. 2018. Community energy plan for Churchill, Manitoba: Preliminary stages. Winnipeg: Department of Geography, University of Winnipeg.

Manitoba Government. 1996. The Municipal Act. Continuing consolidation of the Statues of Manitoba c. M225. Winnipeg: Manitoba Government. https://web2.gov.mb.ca/laws/statutes/ccsm/m225e.php

Manitoba Hydro. 2003. A history of electric power in Manitoba. Winnipeg: Manitoba Hydro Public Affairs. https://www.hydro.mb.ca/corporate/history/history_of_electric_power_book.pdf

———. n.d. Calculate heating costs. Winnipeg: Manitoba Hydro. https://www.hydro.mb.ca/your_home/heating_and_cooling/calculator/

Manitoba Sustainable Development. 2017. A made-in-Manitoba climate and green plan: Hearing from Manitobans. Winnipeg: Manitoba Government.

Mcdonald, N.C., and Pearce, J.M. 2012. Renewable energy policies and programs in Nunavut: Perspectives from the federal and territorial governments. Arctic 65(4):465–475. https://doi.org/10.14430/arctic4244

———. 2013. Community voices: Perspectives on renewable energy in Nunavut. Arctic 66(1):94–104. https://doi.org/10.14430/arctic4269

Merriam, S.B. 1988. Case study research in education: A qualitative approach. San Fransciso: Jossey-Bass.

National Energy Board. 2016. Canada's energy future 2016: Energy supply and demand projections to 2040. Ottawa: Government of Canada. https://doi.org/10.35002/qb3a-x355

Natural Resources Canada. 2018a. The Atlas of Canada – Remote communities energy database. Ottawa: Government of Canada. https://atlas.gc.ca/rced-bdece/en/index.html

———. 2018b. Energy fact book: 2018–2019. Ottawa: Government of Canada.

Nyman, J. 2018. Rethinking energy, climate and security: A critical analysis of energy security in the US. Journal of International Relations and Development 21:118–145. https://doi.org/10.1057/jird.2015.26

Proskuryakova, L. 2018. Updating energy security and environmental policy: Energy security theories revisited. Journal of Environmental Management 223:203–214. https://doi.org/10.1016/j.jenvman.2018.06.016

Province of Manitoba. n.d. Churchill River diversion. Winnipeg, Environment, Climate and Parks, Manitoba Government. https://www.gov.mb.ca/sd/water/water-power/churchill/index.html

QSR International. 2018. Nvivo 12. Melbourne, Australia: QSR International.

Rasolt, D.H. 2020. Self-Imposed isolation of Indigenous communities due to COVID-19 reinforces the need for clean off-grid energy sources. Resilience. https://www.resilience.org/stories/2020-04-22/self-imposed-isolation-of-indigenous-communities-due-to-covid-19-reinforces-the-need-for-clean-off-grid-energy-sources/

Rezaei, M., and Dowlatabadi, H. 2016. Off-grid: Community energy and the pursuit of self-sufficiency in British Columbia's remote and First Nations communities. Local Environment 21(7):789–807. https://doi.org/10.1080/13549839.2015.1031730

Riley, B. 2020. Energy security on remote Aboriginal communities during the COVID-19 crisis. In: Markham, F., Smith, D., and Morphy, F., eds. Indigenous Australians and the COVID 19 crisis: Perspectives on public policy. CAEPR Topical Issue 1.2020. Canberra: Centre for Aboriginal Economic Policy Research, Australian National University. 24–25. https://doi.org/10.25911/5e8702ec1fba2

Sovacool, B.K., ed. 2011. The Routledge handbook of energy security, 1st ed. London: Taylor & Francis Group. https://doi.org/10.4324/9780203834602

Sovacool, B.K., and Mukherjee, I. 2011. Conceptualizing and measuring energy security: A synthesized approach. Energy 36(8):5343–5355. https://doi.org/10.1016/J.ENERGY.2011.06.043

Stammler, F. 2020. Impacts on mobility. In: Spence, J., Oddsdóttir, E.E., Sveinbjarnardóttir, E.K., Baer, K., and Plouffe, J., eds. Covid-19 in the Arctic: Briefing document for Senior Arctic officials. Tromsø: Arctic Council. 54–56.

Statistics Canada. 2017. Churchill, Town [Census subdivision], Manitoba and Manitoba [Province]. Census profile, 2016 census.

———. 2019. Population and dwelling count highlight tables, 2016 census. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/pd-pl/index-eng.cfm

St. Denis, G., and Parker, P. 2009. Community energy planning in Canada: The role of renewable energy. Renewable and Sustainable Energy Reviews 13(8):2088–2095. https://doi.org/10.1016/j.rser.2008.09.030

Taylor, L. 2016. Case study methodology. In: Clifford, N., Cope, M., Gillespie, T., and French, S., eds. Key methods in geography, 3rd ed. Thousand Oaks, California: Sage. 581–595.

Travel Manitoba. 2020. Where to stay in Churchill. Winnipeg: Travel Manitoba. https://www.travelmanitoba.com/churchill/plan/stay/

Wang, Q., and Zhou, K. 2017. A framework for evaluating global national energy security. Applied Energy 188:19–31. https://doi.org/10.1016/j.apenergy.2016.11.116

Wates, N. 2014. The community planning handbook: How people can shape their cities, towns and villages in any part of the world, 2nd ed. London: Routledge.

Webster, J. 2016. Data issues and promising practices for integrated community energy mapping. Canadian Geospatial Data Infrastructure Information Product 50e. Ottawa: Natural Resources Canada. https://doi.org/10.4095/299224

Winzer, C. 2012. Conceptualizing energy security. Energy Policy 46:36–48. https://doi.org/10.1016/J.ENPOL.2012.02.067