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Institutional diversity, policy niches, and smart grids: A review of the evolution of Smart Grid policy and practice in Ontario, Canada

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ABSTRACT

Jurisdictions around the world are responding the to potential of smart grids in different ways. This paper employs a multi-level perspective approach to socio-technological transitions to examine why the Canadian province of Ontario has seen a relatively smooth transition of smart meter technologies from the niche to regime levels as compared with other Canadian provinces, and other jurisdictions in the United States, European Union, and Australia. The paper also examines the reasons for Ontario's advanced legislative and policy framework around Smart Grid development, relative to those of other provinces. The complex institutional landscape around electricity that has emerged in Ontario since the break-up of the province's monopoly utility Ontario Hydro in the late 1990s emerges as a significant factor in both outcomes. The role of the province's municipally-owned LDCs spell out "local distribution companies (LDCs) as the primary agents for smart meter deployment, as opposed to a dominant vertically integrated utility, appears to have had an important mediating effect on public opposition to smart meters. With respect to Smart Grid policy, the diversity of high capacity institutional actors that now define the province's electricity policy landscape has facilitated the emergence of several interagency policy development niches. In a manner consistent with the concept of technological niches in the socio-technical transitions literature, the interagency status of these policy niches has shielded them from the regime level selective pressures that would likely have existed in a more unified institutional structure, and empowered new policy ideas to move from the niche to regime levels. These outcomes have significant implications for the understanding of socio-technological transitions, particularly around the role of institutional complexity in the emergence of niches for technology and policy development purposes and in niche to regime level transitions.

1. Introduction

1.1. Smart meters and smart grids

Electricity systems are undergoing rapid modernization as they transition into the digital era of the Smart Grid. This modernization will see the electricity grid shift from a servo-mechanical, paper driven system, to a modern, highly automated network that incorporates sensors, monitoring, and communications to improve the flexibility, security, efficiency, and reliability of the grid [1].

The objective of the Smart Grid is to enhance the grid with digital technologies that can monitor and manage the flows of electricity and information [2]. From the perspective of utilities or grid regulators, the Smart Grid encompasses the entire electricity infrastructure from generation to consumption. It can be understood as an evolutionary *transformation* [3] of the existing infrastructure that will provide a powerful management tool to co-ordinate generation, grid operations, end-users and the electricity market. At the same time it is expected to minimize costs and environmental impacts, and maximize system reliability, resilience, and stability [4].

Others see the Smart Grid is something much bigger than a new electricity system management tool. Through its ability to facilitate two-way information and energy flows, and capacity to support more distributed electricity generation and control, the emerging Smart Grid is seen to have the potential to facilitate challenges to existing economic and institutional structures by allowing new entrants, particularly "behind the meter" (BTM), into energy supply and services markets. These developments may test the viability of traditional utility models [5] and lead to the *reconfiguration* or even *de-alignment* and *re-alignment* [3] of electricity systems. Conventional utilities, their regulators and policy-makers are already struggling to deal with these possibilities and their potentially revolutionary implications [6].

Smart Meters, for their part, are devices capable of recording electricity consumption and reporting it to the supplying utility in real

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time, as opposed to the traditional approach of having utility staff read meters manually at monthly or greater internals. Smart meters are the most publicly visible element of a Smart Grid and their deployment is generally regarded as the first stage in Smart Grid development [7].

This article reviews the literature on the multi-level perspective on socio-technological transitions. It introduces a case study of smart meter deployment in Ontario to illustrate how institutional complexity has smoothed the adoption of smart meters relative to the experiences of other jurisdictions. The paper also examines how institutional complexity has facilitated the emergence of policy development niches around smart grids. These niches have strengthened the province's capacity in smart grid policy development, and help explain its status as the leading jurisdiction in Canada in this regard.

1.2. Multi-level perspectives, institutional structures, niches and Smart Grid policy development

The Canadian province of Ontario offers an important case study in smart meter deployment and Smart Grid policy development and implementation. In contrast to the experiences of other jurisdictions in Canada, [8] the United States, [9], European Union, [10–12], and Australia [13], smart meter deployment, which began in 2004 and was virtually complete in Ontario by 2012, and took place with very low levels of social conflict. Moreover, the province has established by far the most comprehensive legislative and policy framework around Smart Grid development among Canada's provinces.

The multilevel perspective (MLP) literature on socio-technological transitions is potentially helpful in understanding the reasons for these different outcomes. The MLP literature links three scales of analysis [14,15]. The "socio-technical landscape" is defined as the exogenous environment of air quality, resource prices, lifestyles, and political, cultural and economic structures. The "socio-technological regime" consists of infrastructures, regulations, markets, and established technical knowledge. "Socio-technical niches" are the focal points of innovation activity at a local scale. Regimes are nested within and structured by landscapes, and niches are nested within and structured by regimes. The niche level is understood to be the key centre for innovation in technology and practice. The MLP literature focuses on the transition processes that occur when landscape pressures on the regime create windows of opportunity for the adoption of niche-level innovations. Smart meters and smart grids provide opportunities to examine the transition of new technologies from niche level developments to becoming part of the socio-technological regime.

Three major variables are generally identified in socio-technological transitions [3]. These are: actors and social groups; rules and institutions; and technologies and the wider socio-technical and economic system. Other authors have also highlighted the importance of the roles of underlying ideas, norms and assumptions about energy systems, sustainability and the role of the state and markets in energy policy formulation and transitions as a distinct category of variables [16–18].

Transitions are seen to follow one of four potential pathways [3]: *technological substitution*, where existing regimes are overthrown by the deliberate introduction of new actors and technologies; *transformations* where incumbent regimes are gradually reoriented through adjustments by existing actors in the context changing landscape conditions; *reconfigurations*, where the emergence of new technologies leads to more structural adjustments in regimes as a result of landscape pressures; and *de-alignments* and *re-alignments*, where existing regimes are disrupted by external developments, and new niche level innovations and actors emerge and reconfigure the regime.

As new technologies may not fit well with existing socio-technological regimes, niches are understood as spaces where developing technologies are protected from the normal selection pressures embodied in dominant regimes [19,20]. Much of the literature on socio-technological niches takes their existence for granted [19,20]. Niches may be protected from the selection pressures of the regime either by design or by circumstance [21], although the specific understandings of their creation are less well developed [20]. Where such research exists, it has tended to focus on the creation of niches through deliberate policy interventions, and less on other, more circumstantial, mechanisms through which they may emerge [22,23].

The existing socio-technological transitions literature tends to focus on the role of niches for the purposes of technology development and diffusion [19,24–26]. Less attention has been paid to the emergence or creation of niches for the purposes of policy formulation and development. In policy terms, the MLP concept of a technological niche is somewhat analogous to Kingdon's notion of a policy stream, where policy ideas may be developed, but are likely only to be adopted when political factors, social, technological, economic or biophysical problems and the work of policy entrepreneurs converge to create a policy window through which new policy ideas can be advanced [27]. In a Canadian context Jegen and Phillion [28] specifically highlight the weakness of the Smart Grid policy stream (or lack of policy niches) in Quebec as a key factor in the relative absence of a Smart Grid policy framework in that province.

Both the MLP and policy transitions literatures [27,29,30] highlight the point that adoptions of new, potentially reconfiguring or re-aligning technologies, or significant changes in policy direction, are unusual in the normal course of events. Existing technological, institutional, and political frameworks, are simply too well established to be easily displaced. Rather technological and policy transitions require substantial preparatory activity at the niche or policy stream levels, and convergences of landscape level forces or events (physical, economic, technological, ideational, or political) for major changes to occur. The Ontario smart grid policy case study provides an opportunity to examine the concept of policy niches, the processes by which they may emerge, and their role in policy transitions. In doing so the case also links to wider critiques of the MLP and transitions literature that, despite identifying actors and institutions as variables in transitions processes, the political and policy dimensions of these processes are relatively weakly understood [31].

The MLP literature generally understands the role of niches in terms of three functions: shielding, nurturing and empowering [20]. The empowering stage is understood as the key to transitions from the niche to regime level. However, it is the least theoretically developed element of the MLP niche literature [32], and again what literature exists focusses on transitions around technological rather than policy innovations. The Ontario smart grid policy case provides an opportunity to examine the empowerment stage in the context of a highly complex institutional framework.

The central question addressed in this paper is why Ontario has been relatively successful in achieving a socio-technological *transformation* [3] with smart meter technologies from the niche to regime levels, and in the development of a broader legislative and policy framework regarding Smart Grids. The paper draws on primary documents from provincial government agencies and other institutional and non-governmental actors involved electricity policy formulation and implementation in Ontario, media reports, and analyses of media coverage of smart meter implementation and Smart Grid development [28,33,34]. The paper also incorporates findings and observations from a workshop on the state of Smart Grid policy development and implementation in Ontario hosted at York University in November 2013. The workshop involved academic researchers and representatives of key institutional and non-governmental actors in the process of Smart Grid development in the province.

In terms of the landscape level factors, the differences in the social, economic, political, and environmental contexts among the Canadian provinces are well known. Electricity and energy policy are closely connected with provincial economic development strategies, with provincially owned monopoly or virtual monopoly electricity utilities playing central roles in these strategies [27, see also 28]. While many