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Unobtrusive Maintenance: Temporal Complexity, Latent Category Control and the Stalled Emergence of the Cleantech Sector

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ABSTRACT: Disruptive innovation changes the basis of competition within an industry and poses substantial threats for market incumbents. While researchers have focused on whether incumbents can successfully adapt, we know little about how potentially disruptive innovation may be avoided. Studying clean technology in Canada, we examine incumbent resistance when potentially disruptive technologies are seen as socially beneficial. We identify actions taken by incumbents and other socio-technical regime actors to respond to the issue while simultaneously enacting legitimate stabilizing mechanisms within the regime's institutional infrastructure. Specifically, temporal and resource-based actions led to temporal complexity for disruptive cleantech entrepreneurs, and evaluation structuring work led to latent control of the cleantech category, privileging incumbents and resulting in unobtrusive maintenance. Our findings contribute to the disruptive innovation and institutional theory literatures by showing how disruption may be stalled by the enactment of legitimate elements of the institutional infrastructure rather than direct institutional defence.

Keywords: categories, disruptive innovation, institutional maintenance, temporal complexity

INTRODUCTION

Disruptions are 'fundamental changes that disturb or re-order the ways in which organizations and ecosystems operate' (Ansari et al., 2016a, 2016b). Although disruptive innovations typically underperform incumbent technologies initially, the new innovations may eventually threaten to displace old technologies and the incumbent firms that support them (Danneels, 2004), as well as the

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institutional regimes in which they are embedded (Garud et al., 2002; Greve and Taylor, 2000). Much of the literature reveals the difficulties encountered by incumbents as they respond to disruptive innovations (e.g., Andersen and Strandskov, 2008; Christensen, 1997; Danneels, 2004; Macher and Richman, 2004; Tushman and Anderson, 1986), while a few studies show successful incumbent adaptation (Ansari and Krop, 2012; Kapoor and Klueter, 2015; Roy and Sarkar, 2016).

However, in each of these cases, researchers studied disruptive innovations that were successful, leaving the *avoidance* of disruption relatively unexplored. This success bias means that new entrants' ability to destroy and disrupt established industries may be overstated, and the ability of the existing socio-technical regime to avoid disruption and maintain the status quo may be underestimated (Bergek et al., 2013; Geels, 2014). In fact, many potentially disruptive innovations likely do not fulfil their potential because incumbents—often in mutually dependent relationships with political actors, including politicians and civil servants such as regulators and funders (Geels, 2014; Unruh, 2000) – are embedded in systems oriented towards maintaining the status quo. This is particularly likely in regulated markets (Gurses and Ozcan, 2015), and situations in which disruptions challenge entire ecosystems of interrelated firms (Ansari et al., 2016b; Garud et al., 2002).

We study the avoidance of disruption in a particularly challenging situation: when an innovation addresses emerging societal needs, meaning that overt resistance is not a legitimate response. The preservation of status quo arrangements (and thus the avoidance of disruption) has been studied in the literatures on institutional maintenance (e.g., Maguire and Hardy, 2010; Zietsma and Lawrence, 2010) and sustainability transitions (e.g., Geels, 2014; Smink et al., 2015), where incumbents are viewed as one part of an institutional infrastructure that facilitates the smooth functioning and maintenance of the system (Fligstein and McAdam, 2012; Greenwood et al., 2011; Hinings et al., 2017). Drawing on these literatures, we explore the following research question: *How is disruptive innovation avoided to maintain the status quo?* We examine this question using an inductive analysis of interviews, field notes and media data in the rich empirical context of the emergence of the Canadian cleantech sector.

We find that, in a context where overt resistance to disruptive innovation is not legitimate, incumbents signal their legitimacy by speaking positively about the innovation, which potential disruptors perceive as opening a window of opportunity. However, legitimate stabilizing mechanisms associated with a tightly interlocking institutional infrastructure shape and block actions geared towards change, reproducing the temporal and evaluative structures underpinning the regime. Incumbents' activation of the institutional infrastructure creates temporal complexity for entrepreneurs that undermines them and facilitates latent category control that bolsters incumbents, ultimately resulting in *unobtrusive maintenance*. We discuss the implications of our findings for the

literatures on institutional maintenance, sustainability transitions and disruptive innovation.

LITERATURE REVIEW

The Promise of Cleantech as a Disruptive Innovation

Cleantech refers broadly to technology aimed at reducing or optimizing reliance on non-renewable resources by facilitating energy efficiency, clean energy, sustainable transportation, smart grids, green building practices, and power storage (Clean Tech Alliance, 2018). Cleantech holds significant potential to disrupt existing energy systems, and consensus is growing around the need to shift to more sustainable technologies (Geels, 2014). While many examples of these technologies exist and are beginning to be implemented on a smaller scale, they have yet to threaten the dominance of traditional energy production.

However, clean technologies have been identified as *potentially* disruptive innovations (Bergek et al., 2013), since they change the basis of competition by emphasizing factors such as greenhouse gas emissions and other sustainability criteria, while often underperforming conventional technologies on price. Disruptive innovations are defined as new technologies, products or business models that emerge with a 'different set of features…relative to existing products' (Govindarajan and Kopalle, 2006, p. 190), thereby altering 'the bases of competition by changing the performance metrics along which firms compete' (Danneels, 2004, p. 249). Disruptors often focus initially on customers who have lower performance standards than mainstream customers, but want unique features not available in existing products. Over time, improvements in these innovations threaten incumbents (Christensen, 1997; Christensen and Raynor, 2003).

Yu and Chang (2010) reviewed the literature on disruptive innovation, which has been conceptualized in a number of different ways, including innovation attributes such as revolutionary vs. evolutionary (Florida and Kenney, 1990); competency-enhancing vs. competency-destroying (Tushman and Anderson, 1986); modular vs. architectural (Henderson and Clark, 1990); and sustaining vs. disrupting (Adner, 2002). Of particular note is Govindarajan and Kopalle's (2006) innovation measure which accounts for both high-end and low-end disruptions via a matrix of traditional attribute performance and cost, drawing attention to the possibility that disruptive innovations initially could have inferior mainstream attributes and cost more, yet still disrupt by offering other value propositions (Yu and Chang, 2010). Although most researchers have emphasized cost, some have considered other attributes of technologies (e.g., wind, electric vehicles) that initially are more expensive and may even be inferior based on mainstream attributes, but offer some new value or 'values' proposition (Kirsch, 2000; Pacheco et al., 2014; Sine and Lee, 2009; York et al., 2016). With a few noted exceptions, these types of innovations and the value propositions they provide beyond more

traditional improvements on cost and functionality are underrepresented in the literature (Yu and Chang, 2010).

Disruptive innovation also has been examined as a multi-actor process (Yu and Chang, 2010). Theorists have focused primarily on disruption as the focal outcome of this process, paying particular attention to why incumbent firms have such difficulty responding (Christensen and Raynor, 2003; Dewald and Bowen, 2010), suggesting that innovations tend to destroy the value of incumbents' competencies and resource endowments (Benner and Tushman, 2003; Tushman and Anderson, 1986). In the typical pattern, incumbents dismiss initially inferior technologies or business models; as challengers improve their performance, incumbents struggle to catch up and often are replaced (Danneels, 2004). In this body of work, scholars cite internal factors, such as the inability or unwillingness of managers or employees to see or act on promising technologies (Christensen and Raynor, 2003; Denning, 2005; Henderson, 2006; Murase, 2003); and market or customer dynamics, such as incumbents' inability to notice or address changes in the market or customer needs (Yu and Chang, 2010). Relatively fewer scholars have studied external factors such as contextual or environmental features (Yu and Chang, 2010).

More recently, scholars have challenged these explanations, suggesting that they overstate new entrants' abilities to disrupt established industries, and underestimate incumbents' capabilities to respond (Bergek et al., 2013). Incumbents may use a wide range of strategies to deal with disruption, including inaction (Charitou and Markides, 2003), resistance (Markides, 2006), adoption (Christensen and Raynor, 2003), or resilience (Dewald and Bowen, 2010; Sutcliffe and Vogus, 2003). A firm may opt to augment its core business with additional products or services to defend against the impact of disruption (Howells, 2002), or adopt the new technology, either internally or as a separate enterprise (Lange et al., 2009).

While this work focuses predominantly on incumbents' abilities to incorporate innovations, several studies have demonstrated that incumbents attempt to resist disruptive innovations to maintain their market advantages, thereby disrupting the disruptors (Hargrave and Van de Ven, 2009). For example, in the case of the digital video recorder, incumbents in the television industry attempted to block TiVo's market entry by coordinating collective action amongst network actors, forging alliances with TiVo's competitors, and blocking access to airtime (Ansari et al., 2016b). Similarly, in the case of pay TV, incumbents and disruptors engaged in framing contests and collective action to influence regulations (Gurses and Ozcan, 2015). When Sun Microsystems launched its Java technology, Microsoft first tried to discredit Java and forge alliances with competitors, and later extended Java in ways that compromised its compatibility (Garud et al., 2002). In many instances, disruptive innovations 'unfold as 'trials of strength' (Latour, 1987), between multi-party networks of firms as they try to convince industry members to adopt their innovations' (Garud et al., 2013, p. 789). The stakes are high, and innovations are translated into different forms to fit the

needs of multiple constituents, often involving strategic framing and attempts to bridge relational and temporal complexities (Garud et al., 2013).

Yet, each of these are examples of products or services that were not widely seen as fulfilling a pressing societal need; as a result, incumbents' attempts to block these disruptions did not need to be couched in actions that appeared to embrace them. These examples also primarily did not involve different *types* of actors; rather, incumbents typically acted in concert. Thus, it remains unclear how incumbents' responses may change when their interests are closely aligned with other powerful institutional actors. More broadly, the avoidance of disruption, particularly when overt resistance is not a legitimate response, has not been studied; a gap therefore remains in our understanding about when and why potentially disruptive technologies fail to disrupt, particularly when these innovations address constituent demands. This is surprising, since failing to disrupt is a highly likely outcome of attempted disruption given incumbents' power and the significant resource commitments, existing infrastructure, and general path dependency associated with existing products, services and business models (Garud et al., 2013).

Institutional Maintenance in the Face of Disruptive Innovation

On the other hand, institutional theorists have much to say about the processes and mechanisms underlying the maintenance of existing institutional arrangements, as well as the work performed by actors to maintain them. Maintenance occurs not only through the deliberate efforts of actors, but also through systemic institutional forces, since institutions themselves are 'repetitively activated, socially constructed, controls' (Jepperson, 1991, p. 145). Studies have documented that these mechanisms and processes range from strategic efforts to more systemic forms of maintenance.

Strategic institutional maintenance. A range of studies show how organizations can strategically resist institutional change, at both the organizational and field levels. At the organizational level, multiple studies have documented that established incumbents resist institutional pressure to change, instead seeking to maintain the status quo and protect their interests (Anand and Peterson, 2000; Hargadon and Douglas, 2001; Hensmans, 2003; Maguire and Hardy, 2009; Munir, 2005; Oliver, 1991). For example, auto manufacturers in Germany resisted pressure to adopt diesel particulate filters (Guérard et al., 2013), coffee sellers in the Netherlands resisted the introduction of fair trade coffee (Ingenbleek and Reinders, 2013), gas lighting companies resisted the introduction of electric lighting (Hargadon and Douglas, 2001) and the recording industry resisted the advent of peer music sharing (Hensmans, 2003). In each case, incumbents mobilized networks of other organizations in the field, including policymakers, to resist with them.

Documented strategic responses to institutional pressures encompass avoidance, defiance, manipulation, compromise and compliance (Oliver, 1991), with powerful incumbents tending to respond more overtly through avoidance, defiance and manipulation. Such resistance can be seen as institutional maintenance

work (i.e., intentional action to maintain institutions; Lawrence and Suddaby, 2006), which involves both active, episodic work and the more systemic work of establishing systems for self-reproduction (Lawrence et al., 2009). Maintenance work includes efforts to embed and routinize practices in day-to-day activities, rules, roles and resources; valorize and demonize practices; police practice use; and use deterrence to establish barriers to change (Lawrence and Suddaby, 2006). Scholars also have identified more active types of defensive maintenance work. Facing pressure to change, incumbents are likely to craft a resistant and defensive field stance that supports their activities within the system (Clemente and Roulet, 2015); collectively, 'dominant incumbents "construct" practices as effective, beneficial, appropriate, inevitable, and so on (i.e., as unproblematic)' (Maguire and Hardy, 2009, p. 150). Since elites have established centrality (Farjoun, 2002), communication networks (Lounsbury, 2001), and legitimacy (Maguire et al., 2004), they are well positioned to maintain institutional arrangements.

Scholars who study sustainability transitions have revealed similar institutional maintenance accounts, not only at the incumbent or organizational level, but also at the broader regime level. In articles by Geels (2014), and Unruh (2000), political actors and incumbent business actors in mutually dependent relationships comprise 'socio-technical regimes' or 'techno-institutional complexes' which work in concert to maintain extant institutional arrangements. Geels (2014, p. 35), for example, described anecdotally how 'incumbent regime actors used instrumental, discursive, material and institutional forms of power to resist climate change-related pressures and to reposition themselves for low-carbon futures without fundamental system change'. In his example, government actors asserted solutions to climate change which privileged incumbent firms, reframed problems in terms that favoured incumbents, provided resources to incumbents to improve their technical feasibility while marginalizing alternative paths, and referred to market logics to justify *not* taking action to support climate change efforts (Geels, 2014). Smink et al. (2015) showed the actions incumbent firms took to influence governments to maintain the status quo, with a particular emphasis on framing and standard setting activities, for example, to block innovations in the LED lighting and biofuel industries. While this research stream uses primarily exemplary cases to show the active resistance strategies available to powerful regimes fighting sustainability transitions (Markard et al., 2012), more empirically grounded work is needed to understand the underlying mechanisms that connect regime actions to institutional impacts in the context of disruptive innovations more broadly.

Systemic institutional maintenance. Not all institutional maintenance is strategic. Maintenance can also be systemic, whereby institutions are upheld by an institutional infrastructure, or those 'mechanisms of social coordination by which embedded actors interact with one another in predictable ways' (Zietsma et al., 2017, p. 392). Two key elements of this institutional infrastructure that are particularly relevant to disruptive innovation are temporal issues and categories. Orlikowski and Yates (2002, p. 684) argued that 'temporal structures emerge

from and are embedded in the varied and ongoing social practices of people in different communities, and at the same time…such temporal structures powerfully shape those practices'. According to Garud et al. (2013), time is a recognized factor in innovation processes. Often, temporal issues are conceptualized as technical in nature, whereby systemic asynchronies in temporal rhythms among the different actors and elements of an innovation and its ecosystem can lead to delays in the emergence of supportive infrastructure (Ansari and Garud, 2009), and unanticipated roadblocks (Pickering, 1993). This temporal complexity generally presents significant barriers to innovation (Garud and Gehman, 2012). Yet, more recent studies have revealed time's strategic side: temporal institutional work involves 'how [actors] *construct, navigate, and capitalize on timing norms in their attempts to change institutions*' (Granqvist and Gustafsson, 2016, p. 1010; emphasis in original). In studying the efforts of institutional change agents, Granqvist and Gustafsson (2016, p. 1009) identified three forms of temporal institutional work. *Entraining* is a 'top-down, routinized, reproductive form' in which a dominant, perhaps external player imposes timing norms on those in a field. More bottom up, issue-driven forms of temporal institutional work include *constructing urgency* and *enacting momentum*. They argued that change agents can sequentially use these strategies to create windows of opportunity for their projects (via constructing urgency and entraining), facilitate synchronicity (by enacting momentum and entraining), and strengthen perceptions that change is irreversible (by enacting momentum and constructing urgency).

Categories, or 'meaningful conceptual systems' that classify organizations, issues, technologies or other elements into groups with specific attributes and meanings (Navis and Glynn, 2010, p. 440), are another component of institutional infrastructure and a second key element of innovation described by Garud et al. (2013). Categories can be used strategically, for example by promoting (or deciding not to promote) certain attributes (Gehman and Grimes, 2017). Categories also can be systemic elements used to stabilize meaning across industries, providing 'industry-wide technological frames' that hold 'the different actors of an ecosystem in place' (Garud et al., 2013, p. 790). Framing makes 'some aspects of a perceived reality…more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation' (Entman, 1993, p. 52), and thus can be used to define or redefine what a category means, particularly when it is seen as ambiguous (Garud et al., 2002; Smink et al., 2015). More specifically, when incumbents face disruptive pressure to change, they often attempt to reframe category criteria or to frame their own actions or technologies as part of the category (Guérard et al., 2013; Maguire and Hardy, 2009). For example, proponents of nuclear energy argued that it is a critical source of sustainable energy because it is emission-free (Garud et al., 2010), and political and incumbent actors reframed concerns in the energy sector by shifting the focus from climate change to energy security and affordability, thereby privileging nuclear and fossil fuel options (Geels, 2014). This exemplifies how aligned incumbents frame categories to emphasize how disruptive

innovations do not fit the prototype of a legitimate category. In summary, taking an institutional perspective on disruptive innovation can provide insights into the circumstances and mechanisms underlying failed disruptive innovation.

METHODOLOGY

We address our research question in the context of clean technology and renewable energy in two Canadian provinces, British Columbia and Ontario, where the majority of cleantech startups in Canada are located. Although significant pressure for disruption exists, these technologies do not yet threaten the dominance of traditional energy production.

Context of Clean Technology in British Columbia and Ontario

According to the Clean Technology Trade Alliance, clean technology includes 'pollution control, resource reduction and management, end of life strategy, waste reduction, energy efficiency, carbon mitigation and profitability'.[1] Renewable energy refers to energy derived from renewable resources or waste, such as solar, wind, biomass, tidal, geothermal and wave energy.

Over the last 10 years, pressure for clean technology and renewable energy has risen in Canada generally, and in British Columbia and Ontario specifically, in response to concerns about climate change, energy security, the depletion of oil reserves, and expensive extraction techniques such as those used in the Alberta tar sands and in deepwater drilling and fracking. Pundits tout clean energy and cleantech as the key to competitive advantage and economic renewal (Friedman, 2007), and politicians often promote the advantages of green job creation.

In sentiment, Canadians also appear inclined to support action on climate change. For example, results of a poll conducted by the *Vancouver Sun* published on September 4, 2012 reveal that 'British Columbians put a top priority on using sustainable energy sources and conservation' and are more accepting of measures such as carbon taxes, which have been in effect in the province since 2008. In Ontario, a Green Energy and Green Economy Act was passed in 2009 with the intention to support renewable energy and create green jobs. In general, cleantech and renewable energy were election issues during the study period, with increased media coverage during periods leading up to elections (see Figure 2 in the data section).3.1.1. Interdependence in the ecosystem.

Electrical energy generation and transmission is organized provincially and is heavily regulated in Canada. BC Hydro, a crown (public) corporation, has a near-monopoly on power generation and transmission in BC, although the government requires it to purchase a small amount of power from independent producers. In Ontario, Hydro One, which is owned by the Ontario government and regulated by the Ontario Energy Board, controls 97 per cent of electricity transmission. Most clean technology firms require cooperation from incumbent firms

and government intervention to sell their technologies. For example, cleantech entrepreneurs selling energy conservation (smart metres, smart grid devices or systems, etc.) or energy generation technologies (e.g., solar panels, wind turbines, co-generation technologies, biomass converters, etc.) generally must obtain the permission of BC Hydro or Hydro One before they or their customers can connect to the electrical grid.[2] Companies that develop technologies for the automotive industry must partner with automakers to get them installed in vehicles. Biofuel technology entrepreneurs must work with oil companies to add biofuels to traditional fuels and with automakers to develop engines that can work with biofuels. Green building technologies must be adopted by construction firms, and building codes originally written for incumbent technologies often must be modified to reflect both regulatory and business practice changes. Thus, in most contexts, cleantech entrepreneurs must work not only with incumbent firms to facilitate the adoption of technologies, but also with governments to ensure supportive regulations.

In addition, mutual dependence exists between governments and incumbents. Fossil fuel incumbents and automakers have very strong relationships with the federal government, electricity firms have strong relationships with provincial governments, and waste removal and construction firms often have strong ties to municipal governments. Incumbents rely on politicians and regulators to establish a favourable regulatory environment, and the government relies on incumbents to power the economy, both literally and figuratively. Due to these mutual dependencies, and similar to other jurisdictions, political actors and incumbent firms in Canada can be viewed as components of a socio-technical regime (Geels, 2014; Unruh, 2000; see Figure 1) in which institutional arrangements provide significant benefits, including tax revenue, employment and political capital for governments, and profit and power for firms.

Thus, the cleantech context is ideal for exploring institutional maintenance in response to disruptive innovation. Clean technologies resonate with Canadians, who support their adoption, and cleantech companies frequently are touted in the

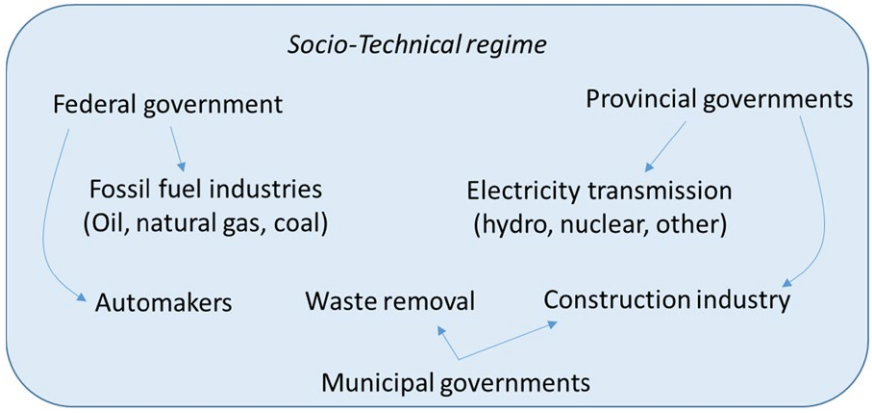

Figure 1. The socio-technical regime facing clean technology firms in Canada. [Colour figure can be viewed at wileyonlinelibrary.com]

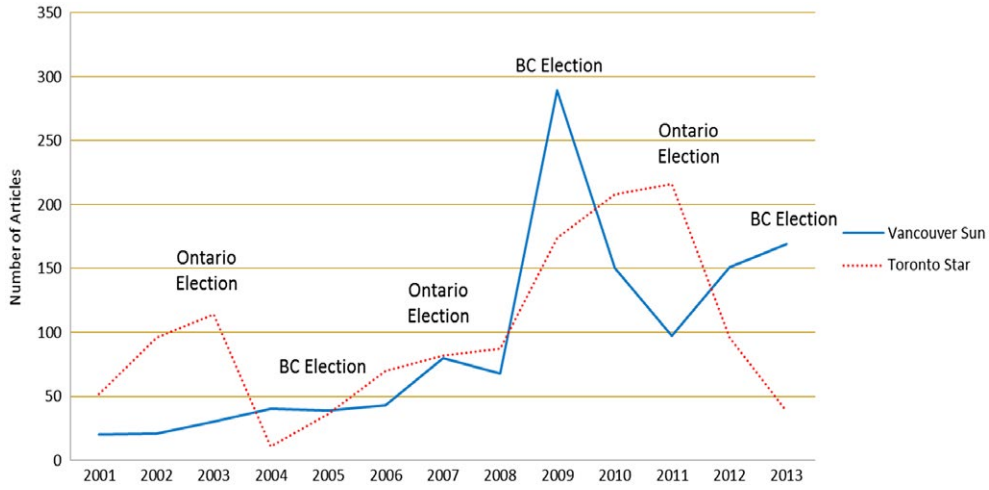

Figure 2. Newspaper articles covering clean technology and renewable energy. [Colour figure can be viewed at wileyonlinelibrary.com]

media for creating jobs and economic prosperity. With these characteristics, incumbent firms such as producers of energy (oil, gas, coal and electricity) and governments face pressure to support and implement these disruptive technologies. Nevertheless, according to an article in the *Toronto Star* published on November 12, 2011, experts have repeatedly labelled the cleantech sector as 'stalled'.

Data

Interviews

Between 2010 and 2011, we interviewed 56 cleantech entrepreneurs in Ontario (24) and British Columbia (32), along with seven incumbents and policymakers, including government regulators, a government funder of clean technology, a manager who dealt with renewable energy at an electrical utility, and lobbyists for clean technology. On average, cleantech entrepreneurial firms in British Columbia had 43 full time equivalent employees (range: 1–580) and were 9 years old (range: 1–25) and those in Ontario had 59 full time equivalent employees (range: 1–850) and were 11 years old (range: 4–25). Semi-structured in-person interviews lasted approximately 90 minutes each and were recorded and transcribed. Questions focused on the nature of interviewees' work as well as successes and challenges in the cleantech industry.

Newspaper articles

We collected 2,477 newspaper articles covering clean technology, renewable energy and energy conservation and related terms from 2001–2013 from the main provincial newspapers. This timeframe was ideal, as it enabled us to explore the early stages of the sector's formation through its emergence as a significant issue

for society. We searched the *Toronto Star* (1,280) and the *Vancouver Sun* (1,197) for the terms *green energy*, *alternative energy*, *renewable energy*, *clean energy*, *cleantech** and *green tech** using Factiva. We excluded any articles not related to clean technology or renewable energy in Ontario or British Columbia. The *Vancouver Sun* is the main newspaper in British Columbia, and the *Toronto Star* is the daily newspaper with the largest circulation in Canada. Early in the study period, only a few relevant articles were published each year, but this number increased to 289 articles in a single year at the peak of cleantech's emergence in British Columbia in 2009. Figure 2 shows the distribution of articles in the two newspapers over time. Peaks in coverage for both newspapers correspond with provincial election years, suggesting that clean technology and renewable energy were key election issues. For in-text citations, we cite the newspaper name (the *Vancouver Sun* is abbreviated as Sun, while the *Toronto Star* is abbreviated as Star) and the publication date.

Archival data

Using data from interviews and newspaper articles, we also assembled publicly available data on projected and actual uses of funds from the major provincial and national funding sources available to cleantech entrepreneurs in Ontario and British Columbia during the study period. Data from Sustainable Development Technology Canada ($250 million), NRCan's Technology Early Action Measures ($1.16 billion), and BC's Innovative Clean Energy Fund ($77 million) enabled us to verify the accuracy of accounts from interviews and the media.

Data limitations

While we acknowledge that a perfect data set would include more interviews with incumbent firms and governments engaged in institutional maintenance, this was made difficult by the very nature of institutional maintenance and the growing legitimacy of clean technology. Indeed, the few interviews we conducted with incumbents were difficult to obtain, and interviewees appeared to carefully discuss only organizationally approved perspectives, essentially reiterating public statements. We used these interviews to augment and challenge media accounts (which often quoted incumbents directly), data on funding programmes, and the entrepreneurs' accounts. We triangulated across data sources to corroborate the findings.

Data Analysis

We used an inductive qualitative approach to analyse the data in four stages, iterating between our data and the literature (Miles and Huberman, 1994). First, we used media articles and industry events to create an extensive event history database of sector emergence in each jurisdiction to better understand the context for the actions of entrepreneurs, incumbents and political actors. Through this analysis, we noted that the institutional context appeared to significantly affect

the emergence of the cleantech sector, so we organized our subsequent analysis around institutional maintenance.

Second, we used open coding to identify first-order categories in the interview transcripts and media coverage. We coded evaluative comments about cleantech and its challenges, using codes such as 'the time is right', 'significant growth', 'resource commitments', 'changing policies/support', 'delays', 'need for more testing/piloting', 'not ready yet', 'economic metrics', 'cleaner tech', etc. Then, we grouped related codes together in second-order themes. Comparing the similarities and differences among entrepreneurs' accounts, media articles and incumbent/government reports enabled us to add further nuance to our emerging themes.

In the third stage, we iterated between our data and the literature, grouping themes into aggregate categories that explained the phenomenon and extended our understanding of how disruptive innovation is avoided when overt resistance is not a legitimate response. Finally, in a fourth stage we searched the data for links between aggregate dimensions and outcomes, as described by entrepreneurs, incumbents, government representatives and the media. For example, entrepreneurs explained that they were 'going out of business' due to the 'temporal complexity' that had emerged from incumbents' paradoxical opening of a 'window of opportunity' for technology that was 'not ready yet'. We used these emic causal interpretations to construct a process map of institutional maintenance in response to potential disruption.

FINDINGS: UNOBTRUSIVE MAINTENANCE

Our findings reveal the difficulties cleantech entrepreneurs faced in disrupting a highly institutionalized socio-technical regime (see Figure 3 for a model of the findings and Table I for representative quotes from the data). In response to public demand for action on the cleantech issue, incumbents and political actors in the regime framed a window of opportunity that included resource commitments and

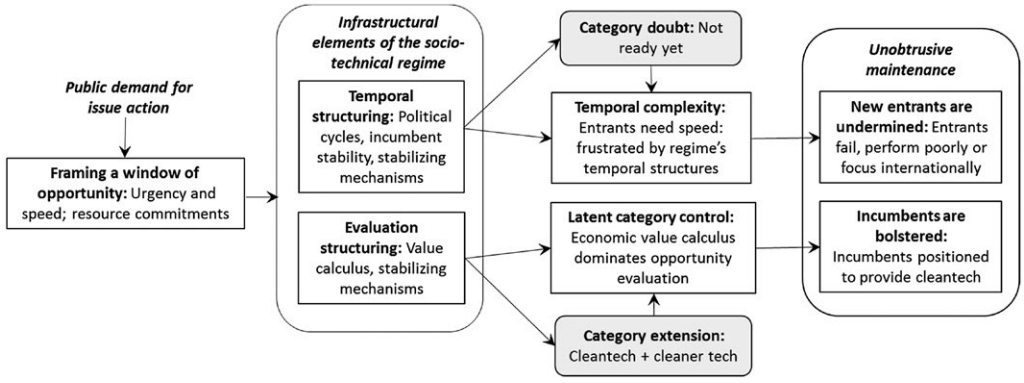

Figure 3. Unobtrusive maintenance to avoid disruptive innovation

Table I. Time- and resourc-based actions and institutional maintenance outcomes

Construct	*Representative quotes*
Framing a window of opportunity	
Urgency and speed	'This is an area of significant growth and the province is uniquely positioned to capitalize on some of our existing assets and our existing resource base and our existing policy environment to see this sector or this area of the economy grow and expand…we have the full abundance and variety and array of clean energy resources. That bodes well, I think, for the sector and is a—I think it's a flag of where things are going and what their opportunities are in the future'. (F02, Regulator) 'McGuinty [Ontario premier]…noted the bill will "address local bylaws and regulations that are used to delay or stop proposed renewable energy projects"' (Star, 11 Feb 2009)
Announcing resource commitments	'Another program that was created as an offspring of the energy—the [action plan]—was … a bioenergy strategy, which I was very involved in. One of the key features of the bioenergy strategy was the creation of a $25 million bioenergy network. The network is focused on a number of things related to encouraging bioenergy development in British Columbia, but one of the things it can do with the…one-time $25 million endowment it received was support bioenergy technology development and deployment as well'. (F02, Regulator) 'We also have some other fairly significant, driving legislative pieces and policy pieces, such as the [action plan] and the suite of [legislation]…The [action plan] established a number of policy actions and also some funding mechanisms, some funding programs'. (F02, Regulator)
Infrastructural elements of the socio-technical regime	
Temporal structuring	'It depends if you ask us now or you ask us at the end of October because quite frankly, after an election it depends on where you want to go with these programs…So if the program shuts down then we can fire five people'. (F05, Government Funder) 'This ministry and this agenda is a creature of the government's economic agenda and little more. A government could make choices at any time, and one would expect that certainly following an election, is usually one of those times that governments make hard-nosed choices either to do more of, do less of, or something in between'. (F05, Government Funder) 'Someone has an obligation to maintain power quality. Someone has an obligation to provide that product in a cost effective, very safe, reliable manner…the deeper question here is, how do you introduce a more decentralized approach to electricity, yet maintain the quality and safety and reliability that's fundamental to our society?' (F01, Utility Company) 'Every contract that we sign, every amendment in the contract, has to have [the regulator's] approval … so we have needed a strong interface. So that involves very lengthy…like my whole thing would get filled here with…six or seven binder applications to [the regulator], and then significant econometrics and those kind of analysis around different submissions'. (F01, Utility Company)

(*Continued*)

Table I. (Continued)

Construct	*Representative quotes*
Evaluation structuring	'I look at leverage. For every dollar that we put in, there's two-and-a-half dollars of private sector money'. (F05, Government Funder) 'There's an intrinsic goal to grow your rate base, because that's how you increase your rate of return'. (F01, Utility Company) 'As we would hope any prudent holder of public funds would do, they want to be satisfied that there's a good management team and a good business plan, a good commercialization road map…They need to have a requisite degree of comfort to make their investment and that's not dissimilar from the approach we would take as well'. (F02, Regulator)
Temporal actions in response to the cleantech issue	
Category doubt	'There are roadblocks, for lack of a better word, for Environment and Energy. Because that's just the nature of where the technologies are'. (F05, Government Funder) 'No one could seriously propose replacing all of Ontario's nuclear power exclusively with wind'. (Star, 7 May 2011)
Temporal complexity	'It won't be a fast process. Chris Tyrrell, chief conservation officer of Toronto Hydro, says two years of data will be needed to make a decision on whether to proceed'. (Star, 11 Jun 2010) '"We're going to have to do a pilot first." A pilot? I've done 32. I mean how many more beta sites do we need to do? … I said, "How big a pilot do you want to do?" He says, "Six." I said, "Alright." "How soon do you think you can get those six in?" I said, "Within 90 days" …Do you know how long it took them to do the audit? Eighteen months!' (ECM04, Entrepreneur) 'You've got to do all the paperwork and it takes time and there's the length of churn for them to go through their cycles and that can be a little frustrating'. (EPS12, Entrepreneur)
Resource-based actions in response to the cleantech threat	
Category extension	'Well it's tough in this jurisdiction because now…95% [of current power generation] is clean'. (F01, Utility Company) 'We've instead chosen to tailor and target our intended feed-in tariff to encourage emerging new clean technologies…and/or to focus on specific regional deployments where a broader range of clean energy resource development could offset or reduce reliance on diesel-fired generation in remote communities, for example'. (F02, Regulator)
Latent category control	'The [Utility] can really reduce attrition by really ramping up their qualifications for people that are going to participate…you can structure things in a way that the only people that can participate are people that have this predevelopment capital'. (F01, Utility Company) 'I don't think that debate is going to shift, because at the end of the day, rates going up is hard'. (F01, Utility Company)

Unobtrusive maintenance	
Entrepreneurs are undermined	'Government of [another province] announced five projects today in renewable and alternative energy…So if we get one of those awards, we'll go ahead. If we don't, we'll close our offices and do something else'. (EPS05, Entrepreneur) '[When solar subsidies were cut by 27%,] the industry was blindsided. Many solar installers had already ordered inventory, put down deposits, and hired and trained staff to meet expected demand' (Star, 19 Jul 2010)
Incumbents are bolstered	'To support the development and deployment of innovative clean energy technologies… and also to encourage improvements in conventional energy use…It covers a range of continuous improvement-type energy technology development'. (F02, Regulator) 'It's both a blessing for us here in British Columbia to have had for many decades a reliable source of clean electricity that has provided…that has been paid for long ago, so all we're really paying for right now in the utilization of electricity is the cost of operating the system'. (F02, Regulator)

emphasized urgency and speed to support this potentially disruptive innovation. However, two interlocking elements of the socio-technical regime had particular influence over the enactment of the opportunity: the temporal structuring of political bodies, regulators and incumbent firms based on cyclicality and stability; and evaluation structuring involving a value calculus that reinforced the status quo. These two interlocking elements were underpinned by legitimate stabilizing mechanisms, which are taken-for-granted institutions (rules, structures, beliefs, practices, values, etc.) embedded in the institutional infrastructure. These legitimate stabilizing mechanisms entrenched a value calculus and temporal rhythms which favoured incumbents. Based on these stabilizing mechanisms, political actors and incumbents framed doubt about the category of cleantech 'not ready yet', and enacted delays and intermittence, resulting in temporal complexity for entrepreneurs. In addition, regime actors extended the cleantech category to include their own technologies as 'cleaner tech'. Incumbents then applied the status quo economic value calculus to both clean and cleaner tech innovations, resulting in category absorption by incumbents of the cleantech category. This combination of actions and stabilizing mechanisms led to unobtrusive institutional maintenance: new entrants were undermined, incumbents were bolstered, and disruption was avoided.

Framing a Window of Opportunity

Responding to public pressure, politicians and incumbents framed a window of opportunity for cleantech by emphasizing urgency and speed and announcing resource commitments.

Urgency and speed. In response to public pressure, regime actors framed a window of opportunity for cleantech and renewable energy: 'BC's Premier called BC's renewable energy industry a "sleeping giant"' (Sun, 12 April 2005), heralding 'an unprecedented opportunity to shape the character of the future global energy system…that we can't afford to miss' (Sun, 24 November 2005). The Ontario government also emphasized speed in 'aggressively pursuing both renewables and conservation' (Star, 20 February 2010). The Premier of Ontario said: 'The Green Energy Act is designed to speed those kinds of projects along, by removing roadblocks that have typically emerged during municipal approval processes' (Star, 11 May 2009).

Resource commitments. Those in government ministries promised to provide support for the implementation of cleantech projects. One regulator explained: 'We'll ask them, 'What do you need? What do you need to make this work here?' We'll look at what tools we have and we'll see what we can do' (F02, Regulator). Additionally, the government developed policies to support cleantech that included substantial funding programs:

> We've got a couple of programs. One that you may be familiar with is called the [funding] program that is essentially a funding program providing grants and incentives to improve energy efficiency in the built environment…in some other areas, we have created the [program fund]… It was established as a policy action from the [action plan] and it was established as a $25 million per year fund to support the development and deployment of innovative clean energy technologies. (F02, Regulator)

The regulator went on to describe 11 different funding platforms/programmes in the province that were designed to support cleantech because

> we've recognized it needs some special attention and some special strategic development support to grow, hence our creation of the [fund] and the [network] and our interest in further supporting that development through things like a feed-in tariff that we've proposed or that was indicated in the [act]. (F02, Regulator)

Incumbents, too, signalled resource allocations for cleantech in the form of purchasing programmes. For example, utilities in both Ontario and BC announced they would purchase clean power from independent distributors: 'Both Energy Minister Richard Neufeld and BC Hydro CEO Bob Elton have been making signals in recent days that indicate greater opportunities are looming for private-sector companies to join Hydro's grid' (Sun, 27 Oct 2004). Requests for proposals were issued and large oil and gas companies offered investment programmes to which cleantech entrepreneurs could apply for equity funding. By signalling urgency and speed and committing resources, regime actors framed a window of opportunity for cleantech entrepreneurs.

The Interlocking Infrastructure of the Socio-Technical Regime

Two elements of the socio-technical regime's institutional infrastructure influenced the enactment of these cleantech opportunities: temporal structuring based on the existing temporal rhythms within the regime; and evaluation structuring based on the existing value calculus. These elements of the institutional infrastructure acted as legitimate stabilizing mechanisms.

Temporal structuring. Politicians, who are focused on obtaining electoral support, and funders and regulators, who respond to political directives, have intermittent timing norms based on the political cycle. Politicians attempt to create and enact policies or funding programmes supported by voters. Given 4-year political cycles, issues become more or less salient based on their relevance to voters or the ability to implement solutions prior to the next election. Because of this cycle, government funding programme managers and regulators expect change to occur: 'In [province], the government has created a policy envelope… where they dictate…What is the energy policy? What are the desired outcomes?' (F01, Utility Company). Moreover:

> This ministry and this agenda is a creature of the government's economic agenda and little more. A government could make choices at any time, and one would expect that certainly, following an election is usually one of those times that governments make hard-nosed choices either to do more of, do less of, or something in between… Government, essentially with the stroke of a pen, could decide more, less, same. (F05, Government Funder)

Electrical utilities, as government-owned corporations, frequently must meet targets set by the government. Yet, electrical utilities require stability and security to protect the integrity of the electricity grid in the long-term. Utilities are expected to entrain themselves to political timing norms while simultaneously ensuring stability and security, resulting in complex temporal structuring. Politicians frequently give utilities ample time (i.e., years) to implement policy changes, and utilities usually implement those changes close to deadlines in the interest of maintaining stability, knowing that policies might change in the meantime. Furthermore, beyond direct political intervention, utilities are governed by a regulator which must approve significant changes: 'Every contract that we sign, every amendment in the contract, has to have [the regulator's] approval' (F01, Utility Company), which introduces delays and the possibility that a change will not be implemented. To avoid compliance with political directives, utility incumbents can apply to the regulator, which occasionally disapproves associated expenditures, resulting in cancelled programmes or contracts. Thus, although politicians issue directives with respect to utilities, temporal structuring introduces the potential for those directives to be ignored or delayed substantially to ensure long-term stability within the regime:

> The first draft of the Integrated Power System Plan, released in 2007, was sent back to the drawing board in 2008 by then energy minister George Smitherman, who wanted a greater focus on renewable energy and conservation. It has not resurfaced since then. In the absence of a plan, 'conservation policy has been made through directives in a closed and seemingly ad hoc fashion,' reported Miller. (Star, 5 May 2010)

Evaluation structuring. While managing these competing demands for change and stability, new opportunities and investments must be evaluated. Regulators, funders and incumbents in the energy sector's socio-technical regime use a value calculus that prioritizes economic metrics. As a utility manager explained, regulators 'review things from an economic basis;' 'they try to do the very best that they can, but their job is an economic regulator. And whoever's bringing forward something has to prove that what they're doing is prudent and in their ratepayers' best interest' (F01, Utility Company). Even the description of consumers as 'ratepayers' reflects the primacy of economics. Although regulators worked with incumbents to implement governmental priorities (e.g., job creation, environmental protection, etc.), this was always balanced by financial concerns:

> Our policy and legislative development is ongoing… to the extent that we can, knowing what other interests government has to balance and what… the chequebook looks like in the province, we make incremental steps to better improve what is happening… for this sector. (F02, Regulator)

By prioritizing economic metrics over carbon reductions, evaluators privileged status quo technologies with proven business models.

Another key feature of this economic evaluation was the careful consideration of *new* costs while taking *old* costs for granted. Subsidies for incumbent technologies were decided long ago and had become institutionalized through an 'incremental' budgeting process that bases current public financial decisions on prior years' budgets (Greenwood, 1984). This structure functions as a stabilizing mechanism that ensures continuity in the regime. Furthermore, in calculations of electricity rates, the cost of capital infrastructure for hydroelectric dams and nuclear power typically is not included in pricing. A government official explained: 'It's…a blessing for us here in British Columbia to have had for many decades a reliable source of clean electricity…that has been paid for long ago, so all we're really paying for right now in the utilization of electricity is the cost of operating the system' (F02, Regulator). As such, evaluations not only prioritized economic concerns in the value calculus, but the economic calculus itself was lopsided, focusing on all costs associated with new technologies, but only some of the costs associated with existing technologies.

To ensure the reproduction of the existing value calculus, the governance of energy in Canada includes core members of the regime. For example, at the time of writing, among the eight permanent board members on Canada's National Energy Board (a regulatory agency), five were employed in the oil and gas industry, one represented the government of Alberta (which depends heavily on the oil industry), and two were consultants who provided expertise on Indigenous affairs affected by energy and land use.[3]

Overall, temporal and evaluation structuring – and the stabilizing mechanisms of the institutional infrastructure that underpin them – comprise a tightly connected system of meanings and practices that can block innovations that threaten regime stability. Thus, despite the window of opportunity reflected in regime actors' positive rhetoric and resource commitments to cleantech, entrepreneurs still faced challenges enacted through these legitimate stabilizing mechanisms.

Time-Based Actions in Response to the Cleantech Issue

Entrepreneurs responded to the window of opportunity by entering the sector, as the window aligned with the needs of entrepreneurs to pursue timely opportunities with the promise of quick results. Although the window provided evidence that regime actors were taking cleantech seriously, they were simultaneously enacting legitimate stabilizing mechanisms from the regime's institutional infrastructure, framing doubt about the cleantech category and enacting existing temporal structuring, which created temporal complexity for the entrepreneurs.

Category doubt. Based on legitimate stabilizing mechanisms that embedded perceptions of the category in the temporal structuring of the regime, actors framed the new category of technologies as important, but expressed doubts about implementation readiness. One government funder animated this perspective: 'There are roadblocks, for lack of a better word, for Environment and Energy. Because that's just the nature of where the technologies are' (F05, Government Funder). A BC Hydro engineer expressed similar views: 'The technologies could never replace conventional hydro or gas generation because they are dependent on weather and tide' (Sun, 6 Nov 2002). Similarly, oil and gas company executives publicly stated: 'Nothing is going to render fossil fuels obsolete tomorrow or make renewables suddenly technically and commercially viable and available' (Sun, 25 Mar 2010).

Project failures were attributed to technological and financial issues associated with increased risk. A utility manager explained, 'They're willing to take a lot of risk on, but at the end of the day it's just not there yet' (F01, Utility Company). Although a window of opportunity had been opened, indicating speed and urgency, doubt was cast on the viability of cleantech, emerging from the risk-averse, stability-focused temporal rhythms of incumbents and regulators.

Temporal complexity. Accessing the window of opportunity required entrepreneurs to conform to the timing norms of the regime, both in terms of political cycles and incumbent stability, and antithetical to the speed and urgency that dominated conceptions of entrepreneurial opportunity exploitation. Entrepreneurs noted that it was difficult for long-term technology development projects to fit into the 4-year political cycle. For example, 'Even if you do a run-of-the-river project, as they did with the [name], it's about a 5- to 10-year program'. (ECM04, Entrepreneur). Such projects would be completed under a subsequent government after political attention had shifted. Often, funding programmes were announced before an election and then changed or discontinued before entrepreneurs could take advantage of them: 'Since their last electoral victory in 2011, the Liberals have started throttling back their green-at-any-cost energy vision…Soon after the 2011 election, the government initiated a review of its program to buy wind and solar power' (National Post, 12 March 2013).

Entrepreneurs also had to conform to the timing norms of incumbents. Because utility incumbents had become accustomed to politicians' temporary, cyclical commitments and because they needed to ensure stable supply, they often delayed enactment of policy directives to balance temporal requirements. For example, the government mandated that BC Hydro purchase specific amounts of green power, so BC Hydro announced a call for proposals in June 2008.[4] After the deadline (i.e., after entrepreneurs had spent thousands of dollars to have their proposals considered), BC Hydro asked its regulator for a delay:

> BC Hydro has put together a carefully considered argument for delaying its green-power needs. In a 100-page submission to the commission, it says higher prices for electricity passed on to its customers, along with conservation measures, will mean energy savings and reduced consumption. (Sun, 7 Jan 2009)

This process delayed decision-making until March 2010, with 27 projects eventually contracted by August 2010, more than 2 years after the initial call for proposals. Then in 2013, BC Hydro announced it was cancelling up to 10 of the executed contracts and deferring delivery on nine others (Sun, 12 September 2013).

A government funder attributed the delays to the due diligence process: 'They also have regulatory people who, not that they're hostile against technology, but it's like 'We need a lot of evidence. We need this and that. We need…' They're very, very conservative because that's their job' (F05, Government Funder). As a stabilizing mechanism, such due diligence facilitates swift action for standard operations, but is designed to impede new initiatives that could threaten the system; one industry member reported that it took over a year to obtain environmental approval to instal a windmill, yet it took 6 weeks to obtain approval to drill an oil well (conference field notes). A utility manager acknowledged that as a result, 'We've had a very high attrition rate… almost a 60 per cent failure, because of changes in policy', and that entrepreneurs often were told that they had 'not thoroughly investigated and put together all the pieces of their project to an adequate standard' (F01, Utility Company).

Doubt about the category combined with the industry's rigid temporal structuring ensured the smooth functioning of the existing system, but made it difficult for entrepreneurs to take advantage of opportunities. Due to this temporal complexity, entrepreneurs struggled to entrain to existing temporal rhythms characterized by delays and inconsistencies. Although the window of opportunity appeared open, entrepreneurs found it difficult to make progress.

Unobtrusive maintenance: new entrants are undermined. Although politicians, government bodies and incumbent firms had framed cleantech as an urgent imperative and publicly committed resources to it, entrepreneurs who pursued the opportunity encountered delays and inconsistencies introduced by those same actors and struggled to survive. To meet payroll, capital and operating expenses, entrepreneurs required the speed promised in the window of opportunity to stay afloat: 'Every meeting [with utility] seems to be 3 to 6 months apart, and so nothing happens because, you know, when you're a company like ours and you're starting up, every day is an expense, right? I've got payroll, I've got rent'. (ECM04, Entrepreneur). Similar cases were reported in the media:

> But Siple [an entrepreneur] says that because the review won't be completed until sometime in the new year, his company's hands are now tied for months. 'Our sales have stopped. Zero,' Siple said. As sales manager with no sales, he's looking for work. Several employees have been laid off. (Star, 8 Nov 2011)

Others testified to failures within the industry: 'So they pulled the grant. I guess times were tough economically…The whole industry almost went bankrupt' (ECM16, Entrepreneur).

> They give you enough money just so you can fail, as opposed to if I didn't have any money, then I know what I've got to do and I go focus on that. But they de-focus us all enough to think that there's something there for us, and then… we have just enough to fail. (EPS11, Entrepreneur)

Even employees of regulatory bodies and incumbent firms acknowledged the challenges for entrepreneurs. A utility manager recognized how such challenges directly caused entrepreneurs to fail: 'Projects fail after they get a contract because they get delayed…There's whole things that can happen, not moving ahead, and then kind of time turns against them' (F01, Utility Company).

Facing these complexities, entrepreneurs sought alternatives. One entrepreneur described their exit strategy: 'Like we…we had a child here, right? Its tidal energy…It was a 7- or 8-year-old child for us. Our hearts and souls were in this child and then we put it up for adoption' (EPS04, Entrepreneur). Another entrepreneur focused on internationalization: 'Canada's not an exciting market for us in the biggest picture…The U.S. is our largest market for now. Asia, China, India, other parts of the world are significant markets…we don't see as strong of a market here' (ECM17, Entrepreneur). As such, the window of opportunity had been closed, blocking entrepreneurs' market entry. The legitimate stabilizing mechanisms in the regime's institutional infrastructure, including its temporal and evaluation structures, and the framing of doubt about the category, undermined entrepreneurs.

Resource-Based Actions in Response to the Cleantech Issue

Entrepreneurs responded to the resource commitments announced in the window of opportunity. However, regime actors simultaneously extended the category of cleantech to include improvements in traditional energy technologies ('cleaner tech'), and because of the evaluation structuring, exerted latent category control over the cleantech category. That is, the existing economic value calculus, a legitimate stabilizing mechanism of the institutional infrastructure, dominated opportunity evaluation in the cleantech category. We refer to this control as latent since no overt action was required to control the cleantech category as long as the economic value calculus was accepted as the legitimate evaluative criterion. This control allowed incumbents to absorb most of the resource commitments, bolstering them as providers of cleantech.

Category extension. Based on the evaluation structuring of the regime, politicians and incumbents extended the cleantech category to include a wider range of technologies, both cleantech and 'cleaner tech', as one regulator explained:

> The cleantech definition as is most broadly being utilized, I suppose, is not limited to clean energy technology, although it does tend to be dominated by clean energy technology—at least in the [provincial] context, but in other contexts as well. But it does also include some areas of interest to [the province] beyond clean energy technology. We're clearly and obviously very interested in clean energy technology, as I'm sure you will have noted from many of our policies and legislative approaches and program design. But it does also include things like environmental management, environmental remediation, wastewater treatment and other, as you've noted earlier, clean—cleaner ways of doing things in the technology space. Just so that those very important opportunities are not overlooked in the [provincial] context. (F02, Regulator)

Similarly, a gas company executive said replacing oil and coal with 'increasingly abundant and cleaner burning natural gas is another part of the solution' (Sun, 25 March 2010). As such, the category of cleantech 'covers a range of continuous improvement-type energy technology development' (F02, Regulator). This extended definition of cleantech was embedded in institutional structures, such as the SDTC's seven project categories, among which two were 'unconventional oil & gas' and 'clean fossil fuel'.

As such, the category of cleantech was broadened to include these 'cleaner tech' innovations and the new breadth was built into the structures that guided decision-making. When evaluating new opportunities, radical cleantech innovations were thus competing against more incremental efficiency and waste management improvements in traditional technologies for which it was easier to make a business case since economic evaluations were privileged.

Latent category control. Despite announcing resource commitments for cleantech, when deciding on resource allocation, economic criteria associated with the regime's existing value calculus dominated. 'The metrics we're asked to put around it are jobs and leveraged money [matching private sector investments], but jobs is way up there on the top because it's so important to [the province]' (F05, Government Funder). While economic trade-offs were explicitly recognized, environmental measures were considered, but, 'again, within the confines of other things that have to be balanced corporately, within the provincial budgets, etc'. (F02, Regulator). As one regulator articulated, when evaluating the array of innovations, upfront investment in cleantech projects was a huge barrier, compared to investments in traditional energy infrastructure for which capital costs had been paid long ago:

> The kicker with geothermal projects is they're very expensive up front. They're very capital intensive, particularly in the areas where the resources exist. [Geothermal is] in very rugged mountainous terrain and you're having to use the same equipment that the oil and gas industry uses to drill several kilometres down to get into the sufficient temperature zones… it is very expensive. (F02, Regulator)

Oil and gas companies benefit from tax policies which subsidize their activities. The International Institute for Sustainable Development 'put the amount of subsidies to the oil industry by Canadian federal and provincial governments at $2.84 billion in 2008' (Sun, 21 July 2011). While old subsidies for traditional technologies were essentially hidden because they had become taken for granted parts of repeating budgets, new subsidies for cleantech were called out and problematized. For example, a political leader in Ontario decried 'rich subsidies for costly industrial wind farms we don't need' (Star, 19 April 2013). The Toronto Star reported that despite subsidies to incumbents that exceeded those to cleantech, 'the fossil fuel and nuclear industries are screaming foul, conveniently ignoring the public handouts they have enjoyed for decades' (1 October 2011).

The success of cleantech funding programmes thus was measured by economic impact:

> We brought in KPMG to do an impact evaluation… The lens that they looked at it through was primarily economic impact. So, of course innovation has a number of potential beneficial impacts, not the least of which new knowledge and new social outcomes and better environment, better health technologies, those kinds of things. Some of those are difficult to quantify and evaluate, particularly in the short term, but economic impact, when we look at things like jobs, leveraged investment, hard-nosed stuff, that was really the focus of the KPMG evaluation. (F05, Government Funder)

What is important to note here is that the disruptive potential of cleantech rested on its ability to deliver non-monetary benefits: reductions in carbon emissions. It is normal for emerging technologies not to be economically competitive with existing technologies initially, but if they promise other benefits (e.g., ecological), governments and other investors often invest hoping that economic competitiveness will materialize later through economies of scale and additional technological development. Typically, governments invest in new technology development to support it while it is being proven.[5]

However, the evaluation of new opportunities was dominated by the economic value calculus of the regime as it exerted latent control of the clean tech category. These evaluation criteria, which guided the procedures for project selection and evaluation, privileged applications by large incumbent firms in 'cleaner' technologies, such as carbon capture and storage, since these firms could invest their own capital (increasing the leveraged investment measures). Moreover, projects had shorter payback timeframes because previously agreed upon subsidies and investments in infrastructure were not included in the analysis, and risks were seen as lower because proven actors were investing in more certain projects.

Unobtrusive maintenance: Incumbents are bolstered. Because the category was extended to include a wider range of technologies and was controlled by economic evaluation criteria, 'cleaner' technologies forwarded by incumbents were privileged by regulators and government funders to meet cleantech resource commitments. For

example: 'There continues to be some alternative energy issues, but I think you'll see a bit of a focus now on more of the conventional energy and a better utilization of it' (Sun, 9 March 2012), with investments such as a '$238 million "green science fund for fuel-cell, clean-coal and nuclear-energy research"' (Star, 19 January 2007). One regulator explained: 'The province is uniquely positioned to capitalize on some of our existing assets and our existing resource base and our existing policy environment to see this sector or this area of the economy grow and expand' (F02, Regulator).

Among the STDC's cleantech categories, the 'unconventional oil & gas' category included funding for major oil producers to develop a warm solvent to replace water for oil extraction, and funding for a major oil and gas transmission pipeline firm to develop a self-monitoring composite pipe that could replace a corroded or compromised pipe without the need to excavate. The 'clean fossil fuels' category included funding for a less expensive bitumen diluent, as well as a field-upgrading technology aimed at reducing capital costs by 50 per cent, operating costs by 30 per cent and greenhouse gases by only 6 per cent. Similarly, a report by Canada's Auditor General claimed that Pacific Carbon Trust, a BC government organization that provided grants to carbon reduction projects, gave millions in grants to recipients, including oil and gas companies, for projects that were legally required or would be implemented regardless of the grants in order to save costs (Sun, 30 Jun 2012).

Media and activists criticized spending on 'cleaner tech'. For example, of the $2 billion in funding provided by the federal government to promote 'clean, green technologies that fight climate change', $200 million was earmarked for energy efficiency, fuel cells and renewable energy and $1.55 billion remained unspecified; however, media reports indicate that the oil, gas and coal industries received a significant tax break at this time (Sun, 19 Feb 2003). When carbon capture and storage technology received subsidies allocated to cleantech, activists argued: 'We definitely don't think Canadians…should be paying to clean up industries' pollution', and 'the concept of polluter pay is apparently too complicated for the oil industry' (Sun, 5 February 2008).

The stabilizing mechanisms of the institutional infrastructure led to category extension and latent category control that favoured existing regime actors. The resource commitments to cleantech thus were absorbed by incumbents, bolstering their position in the market.

Unobtrusive Maintenance: Disruption Avoided

As of 2011, after the window of opportunity was opened during an intense period of resource commitments and regulation to accelerate the adoption of clean technology, 97 per cent of Ontario's electric energy continued to be supplied by nuclear (57 per cent), hydro (22 per cent), natural gas (15 per cent), and coal and oil (3 per cent). Collectively, solar, wind and biomass only accounted for 3 per cent of the province's supply. Likewise, non-hydro renewable energy production accounted for less than 3 per cent of the national energy supply. Entrepreneurs were stymied by the contradiction: 'So on one hand we [society] say we want to

be green, we want to do this stuff, but on the other hand, we have much higher, other priorities' (ECM08, Entrepreneur). In the meantime, starved of resources and delayed or blocked from accessing markets by the temporal and category effects of the interlocking socio-technical regime, cleantech entrepreneurs frequently failed, performed poorly, or left Canada to pursue international markets.

Thus, as one entrepreneur described, incumbents were winning the 'war of attrition' (PSCS1, Entrepreneur). The lack of progress in renewable energy generation and underlying clean technologies, and the absorption of government funding by incumbents suggest that the socio-technical regime was maintained and disruption was avoided.

DISCUSSION

We have presented an analysis of incumbents' responses to potentially disruptive innovations when overt resistance to such innovations would not be considered legitimate. We found that incumbents and other regime actors (politicians and other government actors) deployed time- and resource-based actions to signal legitimate action on the issue of cleantech. At the same time, the legitimate stabilizing mechanisms of the existing institutional infrastructure enabled them to absorb the cleantech category and its associated resources, thereby undermining potential disruptors. Ultimately, incumbents' unobtrusive maintenance work resulted in a largely unchanged socio-technical regime, with some incremental environmental improvements in incumbent technologies frequently funded largely by taxpayers.

While our data do not allow us to assess incumbents' and political actors' intentions with respect to this maintenance work, we outline three possible scenarios: weak intentionality based on habitual reproduction, strong intentionality based on Machiavellian self-interest seeking with guile, and moderate intentionality based on basic self-interest seeking.

An assumption of weak intentionality would suggest that incumbent actors and political/regulatory actors intended to be supportive of cleantech in line with their public statements and intended to follow through on their resource commitments, but their habitual enactment of institutional prescriptions got in the way. For example, because stability of the electrical grid was important to utilities and required exceptional due diligence, and because approval from the utility regulator was required and took time, delays in the process were inevitable. These could be attributed simply to the systemic asynchronies that arise in many new technology developments, such as unanticipated roadblocks (Pickering, 1993) and delays in the emergence of supportive infrastructure (Ansari and Garud, 2009). Similarly, it could be argued that political exigencies shifted, and funds were no longer available for cleantech. Further, it could be seen as very natural that economic metrics would be the primary means of evaluating investments in cleantech, because economic metrics dominate most business decision-making processes.

However, internal inconsistencies abound in this set of arguments for weak intentionality. First, the utility took over 2 years to announce the results of its request for proposals related to independent power production. However, according to its website,[6] the utility had been purchasing independently produced energy and connecting it to the grid since the 1980s, thus negating the argument that supportive infrastructure was not available, or that extensive due diligence was required due to a lack of familiarity with the technology. Furthermore, while the utility needed the approval of its regulator to purchase independent power, it waited until *after* the deadline for its request for proposals before asking the regulator to exempt it from purchasing independent power, creating additional delays. Additionally, even after it announced purchase agreements, it later cancelled many of them. With respect to government funding for cleantech, in most cases, many of the funds allocated to cleantech were not cancelled, but were distributed to incumbents based primarily on an economic value calculus, despite statements in announcements and on websites[7] that placed ecological criteria first. Finally, the extension of the cleantech category to include 'cleaner tech' is hard to interpret as habitual action with weak intentionality, since it involves deviating from the status quo.

In contrast, an assumption of strong intentionality would suggest that incumbents and political actors framed a window of opportunity around cleantech with the express purpose of luring in unsuspecting entrepreneurs, then crippling them with delays, changes in funding allocations, and absorption of the cleantech category, thereby winning the 'war of attrition', as one entrepreneur framed it. The entrepreneurs' failure to thrive would publicly demonstrate that cleantech was 'not ready yet', absolving incumbents from delivering on their window of opportunity framing and resource commitments, and thereby rendering 'cleaner tech' the only legitimate response to ecological concerns. We feel the strong form of intentionality, equivalent to pre-meditated assault, is not credible either, since it would require significant scheming and hypermuscular coordination among incumbents and political and regulatory actors across different industries and jurisdictions.

The assumption of moderate intentionality is more credible because it suggests only that incumbents and regime actors sought to maintain institutional arrangements which were in their own best interests. Entrepreneurs were collateral damage in self-defence actions, not victims of premeditated violence. We suggest that when pressured, it makes sense for actors in a regime to use positive rhetoric and make (symbolic) resource commitments to signal that they are working on an issue in an effort to gain legitimacy, as shown in other contexts (see e.g., Zietsma and Lawrence, 2010). Furthermore, when political directives are in a constant state of flux, it is perfectly reasonable for utilities to delay implementation as long as possible since the rules could change at any time. Similarly, it is perfectly reasonable for oil and gas companies to try to attract government cleantech funding for projects that make their own operations a little cleaner, and it is perfectly reasonable for political actors to fund 'clear winners'—projects that show low risk,

promise job creation and support a nationally important industry. Interpreted from each actor's own set of institutional norms and constraints, each action is defensible, which is why we label the stabilizing mechanisms as 'legitimate'. While our data cannot definitively determine which form of intentionality was operating in this context, we argue that this moderate form of intentionality featuring institutionally-influenced self-interest seeking is most consistent with the data patterns we observed. Regardless of the intentions of incumbent and regime actors, our study makes several contributions to the literatures on disruptive innovation and institutional maintenance.

Contributions to the Literatures on Disruptive Innovation and Institutional Maintenance

In the literature on disruptive innovation, scholars have focused primarily on successful disruption by studying incumbent failure (Benner and Tushman, 2003; Danneels, 2004; Tushman and Anderson, 1986) or adaptation (e.g., Christensen and Raynor, 2003; Howells, 2002; Lange et al., 2009). Furthermore, with few exceptions, researchers have concentrated solely on the dynamic interactions between incumbents and challengers. Using insights from institutional theory, we have focused instead on the avoidance of disruption through the unobtrusive maintenance work of incumbents and other regime actors. Moreover, in contrast to previous studies in which scholars viewed incumbent resistance as unproblematic (e.g., Ansari et al., 2016b; Garud et al., 2002; Gurses and Ozcan, 2015), social demands for action on cleantech in our context meant that overt resistance and purely symbolic action likely would have been deemed illegitimate. Nonetheless, incumbents found ways to avoid changes to the field and their positions within it. Our study's focus delivers unique and valuable insights to the disruptive innovation literature by overcoming the success bias, and looking beyond simplistic conceptions of hypermuscular agency to understand disruptive innovation at the field or regime level.

We have used institutional theory to shed light on how incumbents and other regime actors were able to unobtrusively avoid legitimate demands. Although technological innovation is a recognized source of institutional change (see, e.g., Ansari and Phillips, 2011; Barley, 1986; Greve and Taylor, 2000; Hargadon and Douglas, 2001), few have considered institutional theory in tandem with disruptive innovation. We contend that institutional theory provides interesting insights into disruptive innovation processes, because the theory focuses specifically on what makes change difficult. Institutions, as 'repetitively activated, socially constructed controls', (Jepperson, 1991, p. 145) are legitimate stabilizing mechanisms that interlock with other institutions in an infrastructure that is often difficult for outsiders to penetrate. The institutions themselves work to maintain status quo arrangements; when incumbents and other regime actors activate them in particular ways, they often are able to resist even legitimate social pressures for change, maintaining the existing arrangements which privilege them (Fligstein, 2001; Garud et al., 2002; Lawrence and Suddaby, 2006). We have shown how incumbents

framed a window of opportunity around cleantech through urgent rhetoric and resource commitments, thus bolstering their legitimacy by appearing to respond to the cleantech issue. However, they simultaneously activated legitimate stabilizing mechanisms (i.e., temporal structuring and evaluation structuring) that supported the existing infrastructure of the socio-technical regime, which simultaneously bolstered their dominant position and legitimacy. The undermining of potential disruptors was collateral damage.

Temporal Structuring as a Legitimate Stabilizing Mechanism Leading to Temporal Complexity

Temporal structuring involves entraining new entrants to the integrated temporal cycles of regime actors, in this case, political actors and incumbents. It was perfectly legitimate for each type of actor to behave in the usual way in accordance with typical temporal rhythms. However, intermittent political and bureaucratic government and incumbent temporal structures were anathema to entrepreneurs who needed the speed that seemed to be promised in the window of opportunity framing. *Temporal complexity* refers to 'multiple temporal rhythms and experiences rather than…a single linear conception of time' (Garud et al., 2013, p. 793). The temporal complexity created by the requirement to manage three vastly different sets of timing norms had the effect of undermining new entrants. As new entrants failed to thrive, they validated the incumbents' and regime actors' rhetoric that the clean tech category was 'not ready yet' for adoption.

In a review of the innovation literature, Garud et al. (2013) noted the effects of temporal complexity in innovation processes, describing how differences in timing norms can lead to roadblocks, delays and partial implementation (see, e.g., Ansari and Garud, 2009; Pickering, 1993). While our data do not allow us to infer that incumbents and other regime actors deliberately used delays and temporal complexity to undermine entrepreneurs, they do point to the ways in which temporal structures enacted by regime actors can contribute significantly to institutional maintenance in the face of demands for change. In fact, temporal effects are ideal for performing *unobtrusive maintenance* because temporal rhythms are systemic rather than episodic structures (Lawrence et al., 2001), thus actions appear to be inevitable rather than malevolent, intentional strategies to resist institutional pressures. In our study, the overt actions incumbents took in support of cleantech (i.e., framing a window of opportunity, committing resources) helped build legitimacy for incumbents. Enacting legitimate stabilizing mechanisms did not appear to detract from their legitimacy significantly even though these mechanisms enabled unobtrusive maintenance. Similar to recent work showing how change can occur unobtrusively through everyday practices (Smets et al., 2012), such unobtrusive maintenance does not necessitate visibly conscious and active institutional work and thus may have fewer negative legitimacy implications for the resisters. Our findings therefore provide insight into unobtrusive forces that help avert disruptive innovation, and suggest that potential disrupters would benefit by assessing the temporal rhythms they face in disruption and plan accordingly.

Indeed, windows of opportunity may in fact be more closed than they appear because temporal complexity inhibits market entry.

Institutional theorists are beginning to take a greater interest in temporal rhythms. Scholars have revealed the work required by entrepreneurs to manage temporal complexity (Granqvist and Gustafsson, 2016; Reinecke and Ansari, 2015; Slawinski and Bansal, 2015) to *support* efforts for institutional change. We extend this work by showing how temporal complexity can *block* change and disruptive innovation, leading to institutional maintenance.

Evaluation Structuring as a Legitimate Stabilizing Mechanism Leading to Category Hijacking

Often, innovation is disruptive precisely because it redefines the evaluation criteria for a particular technology or business area. When regime actors can instead repeatedly activate a value calculus that privileges status quo metrics, new entrants may be undermined based on their performance against these legitimated metrics, while attention is directed away from the metrics on which disruptors excel (in this case, ecological performance), effectively giving the regime latent category control. Economic metrics in this context were legitimate in that they were comprehensible, taken-for-granted and normatively justified. Activating evaluation structuring as a stabilizing mechanism enables incumbents and political actors to not only excuse their own mediocre support for cleantech, but also justify the extension of the cleantech category to include their own 'cleaner tech', allowing incumbents to absorb category resources. Such recategorizing work can yield substantial benefits for firms or industries (Vergne, 2012), as strategically promoting certain attributes (and not others) of categories can privilege particular actors (Gehman and Grimes, 2017) in terms of both legitimacy and resource access, as was the case in our context. When disruptive innovators attempt to introduce new or refined categories with different criteria, category language and attributes can be hijacked by incumbents as they frame themselves as category members, and then dictate the use of previously legitimated metrics to convey or evaluate the category's value. The lesson for potentially disruptive innovators is to focus heavily on controlling evaluation criteria in new or refined categories to avoid latent category control (and category hijacking) by incumbents. While Govindarajan and Kopalle (2006) suggested that researchers pay attention to how disruptors can disrupt by offering new value propositions despite having mainstream attributes, our findings suggest that such a strategy opens possibilities for incumbents to engage in institutional maintenance via evaluation structuring, thereby helping them to avoid disruption. Further research is required to understand when and how incumbents (rather than new entrants) successfully control a category's evaluative criteria.

These findings also contribute to an improved understanding of institutional maintenance. In prior work, scholars have focused on efforts such as valorizing or demonizing, and deterring or enabling an institution (Lawrence and Suddaby, 2006); however, such overt work is likely to be seen as illegitimate in a context like

ours where the innovation being defended against is seen as socially desirable. By focusing instead on a legitimate value calculus, institutional maintenance in our context was unobtrusive—that is, choosing cleaner tech over cleantech made sense based on economic value criteria. Economic sociologists like Callon and Muniesa (2005, p. 1229) clarified that calculation counts, and that 'in order to be calculated, goods must be calculable'. In many ways, the reversion to economic criteria seems natural (and is taken for granted), because they seem more calculable than other criteria. Yet, ecological performance also is calculable, as is the cost of infrastructure depreciation for hydro dams, and the cost of subsidies to oil and gas companies. These 'disappeared' in our context, however, by a consistent focus on interpretations of economic criteria that privileged incumbents, and which appeared legitimate because they were used regularly. Our findings illustrate how incumbents and other regime actors have agency to maintain institutions within their institutional sphere by activating legitimate stabilizing mechanisms (i.e., temporal and evaluation structuring). The (selective) reproduction of existing structures helps incumbents avoid disruption: the institutional infrastructure of the field provides regime actors with an arsenal of legitimate stabilizing mechanisms which can be activated that are justified by longstanding beliefs and values in the field, but which nonetheless can help avoid even socially desired disruptive innovations.

CONCLUSIONS

The literature on disruptive innovation is rarely integrated with the literature on institutional change, despite the fact that such innovation often creates institutional change. Our findings suggest that more deliberate attempts to integrate insights from both literatures would be fruitful, since the notions of legitimacy and stable social structures clearly are important to disruptive innovation, and institutional theorists could learn from literature that examines how innovations become adopted. Both literatures could benefit from more attention to the avoidance of potential disruption, since a success bias tends to affect both institutional theory and disruptive innovation studies. Furthermore, scholars in both areas should look beyond challengers and incumbents and focus on other actors who are influential in the socio-technical regime.

We note three important boundary conditions for the study. First, we focused on disruptive pressures that are perceived as legitimate by external audiences. Second, we focused on a context which was politically important, creating regulatory and political dynamics that strengthened the effects of incumbent responses. Third, we focused on a situation characterized by resource-dependency on incumbents in which entrepreneurial firms faced what Ansari et al. (2016b, p. 1829) called 'a disrupter's dilemma'. It is likely that the ability of incumbents to successfully defend against entrepreneurial entry would be diminished in other settings where incumbents are less important to political actors and have less resource control. These situations are not rare, particularly since more and more

transactions are managed through platforms involving ecosystems of related actors. As a result, our findings call attention to important factors which should be studied further to reveal their influences under various conditions.

Finally, and on a practical note, because disruptive innovations often are seen as creating new sources of value, particularly when they address social issues that impact quality of life, our findings may appear disheartening. The clear barriers to clean technology innovation identified in this study suggest significant limits to what we can expect in terms of innovation when both incumbents and political actors benefit from the continuation of existing regimes, even when they overtly support such innovations. Those focusing on wicked problems in society, disruptive entrepreneurship and social change initiatives in general are well advised to attend to the interests of actors in their environments, and to understand the institutional effects that support their unobtrusive maintenance. While our findings shed light on these institutional effects that maintain status quo arrangements, we acknowledge that scholars have identified effective tools that support institutional change, and suggest that actors who are trying to make socially desirable change may be able to counteract unobtrusive maintenance using these same tools. Furthermore, if these actors are successful in effecting change, new arrangements are likely to be maintained using the same mechanisms that current regimes use to avoid disruption.

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NOTES

[1] https://whatis.techtarget.com/definition/clean-technology-clean-tech.

[2] Exceptions include large industrial or institutional users which produce power to supplement their grid-tied power use, or remote, non-grid tied communities which supplement their use of fossil fuel generators. Similarly, a small number of users retrofit their own equipment for biofuel and acquire or produce biofuel for their own use.

[3] https://www.neb.gc.ca/bts/whwr/rgnztnndstrctr/brdmmbr/brdmmbr-eng.html#s3

[4] https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/planning_regulatory/acquiring_power /2010q3/cpc_rfp_process_report.pdf

[5] For example, Mark Walsh and Matt Weinberg of the U.S. Small Business Administration's Office of Investment and Innovation stated: "Unlike the professionally managed funds that are driven to

maximize profit for their limited partners and investors, the government's bottom line is not profit. That makes its work fundamentally different. Because of this difference, the federal government has for centuries been investing in moonshot ideas that have led to groundbreaking technological advancement, new market creation and significant improvements in the lives of ordinary Americans." https://techcrunch.com/2016/07/03/your-federal-government-drives-innovation-by-investing-in-moonshots/, accessed 25 Feb 2018.

[6] https://www.bchydro.com/work-with-us/selling-clean-energy/meeting-energy-needs.html

[7] For example, the eligibility section of Sustainable Development Technology Canada's website indicates: "SDTC's mandate is to fund projects that support Canadian small and medium size enterprises advancing innovative technologies that are pre-commercial and have the potential to demonstrate significant and quantifiable environmental and economic benefits in one or more of the following areas: climate change, clean air, clean water and clean soil." https://www.sdtc.ca/en/apply/eligibility-and-evaluation

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