Energy Policy 118 (2018) 169–181

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

# Tracking the transition to renewable electricity in remote indigenous communities in Canada

Konstantinos Karanasios*, Paul Parker

*Department of Geography and Environmental Management, University of Waterloo, Canada*

ARTICLE INFO

*Keywords:*
Off grid
Remote indigenous communities
Renewable energy
Policy
Hybrid electricity system
Canada

ABSTRACT

Diesel generated electricity in 144 Canadian remote indigenous communities is responsible for carbon emissions, spills, leakages, poor quality services, and potentially restricts community development. Introducing renewable electricity technologies (RETs) into community electrical systems could address both environmental and socioeconomic development issues. This paper identifies 71 RET projects developed in remote communities between 1980 and 2016 and uses the multi-level perspective (MLP) to examine the diffusion and governance processes influencing the transformation of these systems. The MLP framework explains the non-linear deployment of RETs through the shift from a utility driven phase focusing on hydroelectricity and small wind applications to a community driven phase concentrating on solar projects. Reasons for the development of projects in Yukon, Northwest Territories, British Columbia and Ontario include community interest in participating in local electricity generation, learning processes facilitated by multiple experiments, and the existence of supporting regulatory and fiscal policies that were negotiated and adapted to indigenous sustainability visions. The MLP framework indicates that remote indigenous communities now reject the role of passive recipients of technologies promoted by non-aboriginal interests. Instead, active participation in transforming electrical systems is sought, based on local sustainability agendas which further their goals of economic development and self-governance.

## 1. Introduction

In 2015, 193 member states of the United Nations adopted the 17 Sustainable Development Goals including goal number 7: "Ensure access to affordable, reliable, sustainable and modern energy for all" (UN, 2016). Although renewable sources account for over half of all electricity generated in Canada (NRCan, 2016a, 2016b), there are 144 remote indigenous communities[1] with a population of approximately 100,000 that are powered by isolated diesel systems (AANDC and NRCan, 2011; AANDC, 2012). Alternatives to diesel generated electricity include the connection to electrical grids, the use of alternative fuels (such as natural gas), and the introduction of renewable electricity technologies (RETs) into the communities' electrical systems. Despite the availability of renewable resources in remote indigenous communities, and research on the potential for integration of RETs, the shift to increased renewable electricity generation has only just begun. Seventy-one small RET projects over the 1980–2016 period serve as transition experiments to generate valuable learnings for a broader transition toward distributed and locally/indigenous owned RETs in remote communities.

Analytical tools for studying the diffusion of RETs include the STEP and AKTESP frameworks, which are used to identify agreement (A), knowledge (K), technical (T), economic (E), social (S), and political (P) factors influencing deployment. These frameworks have previously been used to identify and examine the deployment of grid connected large scale RETs in Saskatchewan (Richards et al., 2012) and Canada as a whole (Valentine, 2010). In the case of Canadian remote indigenous communities, non-technical barriers to communities' participation in RETs include institutional weaknesses and capacity issues, vested interests in diesel generated electricity, lack of capital, high capital costs, lack of expertise, missing infrastructure, and limited community acceptance (Ostrom, 1981; Parcher, 2004; INAC, 2005, 2007; Inglis, 2012). Technological constraints include, the need for developer, installer and operator expertise, the availability of distribution infrastructure, information systems, smart grids, lower cost storage, packaged systems control technologies, and robust equipment able to operate in extreme climatic conditions and variable load configurations (Fay et al., 2010b; Baring-Gould and Dabo, 2009; Weis, Ilinca, and

* Corresponding author.
*E-mail address:* kkaranasios@uwaterloo.ca (K. Karanasios).

[1] According to AANDC and NRCan (2011) remote or off-grid communities are permanent or long-term (five years or more) settlements with at least ten dwellings that are not connected to the North American electricity grid or the piped natural gas network.

https://doi.org/10.1016/j.enpol.2018.03.032
Received 4 July 2017; Received in revised form 29 January 2018; Accepted 12 March 2018
0301-4215/ 

Pinard, 2008). Another strand of research examines the financial performance of RET projects through feasibility and optimization studies, conducted between 2003 and 2016 for 96 remote indigenous communities (ARI, 2003, 2016; Krohn, 2005; Maissan, 2006; Pinard, 2007; Weis and Ilinca, 2008; NFL Hydro, 2009; Weis and Ilinca, 2010; Arriaga et al., 2013; Das and Canizares, 2016). Results indicate, under numerous assumptions, that a limited number of RET projects are financially viable, due to the high cost of RET generated electricity and limited economies of scale. Finally, a number of studies point to communities' sustainability concerns in the form of lack of economic benefits and assets control (OEB, 2008; INAC, 2004; Rezaei and Dowlatabadi, 2016), and high residential electricity costs (McDonald and Pearce, 2013; GNWT, 2008) as factors responsible for limited community participation in renewable electricity generation.

Overall, these studies fail to take into consideration the functional dynamics of transforming electrical systems in the form of interactions between participating actors' structures, cultures, and practices that may drive non-linear behaviors, and the existence of positive and negative feedback mechanisms that may accelerate or slow the diffusion of new technologies (Grin et al., 2010). For example, the establishment of new institutions and relationships may give rise to new policies, which in turn, supported by appropriate technologies, may define new institutions and relationships, create new interest groups and new institutions in electricity markets (Yi and Feiock, 2014; Smith et al., 2005). An alternative means of analyzing technological change and the diffusion of innovative solutions is the technological transitions approach, or the multi-level perspective (MLP) framework. The MLP analysis includes economic factors (such as costs, profitability and technological knowledge), but additionally considers interactions between broader overarching political and social institutions (landscapes-macro level), the functional relationships between actors participating in the technological system (regimes-meso level), as well as the influence of technological niches, to conceptualize the transition process towards more sustainable options (Geels, 2005; Geels and Schot, 2007; Smith et al., 2005).

Based on available data for 133 remote Canadian indigenous communities in seven provinces and territories that rely on diesel generated electricity, this paper seeks to apply the MLP framework to examine the development of RETs in these communities between 1980 and 2016. More specifically, the paper examines the extent to which RETs have emerged as a viable electricity generation alternative in remote communities and identifies governance processes responsible for transition patterns, with the goal to provide (i) insights on the effectiveness of governance processes and instruments, and (ii) levers influencing the transition.

The paper is structured as follows: Section 2 presents the analytical framework, while Section 3 describes the methodology followed. Section 4 presents the findings, followed by a discussion in Section 5 and concluding remarks in Section 6.

## 2. Analytical framework

Sustainability transitions examine the transformation of sociotechnical systems into more sustainable alternatives through the interaction of three levels, landscapes, socio-technical regimes, and technological niches (Geels, 2005; Geels and Schot, 2007). Landscape (macro-level) factors represent broader overarching political and social institutions, while socio-technical regimes consist of the structures, cultures and practices of actors that establish and maintain a technological system (meso-level); finally, niches are the spaces where new innovations are created (micro-level), protected from market intervention until they reach maturity and build the necessary networks for market integration (Grin et al., 2010).

DeHaan and Rotmans (2011) conceptualize sociotechnical change by introducing three main subsystems (constellations or regimes) of the sociotechnical system that contribute to the system's functioning and influence the transition process: first, the incumbent regime that currently dominates the functions of the sociotechnical system that meets societal needs; second, novel constellations called niches that are able to provide system functions, but they are not powerful enough to become the dominant regime; finally, niche-regimes that provide, or are able to provide, system functions due to their power and are situated between the previous actors. Accordingly, the transition from the current system to a more sustainable one is conceptualized through the emergence of a niche-regime, either existing or developed out of a niche, that applies a different way (in terms of structure, culture and practices) of fulfilling societal needs, competes with the incumbent regime, and, eventually, takes over its functions, thus becoming the main provider of the system's functioning (deHaan and Rotmans, 2011; Grin et al., 2010).

Transformative change in the system occurs through (a) tensions, or misalignment of the incumbent regime's functioning as a response to new developments at the broader landscape level of economic, cultural, political or ecological nature, (b) stresses, defined as internal misalignments of incumbent regime's functioning that is either inadequate or inconsistent with the societal needs, and (c) pressures, developed towards incumbent regimes from new technologies and/or the existence of niches or niche-regimes (deHaan and Rotmans, 2011). When the regime conditions (tensions, stresses and pressures) reinforce each other towards a certain direction, then the introduction of transition experiments in the form of technological innovative projects aiming at societal change, allow for learning processes and the empowerment of niches and their transformation to niche-regimes that challenge the incumbent regime (deHaan and Rotmans, 2011; Grin et al., 2010; van den Bosch and Rotmans, 2008). Learning processes include learning from transition experiments implemented in a specific context (deepening), in different contexts (broadening), as well as experiments that are integrated and embedded (scaling-up) into mainstream activities and practices (van den Bosch and Rotmans, 2008; Grin et al., 2010). Van den Bosch and Rotmans (2008) add four niche related conditions for the success of transition experiments, namely (a) the internal alignment of the niche, (b) the ability of the niche to exercise power on the incumbent regime locally, (c) the existence of a cooperative regime that is responsive to experiments and the existence of key actors that assist in transforming experiments to practices that address societal needs, and (d) the alignment of the niche with trends and developments at the broader landscape level. The transition contains "slow" phases (pre-development and stabilization), resulting from negative feedback mechanisms caused by the incumbent regime in charge during the specific period, and "fast" phases (take-off and acceleration), where regime and niche regime conditions create positive feedback mechanisms that move the innovation forward (Grin et al., 2010).

Because a transition process (or transition pathway) covers periods of (slow and fast) transformation, it could be represented as a sequence of transition patterns, or a sequence of transformations from a current system state to a new system state, involving changes in the system's functioning (deHaan and Rotmans, 2011). This transformative change can be "managed" by creating supporting mechanisms that create positive feedbacks, thereby influencing the transition. According to Loorbach (2007), transitions governance uses a cyclical process starting at the strategic level by envisioning a solution to a societal problem (problem structuring phase). At a second step, actions at the tactical level (policies and regulations) are negotiated (development of transition agendas). The next phase (implementation) is concerned with transition experiments, where policies and innovative projects and practices are transformed into action, coalitions are formed, and implementation initiated. The final phase (process evaluation) includes monitoring, evaluating, and learning from the implemented experiments and, based on the knowledge acquired, the adjustment of the visions, agendas, experiments and coalitions, initiating an iterative cycle of actions (development rounds), until the system transformation is completed (see also Voss and Bornemann, 2011; Schot and Geels,