Towards Decentralized Power Systems: Market & Regulatory Frameworks for Ontario

by

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supervised by

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FOREWORD

This section will detail how this Major Research Paper (MRP) connects to my Plan of Study (POS). My stated area of concentration for my POS is the interaction between emerging technological and innovative business trends with that of the statutory and regulatory framework of Ontario's electricity sector. The three components that I have identified to comprise my area of concentrations are: (1) Sustainability, Energy, and Socio-technical Transitions; (2) The Design of Ontario's Electricity Market as Represented by its Rules and Regulations; and (3) Emerging Innovations in the Power Sector – Potential Market Participants. My MRP is directly related to all three components of my POS.

With respect to the first component, there is a direct relationship because the primary objective of my MRP is to assess the sustainability transition of Ontario's electricity system using the analytical framework of the socio-technical transitions lens and multi-level perspective theory. Specifically, my MRP details the interaction between niche-level innovation, mainly the integration of DERs technologies and the established electricity regime, dominated at the distribution level by Local Distribution Companies.

With respect to the second component, there is a direct relationship, although it is incorporated slightly differently than initially thought. This is because I quickly realized that focusing on the Market Rules specifically would not be fruitful, as it contains many technical (engineering) rules that I would simply have nothing meaningful to contribute to. Instead, I decided to focus on the market structure and the various ways that it can play a role in supporting a DERs market.

With respect to the third component, there is a direct relationship because I explore the different possibilities of how DERs markets and business models could work. I look to some pilot projects that were implemented by LDCs in Ontario – specifically, Alectra Utilities. I also refer to some recent developments in other jurisdictions where DERs are already participating in wholesale markets and competing against traditional sources for the provision of electricity services. Quite importantly, I refer to much of the DERs market activity as electricity retailing and distinguish it from previous retailing business models to make the case of how technological advancement has changed the business model and why this emerging form of retailing is desirable.

My MRP is supported by the Learning Objectives that stemmed from the three components identified above. I have completed them all and the knowledge gained from their completion was instrumental in understanding and writing this MRP.

ABSTRACT

This MRP is about the sustainability transition of Ontario's electricity system. A sustainability transition is understood as a type of purposive socio-technical transition, which is meant to address some normative goal rather than to exploit commercial opportunity. I use the analytical framework presented by the socio-technical transitions literature and multi-level perspective theory to assess the state of Ontario's grid modernization as evidenced through primarily documentary evidence, most notably the 2017 Long-Term Energy Plan. I conclude that based on this evidence, Ontario is taking a *transformation* pathway, which is characterized as being driven from within the established regime that modifies its own trajectory in response to landscape pressures and an under-developed niche. This is represented by Ontario's preferred approach to enable LDCs as the primary developers of DERs through regulatory changes. I then argue that in light of sustainability objectives that I identify in this paper, Ontario's approach has some shortfalls, and instead I recommend a *reconfiguration* pathway that requires the strategic modification of 3 key areas to enable a competitive retail DERs market. The three key areas are: (1) adjustments to the grid architecture to address the operational and functional roles of grid actors; (2) establishment of a market structure known as a platform to enable the participation of distributed resources to compete with traditional resources on a level playing, which can be done either at the bulk or distribution levels; and (3) the regulation of a competitive retail DERs market in Ontario.

List of Acronyms

BTM = Behind-the-Meter
DER = Distributed Energy Resource
DSO = Distribution System Operator
ICT = Information Communication Technology
IESO = Independent Electricity System Operator
LDC = Local Distribution Company
LMP = Locational Marginal Pricing
MOE = Minister of Energy (Ontario)
NWS = Non-Wires Solutions
OEB = Ontario Energy Board
OPA = Ontario Power Authority
OPG = Ontario Power Generation
VPP = Virtual Power Plant

METHODOLOGY AND SUMMARY

The purpose of this MRP is develop a case study around the sustainability transition of Ontario's electricity sector in order to comment on the structural and sustainability implications of Ontario's chosen approach and explore whether there is a preferable approach. Put otherwise, in this MRP I seek to answer the questions: (a) what is the state of Ontario's sustainability transition in the electricity sector? And (b) what recommendations, if any, can be made, in light of the normative objectives of a sustainability transitions? I proceed to accomplish this in the following way:

In Part I, I set out a normative frame around sustainability. The purpose of doing this is because this MRP posits that Ontario's sustainability transition is purposive, meaning it is designed to achieve some normative objective, mainly sustainability. For the process of operationalizing the concept of sustainability so that it can be used for an analysis, I turn to Gibson et al.'s "sustainability assessment" exercise for guidance and subsequently use his eight sustainability criteria, adapted for context-specific (i.e. electricity system) purposes to inform my own three sustainability objectives. These objectives serve as an important benchmark since they enable me to conduct a rigorous analysis as to whether the transition is achieving its identified objectives. It should be noted that I take an expanded view of sustainability, like Gibson, looking at structural, social, and economic implications, in addition to environmental ones.

In Part II, I start by introducing the socio-technical transitions lens and unpack the multi-level perspective theory. I have chosen to use this analytical framework because it is particularly well-suited to examine the relationship between technological innovation and the social and institutional systems that determine how innovation becomes embedded to fulfill societal functions; it also has a proven track record of use in analyzing various electricity system transitions and demonstrates that it provides value in those analyses. I then proceed to apply the MLP framework in order to identify Ontario's electricity regime, the landscape pressures being exerted upon it, and the niche developments that are percolating to break into the regime. I note that due to the role of rules that coordinate the actions of actors in this context – in essence the industry structure is established by a statutory framework and governed through a regulatory framework – that the niche cannot itself break into the regime because the rules are too restrictive causing an impasse and depend on regime actors to make changes to the rules.

In Part III, I conduct the main analysis, where I rely on primarily documentary evidence supplemented by attendance at various conferences in Toronto in 2018 to comment on the state of Ontario's electricity system sustainability transition. It should be noted that the documents that I rely on comprise part of a statutorily enshrined process that pertains to industry evolution as well as planning of the electricity system. Mainly, I look to Ontario's 2017 Long-Term Energy Plan and following the items related specifically to DERs, I examine the Implementation Plans of the IESO and OEB, which are indicative of the direction that the industry is heading in Ontario. I look at other important pieces of evidence of things happening on the ground, such as pilot projects being undertaken by Alectra Utilities, such as the deployment of a utility-owned and operated virtual power plant, and the Electricity Distributors (trade) Association's vision paper, which presents a comprehensive vision of how Ontario LDCs (vis-à-vis the EDA) envision the evolution of the distribution sector in Ontario. I conclude that, collectively, based on the evidence that I look at, Ontario is heading towards a *transformation* pathway as contemplated in the socio-technical transitions literature. This means that innovation is being adopted in a minimal way predominantly by established actors. This is represented by Ontario's chosen approach of enabling LDCs to deploy DERs, primarily as Non-Wires Solutions, which means that DERs compete with traditional infrastructure investment rather than competing for the provision of electricity services.

In part IV, I continue to examine the implications of Ontario's chosen approach in light of the sustainability objectives identified in Part I. I put forward that there are several shortfalls that arise out of Ontario's chosen approach, mainly related to issues of limiting consumer choice and stifling innovation, among other factors. As an alternative, I recommend a *reconfiguration* pathway that would lead to a competitive retail DERs market in Ontario that would better address the shortfalls that I have identified. Relying on literature such as the MIT's Utility of the Future report, I elaborate on how a more market-oriented approach could be achieved by strategically addressing three key areas of the sector: (1) adjustments to the grid architecture so that operational and market structures are well coordinated between the distribution and bulk system levels, as well as the functional clarification of LDCs with respect to their network and commercial aspects of the business; (2) establishment of a market structure known as a platform where distributed resources will be able to participate and compete with traditional resources on a level playing field for the provision of electricity services; this can be done on either the distribution or bulk levels of the grid; and (3) the regulation of a competitive retail DERs market in Ontario – to understand the basic tenets of this new business model (i.e. aggregation) and how it is distinct from previous electricity retailing activity.

In Part V, I conclude with a reflection of how things are likely to develop in Ontario at the risk of departing from the current plan in the face of policy swings that have been prevalent throughout energy policy in Ontario over the last two decades.

PART I: DISTRIBUTED ENERGY RESOURCES IN POWER SYSTEM SUSTAINABILITY TRANSITIONS

1.4. **Ruminating About Sustainability:** an introduction to the normative context

The notion of sustainability as it is understood in the modern public conscience is at its core premised on the recognition that human activity has an impact on the biophysical condition of our planet. That is to say, the cumulative effects of our activities trigger complex feedback systems that express consequences of shifting climate patterns, severe weather events, and ocean acidification, to provide a few examples. As a matter of global policy, the landmark Report of the World Commission on Environment and Development (also known as the Brundtland Comission/Report) titled "Our Common Future" in 1987 used scientific evidence and methodology to establish that the same economic activities and technological developments that led to our prosperity have also led to the "continued degradation" of the planet's biophysical health and put future generations at severe risk (WCED, 1987). In response, the Report coined the term "sustainable development," which implicitly captures the idea that many economic development activities, mainly industrial activities such as resource extraction, processing, and manufacturing, as well as farming, transport, construction practices, and the production and consumption of energy (the focus of this paper) are not sustainable (i.e. viable) in the long run because they strain the planet's biophysical capacity beyond its safe limit. Thus, concedingly at the risk of sounding tautological, sustainability is perhaps best understood in contrast to unsustainability, whereby a practice is sustainable if it can be engaged in over a long period of time without (or with minimally) inflicting adverse impacts on the planet.

This brings me to the second and more salient point of this paper, about sustainable development, which reveals that in order to achieve this normative objective, we must undertake a transition because our current trajectory, comprised of our cumulative practices, is unsustainable (i.e. not viable in the long run). This transition may be gradual and fragmented but it must be executed with a conscious effort to achieving the objective of sustainability. It is this notion of a transition that underlies this paper and its investigation. The specific type of transition is a "sustainability transition" as it is called by Frank Geels in his prolific literature, which studies "socio-technical transitions" and forms the analytical framework for this paper as will be elaborated in Part II (Geels, 2011). That said, the challenge with all transitions, inherently, is that they necessarily involve a shift away from the routine way of doing things, which - as a matter of human nature - we get locked into repeating. This concept known as "path dependency" is as much true and relevant on a collective scale as it is on an individual one; and a collective scale invariably includes organizations and institutions that are governed through internal policies, guidelines, and bureaucracies. Robert Gibson eloquently and adequately captures this principle in the context of sustainability, when he says that: "[C]urrent sustainability efforts… are also attempts to push us onto a different and more hopeful path as such they are an attack on entrenched habits and structures of decision-making." (Gibson, 2006).

In summary, as the above indicates, this paper is about achieving sustainability (i.e. long term viability) in an industrial sector of the economy, mainly the provision of electrical energy, through a sustainability transition. Furthermore, we have seen that a transition of this sort requires a structural shift away from current decision-making practices in many areas of the sector, such as planning, generation, and consumption, to name a few examples. The remainder of this section will focus on operationalizing the concept of sustainability by identifying context-specific objectives for power system evolution (i.e. the values that a power system sustainability transition seeks to achieve) and why a transition towards a decentralized grid (i.e. a power system with a high penetration of Distributed Energy Resources – DERs), a concept that will be elaborated below, sufficiently addresses and fulfils these objectives, thereby making it a desirable plan to consciously pursue when thinking about policy with respect to Ontario's electricity sector.

1.5. **Operationalizing Sustainability:** identifying the objectives of a power system sustainability transition

Although this paper takes a conceptual approach to analyzing the sustainability transition of Ontario's power system, it is nonetheless important to functionally define what a sustainability transition is and identify the context-specific sustainability objectives that an electricity system sustainability transitions seeks to achieve (i.e. sustainability objectives) so that they may be readily applied for a rigorous analysis. According to Geels, sustainability transitions, understood as deep structural changes to the electricity system, are distinct from other socio-technical transitions that have occurred throughout history. Meanwhile, socio-technical transitions are understood as being changes in the way technology is implemented to fulfil societal functions (this will be exposited in detail in Part II) (Geels, 2011; 2002). Mainly, Geels refers to the following three distinguishing points in reference to sustainability transition: First and foremost, they are purposive, specifically in that "they are meant to address persistent environmental concerns" (Geels, 2011). As I will demonstrate below, this paper takes a broader approach to sustainability outlined by the three sustainability objectives that will follow. This is in contrast to other transitions which were more emergent, meaning that they were based on "exploiting commercial opportunity related to new technology" (Geels, 2011). Put otherwise, the goal of sustainability transitions is the collective good and there (often but not always, as I present in this paper) little incentive for individuals. Second, sustainability transitions do not offer obvious user benefits in the short term so it is unlikely that environmental innovation will be able to "replace existing system without changes in economic framing conditions, such as changes in policy and resistance from vested interests"

(Geels, 2011). And Third, “in the market domain where large firms compete with complementary assets serving economies of scope and scale, sustainability innovators require strategic reorientation with support from regime actors who defend the existing regime” (Geels, 2011). As Geels further points out in providing guidance on sustainability transition, these factors “make it imperative for the analyst to explore the interaction between multiple dimensions including technology, public policy and politics, economic and market developments, and [even] culture.” (Geels, 2011). This reinforces the importance of the role of social agency on an organizational basis in technological development and deployment.

In this light, that sustainability transitions are designed to achieve certain normative outcomes, it is helpful to bring back to the forefront the mischief that sustainability is attempting to solve for as these principles comprise the sustainability objectives that the power system transition being analyzed in this paper are designed to achieve. Once again echoing the words of Gibson, “Essentially, the present concept of sustainability is a response to evidence that current conditions and trends are not viable in the long run, and that the reasons for this are as much social and economic as they are biophysical and ecological.” (Gibson, 2006). Gibson makes these comments in the context of a sustainability assessment, which is a distinct mode of analysis for policy evaluation that this paper will not undertake to complete. However, I will borrow certain concepts to inform my analysis. Mainly, the sustainability assessment begins by taking the eight general sustainability criteria proposed by Gibson et al. in the seminal literature regarding sustainability assessments and adapting them to become context-specific criteria than can be readily applied to any specific policy evaluation. The quote above reveals that the sustainability criteria stem from biophysical and ecological concerns as well as social and economic ones. That said, the sustainability criteria have already been adapted to the context of power system planning in a policy evaluation conducted by Mark Winfield (Winfield, 2016). As a result, I will turn to Winfield's analysis for guidance and to the context-specific criteria used in his analysis to inform and adapt into the sustainability objectives that I will use for this paper's analysis. Based on Winfield's analysis I have distilled, bundled, and adapted the criteria into the following three core sustainability objectives (based on Gibson, 2006; and Winfield, 2016):

Sustainability Objective #1: Environmental Integrity

The first objective is focused on the quintessential focus of sustainability, which is environmental protection and preservation of the biophysical landscape and ecological ecosystems. This objective recognizes and values the intangible benefits derived from the natural world, as well as the fundamental truth of the inter-dependent relationship between the human and otherwise non-human, ecological environment. This objective is concerned with protecting against, minimizing, and avoiding: greenhouse gas emissions and the emissions of other noxious fumes; pollutants in general deposited in either soil, water, or air; the natural habitats and conditions that wild flora and fauna depend on; and other natural landscapes and resources contained in forests, oceans, and the artic that provide ecosystem services such as regulating sea levels and maintaining stable climate patterns through the natural movements of the Earth's weather system and its capacity to find equilibrium. This ties back to the notion that human activity offsets these natural patterns, which then have ripple effects when thrown off balance that can be catastrophic for the conditions that humans, animals, and plants depend on in their natural environment. In other words, achieving this objective involves the protection of irreplaceable life support function upon which human and ecological well-being depend.

Sustainability Objective #2: Economic Responsibility and Adaptive Capacity

The second objective is more closely connected to the social and economic aspects of sustainability, as mentioned by Gibson above, in contrast to the first objective. This objective focuses on maximizing market efficiency and cost-effectiveness when making planning decisions, as well as ensuring prudence, precaution, and adaptation in the outcome. Put otherwise, implementing this objective in decision making means respecting factors such as "the efficiency of energy production, delivery, and use by maximizing use of underutilized facilities, resources, capacities, and minimizing requirements for additional supporting infrastructure, as well as minimizing governance burdens and costs (e.g. regulatory and administrative)." (Winfield, 2016). In a world of rapidly changing technologies, this objective values "the flexibility to pursue and adopt new technologies and methodologies to avoid lock-in, to be cognizant of the demand for material, energy, and ecological system services, and reducing the cost of provisions such as maintenance, operational, capital costs, and risk." (Winfield, 2016). This objective also prioritizes "the need to achieve technological system reliability and resiliency through [strategies such as] the minimization of vulnerability and maximization of modularity and diversification of fuel and technology." (Winfield, 2016). In other words, structures of decision making need to maintain a high degree of adaptive capacity in the face of uncertainty and the minimize path dependence. This means improving the ability to adapt to changing circumstances including externally generated changes and "minimizing commitments to high path-dependency large-scale, capital intensive supply options." (Winfield, 2016).

Sustainability Objective #3: Distributional Effects, Innovation, and Individual Choice

The third objective, similar to the second one, is more closely connected to the economic and social aspects of sustainability, with this third objective being more closely concerned with the social impacts of economic choices. Broadly speaking, this objective emphasizes the need to consider livelihood sufficiency and opportunity, intra- and intergenerational equity, and democratic governance. Specifically, these values are manifested by outcomes such as the reliable and affordable provision of energy services, associated economic development opportunities and risks, and equitable outcomes with respect to consumption patterns, wealth, and impacts of electricity costs and pricing allocation among consumer groups. That said, as the topic of distributional effects is often contested due to different assumptions about the impacts of market economics, it is worthy to make clear that my own perspective on these factors favours market forces and market-based solutions as opposed to more interventionist approaches such as direct redistributions. Additionally, open markets create business opportunities for new and innovative entrants that could provide services that were otherwise not offered prior and increase livelihood opportunities through new revenue models that are accessible to more people due to lower barriers to entry. This is why, for the purposes of this paper, this third objective values innovation and the reduction of decision making to the lower levels that would afford greater individual choice, and in my opinion these these factors would be better served through competitive markets, which may differ from the perspective taken by Gibson.

1.6. **The Desirability of DER:** How DERs contribute to achieving the sustainability objectives

The three themes outlined above collectively show that sustainability objectives are far more encompassing than simply concern for environmental impacts, and as such warrant much deeper investigation and contemplation of a wider range of solutions, than earlier sustainability oriented solutions related to the power sector such as fuel switching alone. One of solutions is greater decentralization in the power grid through DERs, which I will explain in this section. However, before proceeding to do so it important to ground an understanding of what DER is before understanding how its characteristics meet the sustainability objectives. The Massachusetts Institute of Technology (MIT) Energy Initiative published in 2016 a comprehensive report about the future role of the utility in the overall architecture and supply chain of the electricity grid, which this paper will touch upon as well in Part IV.

The MIT report posited that a primary driver that is causing the utility business model to change, and a change in the electricity industry generally, are the proliferation of DERs (MIT, 2016). It explains DERs as "any resource capable of providing electricity services that is located in the distribution system." (MIT, 2016). These resources can exist either primarily for reasons other than to provide electricity services while others are installed specifically to provide them (MIT, 2016). This paper will return to what is meant by "electricity services" in Part IV, however, in the meantime, these services can be understood to mean a range of options from demand response (i.e. dispatchable load), generation, energy storage, and energy control devices. That said it is much easier to envision DERs that are made specifically to provide electricity services like solar PV panels while it can be more difficult to imagine DERs that are meant primarily to provide services other than electricity but can do so. Some examples of this type of DER include plug-in electric vehicle, which are meant to provide transportation services, however when plugged in can provide storage services. Another example is a "Smart Home" device that if connected to power switches of a home or office can provide demand response services by turning down air conditioning, lighting, and other electric appliances. These forms of DERs can be highly effective especially when aggregated. The significances of DERs is twofold: first, that they can be used to form a microgrid, which is a self-sufficient electricity grid that can be islanded; and second, due to the characteristics of these resources, they can be locally sited and often seamlessly placed behind the meter and owned by individual customers, therefore diffusing costs. Now I will move on to how they contribute to the sustainability objectives identified above.

One: Environmental Integrity

This objective values the socio-ecological system integrity by recognizing the often intangible ecological system services that we receive and thus aim to protect and preserve the conditions in which these ecosystems thrive, which in return maintain the conditions that humans need to survive; this is a symbiotic relationship (not really because humans harm wild flora and fauna). Thus it is important to protect the biophysical condition from noxious fumes, pollutants, and landscape degradation. One of the main direct benefits of DERs (but not all DERs) is that they are small-scale renewable generators such as rooftop (or not) solar PV panels or farms or wind farms. These are effectively non-emitting resources, which do not spew out any greenhouse gases in their process of generation. Another direct benefit, is the that for many types of DER, they can be sited without altering or reshaping or the site or land and for the most part they are non-invasive (i.e. rooftop solar, EV, etc.). The land component is a significant benefit that even hydro-generating stations cannot claim to possess as they require extensive alteration to build a hydro-electric dam. However, by the same virtue certain key materials that are used in the construction of some DERs such as solar PV panels and batteries can also have negative impacts as they need to be mined, thus required further study and a balanced approach (Hernandez et al., 2014). Putting that aside, as a more indirect benefit, DERs that can provide demand response services have to potential to offset the need for the use of so-called “peaker plants” which are often fossil fuels generators that are used in times of peak demand, as well as offsetting the need for building new generation, which is also often fossil fuels such as natural gas (Lovins, 1977; 2003).

Two: Economic Responsibility and Adaptive Capacity

This objective values the economic effects of decision-making and other consequences such as lock-in. This means achieving cost-effectiveness choices that are designed with modularity and diversification of fuel and technologies in order to maintain maximum system resiliency and utility, minimize maintenance, and deliver efficiently with a minimal need for additional supporting infrastructure. Arguably, this is the greatest benefit of DER and a decentralized grid generally, which is that it can achieve the effect of solving local issues, whether in reliability or simply being self-sufficient for supply, at a local scale. This avoids overbuilding at the transmission level, which has the adverse effects of congesting transmission lines and thus reducing the efficiency of delivery and the effectiveness of the resources. That said, this is not a new idea. DERs have been advocated for for a long time, especially by prominent energy thinker Amory Lovins, who is credited as the herald of "soft energy paths" (Lovins, 1977).

In his 2003 book, "Small is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size," as the title suggests, Lovins diligently makes the case for what is essentially a decentralized power grid, which this paper will follow (Lovins, 2003). In essence, Lovins argues that properly sited DER has the ability to "right-size" the grid by being able to better target and alleviate local needs (Lovins, 2003). This is because (a) onsite power can provide supply directly to loads (and sized correctly to meet the tailored needs) reducing aggregate demand from the centralized generation of the bulk system, (b) properly sited resources can help address congestion and thermal constraints on the distribution grid by providing reactive power where it is needed most, and (c) there are minimal losses or contribution to additional congestion on existing pathways (Lovins, 2003).

Furthermore, with the proper economic signals such as locational marginal pricing (a concept to be elaborated on in Part IV), needs can be adequately supplied at a much more cost-effective manner (Tabors et al., 2018); this is in line with the reasoning that was adopted when power generation was unbundled and deregulated and market opening. This is also evident by observing the Hourly Ontario Energy Price (HOEP) set through the IESO's spot markets. An LMP would improve on this even further, as the IESO states in its Market Renewal Program because it would provide more accurate pricing signals because they would be able to be computed on a more granular scale, with less variables and thus less uncertainty to model the price on (IESO, 2017). However, this will be elaborated on extensively in Part IV. A clear illustration of the benefits of "right-sizing" is the advent of Non-Wires Solutions (NWS) where distributors can call upon DER, either already installed behind-the-meter or install new resources, to solve local problems, which can often be significantly cheaper than traditional infrastructure capital investments (Navigant Consulting, 2018).

One way this might work is because if the specific resource or resources are customer owned then the entire value of the asset does not need to be pushed off and recovered through the rate-base with the additional top-up for the rate of return on the investment that regulators allow and instead only need to pay for the cost of the service being provided. This concept will be expanded on in Part III. Lastly, the modular and diverse nature (in terms of technology and fuel) of DERs makes the design of a decentralized grid resilient because the connectivity of resources enables the re-routing of power in case of isolated power failures, congestion, and severe weather storms (Lovins, 2003). DERs also contributes to adaptive capacity because individual resources may be easily replaced with relatively low cost and short installation timelines making resource maintenance simpler and more cost-effective (Navigant Consulting, 2018).

Three: Distributional Effects, Innovation, and Individual Choice

This objective values the spreading of costs and diffusion of benefits equitably and fairly. It is also concerned with respecting decision making by those who are impacted by the decision, as well as creating opportunities in business, commerce, and self-sufficiency. The two most relevant points that DER and a decentralized grid can contribute to are distribution of costs for the system and decision making as well as creating commercial opportunity and self-sufficiency. In regards to distribution of costs, it was touched upon in the paragraph immediately above that through the use of arrangements such as NWS, investments into the grid can be made by willing third parties or developers who will pay for DERs but will also be entitled to the benefits through profits made from providing grid services. In a more advanced scenario (that will be explored later in this paper), real estate owners, whether residential, commercial, or just land, can purchase and install DER on their site for their own benefit, but also with the proper system in place can profit from providing services to the grid. This could help avoid having to centrally procure expensive contracts for capacity that are socialized in costs throughout the entire jurisdiction as is the case with Global Adjustment (GA) payments in Ontario. Additionally, as DERs increasingly occupy the distribution grid they provide self-sufficiency at more granular, local scales (i.e. at the individual site level if there is enough generation capacity installed, or on a microgrid level encompassing a neighbourhood or a municipality), which means that, conceptually at least, governance and decision-making can be downloaded and carried out on more local levels such as agencies as distributors or other aggregations of resources (MIT, 2016); this too will be explored in Parts IV and V. In terms of commercial opportunity, this is also a speculative point, but conceptually a decentralized grid can open business opportunity that the traditional monopoly-granted utility did not. This would be in the form of DER equipment providers who may act as aggregators and brokers that provide services on larger scales to the grid, that can effectively be thought of as retailers if they are selling electricity services to end users through the resources that they deploy on the host's site (MIT, 2016). This too will be extensively elaborated on in Part IV.

Summary

To summarize, it is useful to maintain a contextual frame that is captured in this quote by Winfield on the importance of sustainability planning in the electricity sector:

> "Electricity supply, transmission, and conservation systems present particularly complex planning challenges and risks. They require long-term capital investments, and carry risks of technological and institutional choices, and their accompanying environmental, economic, social and technological consequences may be embedded over very long time periods. In addition to these risks of high path dependence and negative resilience, electricity planning needs to respect and environment of rapid technological development, increasing uncertainty about future energy needs, and the relationship between electricity and other energy resources, such as fossil fuels." (Winfield, 2016).

This quote can be seen to implicitly support the objectives mentioned above that signify, in my opinion, a shift towards a partially but not entirely decentralized grid, meaning that there is an increase in the embedding of energy resources at the distribution level, shifting the way the grid operates technically but also prompting adjustments to be made in the way we govern and regulate the grid. The next part of this paper will focus on the analytical framework, which is used for analyzing socio-technical and sustainability transitions.

PART II: SOCIO-TECHNICAL TRANSITIONS & ONTARIO'S ELECTRICITY SECTOR

2.1. **Socio-technical Transitions:** an introduction to the analytical framework

In the first part of this paper, I established the case for why transitioning to a decentralized power grid, characterized by a high penetration of DERs, is desirable from a sustainability perspective. In this part, I will expound the analytical framework that I will use to assess the state and progress of Ontario's grid modernization process in Part III. The benefit of using Geels et al. literature on Socio-technical Transitions and Multi-Level Perspective, is that this framework enables the analyst to characterize the observed structural changes that are occurring in the sector under a transitional pathway, thereby providing insight into the structural process and therefore be able to understand what steps need to be taken in order to continue the desired transitional trajectory, or otherwise adjust the process to reach a different objective or simply reach the same objective through alternative methods.

The Basics of Socio-technical Transitions and Multi-Level Perspective

In broad strokes, the study of socio-technical transitions provides a mode of analysis to help understand and explain Technological Transitions (TT). TT are defined as "major technological transformations in the way societal functions are fulfilled", which "not only involve technological changes, but also changes in elements such as user practices, regulation, industrial networks, infrastructure, and symbolic meaning" (Geels, 2002). The main aspects of TT that this mode seeks to address are: How do TT come about? And are there particular patterns and mechanisms in the transition process? To answer this, Socio-technical transitions literature applies an interdisciplinary approach borrowing principles from the sociology of technology and evolutionary economics, rooted in the assumption that in itself, technology has no power, rather "only in association with human agency, social structures, and organizations does technology fulfil functions." (Geels, 2002). The inclusion of "socio-" contained in the study of socio-technical transition encapsulates this inextricable link between technological systems and the social context of human agency (Geels, 2002).

To elaborate on this, I turn to the work of Frank Geels, who consolidated much of the literature that comprises this "appreciative" theory (i.e. integrates interdisciplinary concepts) and demonstrated the operability of this highly fluid and abstract theory against the context of historically significant transitions (Geels, 2004). Geels initially points to the notions of the "seamless web" and "configurations that work." (Geels, 2002). These visual aids help conceptualize and model the realm in which technological transitions take place as a network of heterogeneous elements that include human and non-human artefacts (Geels, 2002). These elements are the technological artefacts themselves, as well as the socially constructed systems in which they exist and arguably serve, such as human organizations and human agents that, grouped separately, produce, replicate, and consume the technology in the operations of their lives among society (Geels, 2004). They are collectively embedded and enunciated through rules, which reinforce the routine behaviours that are experienced everyday. (Geels, 2004). Rules are understood as a set of cognitive algorithms that prescribe a narrow set of acceptable behaviours, or paths, within contexts (Geels, 2004).

The early work on technological systems focused on the rules that bind organizations such as firms and institutions. However, rules serve a function more powerful than an adhesive because the repetition of rules through routine behaviour entrenches or normalizes them and provides the stability that characterizes the regime (Geels, 2004). A technological transition is thus understood as the substitution of certain elements within the network that probes a readjustment of the other elements in order for the new configuration to be embedded as it fulfills the societal function.

In order to conduct an analysis and assess the state of a given Socio-technical Transition, the theory applies the Multi-Level Perspective (MLP) framework to the set of observed facts, which must be rationalized as they allow for a great extent of discretion and flexibility in their characterization. The MLP is a visually heuristic construct that involves three tiers or levels of concentric networks that form a “nested hierarchy”, where there is interaction between the tiers as well as within the tiers (Geels, 2002). The macro tier is called the landscape level, the micro tier is called the niche level, and the meso-level pressed in between is called the socio-technical regime (Geels, 2002). The specifics of each tier are as follows:

Regime:

The socio-technical regime as stated above is the logical evolution of technological systems where the broadened regime concept recognizes the agency of social groups and the role of rules as being a guiding factor. In a multi-level analysis, the regime is the point of primary focus since the defining feature of a transition is the shift from one regime to another, although it is difficult to demarcate when a shift has occurred as it depends on the timescale of the analysis. Nonetheless, the value of this mode of analysis, with its focal point at the regime, is that it allows the analyst to assess the socio-structural dynamics of transitions as opposed to looking to the technological end state (Verbong and Geels, 2010). Geels further specifies seven dimensions of the ST regime to help ground an understanding that can readily be applied: technology, user practices and application domains (markets), symbolic meaning of technology, infrastructure, industry structure, policy, and techno-scientific knowledge (Geels, 2004). A useful way to think about these dimensions is as nodes within the seamless web. And it is paramount that in a stable regime the junctions that link these nodes together are aligned and co-ordinated in a mutually reinforcing way by the agency of the social actors and organizations that comprise the ST regime. The regime reinforces itself through the enactment of rules, by the agents and organizations, such as those that drive cognitive routines and maintain shared beliefs, lifestyles, and favourable institutional arrangements, to provide a few examples (Geels, 2004). Although stable ST regimes are stable precisely because the system is aligned and embedded, it does not mean that there is no ongoing innovative activity. Instead, the progression of innovation is gradual and incremental but following along what is called a technological trajectory, which Geels situates in the realm of the landscape level of the MLP model (Geels, 2002).

Landscape:

The landscape level can be understood as an external structure that represents the conditions of society. Other factors that are contained within the landscape include "demographical trends, political ideologies, societal values, macro-economic patterns," and other exogenous pressures that influence the actions of societal actors and organizations (Geels, 2011). However, in my opinion, landscape factors are inchoate phenomena that need to interpreted by humans according to cognitive rules and made sense out of before they can exert any exogenous pressure on the regime. Take the example of climate change, where changes in weather patterns, species decline, and scientific data gathered from important biophysical landmarks on earth (e.g. article circles, rainforests, atmosphere, etc.) first had to be interpreted before humans were able to attribute these effects to anthropogenic causes, which only then prompted (read: exerted pressure on) societies to respond with sustainability-oriented initiatives and policies.

Niche

Conversely, the type of disruptive innovation that one imagines challenges the ST regime, grows out of the niche level of the MLP model and when in the presence of points of tension, can become embedded in the ST regime (Geels, 2002; 2004). The niche level can be thought of as an incubation chamber where novelty is seeded and shielded from the selection criteria of the regime, which acts as a barrier to entry since the characteristics of niche developments (e.g. price, performance, etc.) are a mismatch for the regime. The niche level thus insulates or protects the development of innovation until such a time that it can reasonably break into or become embedded into the regime (Geels, 2002; 2004). Put otherwise, the niche is the realm of R&D and even small innovative firms that are testing out prototypical products and services and may even have a few select contracts with early adopters and a miniscule proportion of the market size. Although I will elaborate on the regime dynamics below and transitional pathways in Part III, it is worthy to note in the meantime that the successful integration of niche element into the regime is often facilitated, if not enabled, by downward pressures exerted from the landscape level that creates a "window of opportunity." (Geels, 2002).

2.2. **Operationalizing the MLP:** identifying Ontario's electricity regime

Above I have established that the niche level is encapsulated within the ST regime, which is in turn entombed within the ST landscape, with each successive layer being characterized by greater stability than the previous. All three tiers interact internally as well as with the other tiers. Below I will outline why it is so difficult for a novelty to forge its way into the regime level, which forms the backbone of transitions but first I will proceed to operationalize the MLP within the context of Ontario's electricity sector by matching the elements of the MLP framework with the legislative and institutional realities of Ontario. (i.e. the organization structure, supply chain, and infrastructure).

Regime – Applied

The most important component of an MLP analysis is to identify the regime as it is the shift in a regime that determines the effect of a transition. Taking guidance from Verbong and Geels, the first step is for "the analyst [to] demarcate the empirical level of the object and then operationalize." (Verbong and Geels, 2007). When analyzing the electricity sector, as is the case here, there are several contenders for the object of analysis. For example, in their analysis of the Dutch electricity system, Verbong and Geels turn their attention towards the primary fuel because their transition is focused on fuel switching and types of generation (Verbong and Geels, 2007). Since in this paper, I am focusing on the integration of DERs, which by definition are embedded into the distribution system, then that is the object of my analysis. However, given the statutory framework of the electricity sector, I cannot analyze the distribution system in isolation and must turn my attention towards the larger system (i.e. the provincial grid) in which it is situated.

Minister of Energy

Perhaps the most peculiar aspect of the electricity sector that a layperson would question is why is the role of the government and law so fundamentally important to the provision of a commodity that could otherwise be organized by a private sector supply chain? After all, despite being heavily regulated industries, securities exchanges, telecommunications, and commercial flying are all owned and operated by private entities. To understand this, the reader must first take a brief glance at the historical development of this public utility in Ontario. Shortly after understanding the potential economic and developmental potential that could be harnessed from exploiting hydropower in Niagara Falls, the powers that be created a public body tasked with the construction of generation, transmission, and sale of electricity to municipal distributors (Nelles, 1974). It was perceived that a public body could do this cheaper than profit maximizing private entities (Nelles,1974). This eventually led to the creation of Ontario Hydro, the provincially-owned vertically-integrated monopoly. Seen almost as arm of the government, Ontario Hydro was imbued with broad self-regulatory and price-setting powers (Nelles, 1974). Then in the last decade of the twentieth century, perceptions changed, influenced by neoliberal economics, and it was surmised that a competitive electricity market could service the province more efficiently than the monopoly behemoth that was Ontario Hydro (Trebilcock and Hrab, 2005). As the regulation of electricity constitutionally fits within the provincial heads of power, this paradigmatic change was implemented through an act of the provincial legislature that, although known as deregulation, could probably be more accurately characterized as reregulation because the result comprised of a significantly lengthier and more detailed statutory framework for the sector than was previously the case. The act thus replaced the *Power Corporation Act* that statutorily created Ontario Hydro and effectively implemented a corporate reorganization through the creation of new entities through new legislation (OPA, 2005). The *Electricity Competition Act* created the *Electricity Act, 1998* and amended the then-pithy *Ontario Energy Board Act, 1998* (Clark, Stoll, and Cass, 2012). The former, most significantly, disaggregated Ontario Hydro into Ontario Power Generation, Hydro One Networks Inc., and the Independent Market Operator (IMO); these are the most relevant entities for the purposes of this paper. While the latter empowered the Board to oversee Ontario's newly minted competitive wholesale and retail electricity markets (Clark, Stoll, and Cass, 2012).

The idea behind this strategy was to effectively unbundle the provision of electricity, where at the wholesale level, generators would bid, clear, and get dispatched on a centrally optimized provincial grid, and at the retail level, distributors would maintain their territorial monopolies and be tasked with the role of standard supply unless a third party retailer, participating on an open-access grid, would contract to supply end-users under different offerings than those offered by the standard supply distributor; under this model, the role of the government was as truly minimal (OPA, 2005). For reasons that I will not elaborate on in this paper, this model was quickly replaced by the subsequent government with the passing of the *Electricity Restructuring Act, 2004*. [For further reading see Winfield and MacWhirter, 2019.] The most significant change implemented through the *ERA* was the creation of the Ontario Power Authority and the renaming of the extant IMO to the Independent Electricity System Operator, which signaled a decreased reliance on market mechanisms (Clark, Stoll, and Cass, 2012). This shift also saw a vast increase in the role of the government in the electricity sector. I will spend the subsequent paragraphs elaborating on the entities mentioned here as they collectively comprise Ontario's electricity regime, however, in the remainder of this paragraph I will explain the current statutory role of the Minister of Energy in the electricity sector.

The Minister of Energy currently possesses broad powers with respect to system infrastructure and supply mix planning, procurement, and regulatory decision-making. These statutory powers flow from Part II.2 of the current state of the *Electricity Act* as amended by the *Energy Statute Law Amendment Act, 2016*. With respect to system planning, the Minister is the lead planner through the Long-Term Energy Plan (LTEP), effectively taking over the role of the former Ontario Power Authority's Integrated Power System Planning (IPSP) exercise (Vegh, 2017). Section 25.29 prescribes that the Minister issue a plan every three years that addresses the cost effectiveness of supply and capacity, reliability and resiliency to the effects of climate change, conservation and demand management, use of cleaner and innovative energy sources, sector emissions, and indigenous consultation. In undertaking this process, the Minister must consult the IESO's technical report on the adequacy and reliability of the system and any changes to that forecast that may arise. Although at first glance, the LTEP may seem as merely a descriptive and aspirational policy document, section 25.30 reinforces the authority of the LTEP by enabling the Minister to compel the IESO and OEB to implement items contained in the LTEP that fall within their respective jurisdictions through the issuance of Ministerial Directives. Furthermore, section 25.31 obliges the IESO and OEB to respond with implementation plans, outlining their intended approach to executing the LTEP items that the Minister, under subsection (5) can approve with or without changes, or reject and refer back for further consideration and resubmission. However, the subject matter of Ministerial Directives is not confined to items captured in the LTEP. Subsections 25.32(2) and (5) enables the Minister to direct procurement - that is compel the IESO to solicit counterparties for offers or enter into contracts – for electricity supply, capacity, storage, measures related to the conservation and demand management, and matter related to the development of the transmission system.

Independent Electricity System Operator (and merger with Ontario Power Authority)

The need for an independent system operator arose in Ontario with the commencement of restructuring through the *Energy Competition Act.* Previously, there was no need because the vertically-integrated Ontario Hydro exclusively operated the electricity system from generation to distribution, with limited and marginal departure for non-utility generators (Clark, Stoll, and Cass, 2012). With the advent of a competitive wholesale market, the system required an independent and neutral entity to control access to the transmission network under an open-access policy, balance supply and demand through scheduling and dispatch from a plethora of independent market participants, and oversee power flows for purposes of security and reliability. Furthermore, because Ontario's competitive electricity market was designed as a centrally-optimized model (market design will be elaborated on in Part IV), meaning that an ISO forecasts demand and validates the viability of power flows in the face of the thermal and congestive constraints of the system, it was sensible to additionally task it with the role of the wholesale market administrator and financial clearinghouse, which accepts bids and offers, determines the wholesale price through an algorithm, and clears transactions (Clark, Stoll, and Cass, 2012). Thus Ontario's Independent Electricity System Operator, was incorporated by statute as a non-share, and operated as a not-for-profit, crown corporation.

Under section 6(1) of the current state of the *Electricity Act,* the objectives of the IESO (formerly, IMO) include: to direct the operation and maintain the reliability of the IESO-controlled grid (defined as the transmission network that transmitters have authorized the IESO to operate); establish and enforce standards relating to the reliability of the integrated power system (which expands the IESO-controlled grid to include generation assets and distribution networks as well); operate the IESO-administered markets established by the Market Rules (section 32 enables the IESO to make rules governing the IESO-controlled grid, electricity and ancillary services markets, and reliability); engage in the solicitation and procurement for grid services, engage in the settlement of transactions and payments made pursuant to the delivery of grid services (i.e. electricity supply, storage, capacity, transmission, conservation and demand management). The IESO also authorizes market participants, publishes system forecasts (18-month outlook), market information, and enforces the Market Rules through its Market Assessment and Compliance Division (MACD). However, under section 4, the IESO's market operations and procurement and contracts management functions must be kept strictly separated.

The mandate of the IESO was further expanded when it absorbed the former Ontario Power Authority and merged into one entity retaining the IESO name (Vegh, 2014). When the competitive wholesale market first opened in Ontario, the hope was that long term capacity planning would be driven by market forces (i.e. high spot market prices would induce investors to construct more power plants to turn an extra profit). However, the near immediate effect proved to be the opposite and the high and volatile prices caused the the government to respond by bringing the long-term system planning back within its power through the creation of the Ontario Power Authority, which was created with the *Electricity Restructuring Act* (Clark, Stoll, and Cass, 2012). The OPA was supposed to create a twenty-year Integrated Power System Plan, revised every three years and informed by a Supply Mix Directive from the government (OPA, 2005). That said, the OPA's planning functions has since been eschewed with even prior to its merger with the IESO and replaced by the LTEP, as described above (Vegh, 2017). The current objectives of the IESO that continue from the OPA include the following. The most significant one can be described as the role of a load serving entity (LSE), which is slightly modified given Ontario's governance framework for the sector (Clark, Stoll, and Cass, 2012). Normally, the defining characteristic of an LSE is that it is responsible for securing and directly procuring adequate supply security for its customers, by entering into contracts as a credit-worthy counterparty. While the IESO forecasts demand, it must rely on the Minister's guidance through the LTEP and Ministerial Directives before deciding how to act in response to changes in the needs of the system; although, it has the ability to directly enter into contracts, this may raise some issues given its market enforcement role and character as a neutral system operator (Vegh, 2016). Furthermore, the OPA was allowed to create a charge to collect from ratepayers to pay towards power procured through long-term contract called the Global Adjustment (GA), which continues to exists under the IESO's contract management activities (Clark, Stoll, and Cass, 2012). The IESO's mandate is also embedded with certain policy objectives such as to actively engage in seeking opportunities to increase the use of clean and renewable technologies and collecting data derived from smart meters deployed in Ontario.

Ontario Energy Board

With two rounds of industrial restructuring, the OEB went from being a limited independent reviewer of Ontario Hydro's planned expenditures, to an economic regulator of competition, to now being a public policy regulator with the purpose of protecting consumers from the monopolistic effects of distributors (Clark, Stoll, and Cass, 2012). Currently, section 1 of the *Ontario Energy Board Act* sets out the objectives of the OEB to be the protection and education of consumers, promotion of economic and cost-efficiency, and facilitation of government policies such as the implementation of the smart grid, conservation and demand management, and promotion of renewable sources of generation through accommodation by system expansion and reinforcement. The OEB is also responsible for licensing industry participants (different from authorizing market participants) such as generators, transmitters, distributors, retailers, and even the IESO, and approving the construction of facilities (Clark, Stoll, and Cass, 2012). Similar to the IESO, the OEB has also has the power to issue rules, in the form of codes of conduct such as the Transmission, Distribution, and Retail Settlement Codes, respectively, as stated in section 70.1. The OEB also fulfills a role in relation to Ontario's wholesale electricity market through the Market Surveillance Panel, which works in tandem with IESO's MACD in order to assess the effects of the market design and attempt to improve or adjust it to meet certain objectives (Clark, Stoll, and Cass, 2012). With respect to this paper, however, the most important role of the OEB is its rate and activity regulation of Local Distribution Companies (LDCs) and how in turn this decision making process is affected by Ministerial Directives to what is considered as industry evolution, as per section 2.1.

In regards to the regulation to the regulation of LDCs, this will be elaborated on below, and in regards to Ministerial Directives to the OEB, the following can be said in the meantime. Section 2.1 of the *OEB Act* states that the OEB shall exercise its decision making power with a view to achieving the objectives of any Directive issued. This means that in any given context policy concerns such as giving preference to renewable technologies can outweigh the importance of cost-efficiency (Vegh, 2016). In Part III, I will elaborate how a Directive issued pursuant to the 2017 LTEP is meant to initiate policy reform in the OEB's decision making factors when it comes to allowing LDCs to rate-base certain investments and activities in order to promote and encourage innovation in the distribution sector.

Distribution Segment - Local Distribution Companies

Prior to restructuring, municipal electric utilities (MEU) owned, operated, and maintained the many distribution systems across Ontario, totaling over 300 MEUs spanning across the province's Local Distribution Areas (LDAs) (King, 2016). With restructuring, although the distribution of electricity was unbundled from vertical activities such as generation and transmission, it continued to be deemed a natural monopoly - likely due to the redundancy of duplicating poles-and-wires – and continues to be granted a territorial monopoly. However, since MEUs were made to incorporate under the *Ontario Business Corporations Act,* retaining the respective municipalities as the sole shareholders in most cases, subsequent merger activity across the sector now leaves the number of LDCs hovering around seventy (Clark, Stoll, and Cass, 2012). Ontario's LDCs are in contrast with the above, not statutory actors, rather they are rate and activity regulated corporations that develop the distributions system, connect customers, and control access to the distribution grid, under a non-discriminatory policy (King, 2016). Furthermore, in contrast with many investor-owned utilities in other jurisdictions such as the United States, for example, LDCs are not load-serving entities and consequently more closely resemble a “mere passer-by” business model tasked with purchasing supply on the wholesale market and ensuring the one-way power flow from the bulk transmission system to end-use consumers, with limited instances of embedded generation through MicroFIT and Net Metering programs; as stated above in Ontario the LSE role is role shared between the IESO and Minister of Energy. As the niche section below will reveal, this normative role is beginning to be challenged in Ontario.

Moving on, with respect to rate-regulation, the OEB sets the pricing structure for the distributors’ customers, and in doing so allows the LDCs to earn a reasonable return on approved capital investments made into the system; this is consistent with the OEB’s objective under s. 1(1) of the *OEB Act*, which is to “facilitate the maintenance of a financially viable electricity industry.” With respect to the regulation of business activity, under section 70.1, a condition of every section 57 license is compliance with the provisions (and restrictions) set out in the *OEB Act* and any codes issued pursuant to it such as the Distribution System Code, Retail Settlement Code, Affiliate Relationship Code, and Standard Supply Service Code, as well as the IESO Market Rules. By extension this means that the LDCs are also indirectly tasked with supporting the implementation of the government’s policy objectives for the sector such as deploying smart grid technologies, encouraging renewable generation, and carrying out conservation and demand management initiatives. Specific restrictions on business activities for LDCs include retailing electricity, which is circumvented through the affiliate form, generation, and cross-subsidization of affiliate activities through the rate-base. Thus, as this paper will explore in significantly more detail, the evolution of the distribution industry relies greatly on the regulatory framework that is decided by policy makers.

Landscape – Applied

Recall that landscape is the trajectory formulated by the implications of long-term trends that are inchoate until human actors become cognizant of them and are influenced by these exogenous factors, with the most obvious example being the phenomenon of climate change and the subsequent response by policy makers through law such as Ontario's Climate Change Action Plan. Since my object of analysis is the regulatory framework for a decentralized power system, then it is logical to assert that observed industry trends implicitly reveal the landscape factors that drive the development and trajectory of the evolutions of the industry.

The industry trends to a great extent are driven by consumer trends, not only in the electricity industry through consumption patterns but also in other industries as those influence consumer expectations of their service providers, which carry over from one industry to another. In essence, as this paper will illustrate, consumers begin to expect their electricity suppliers to treat them like their telecommunications suppliers where the consumer has choices for packages based on its needs, etc. Speaking this point, I have attended several industry conferences, mainly the "Leading the Charge" conference that took place at Ryerson University and the Center for Urban Energy in June 2018, the "Future of Energy: Taking the Digital Leap" conference that took place at MaRS Discovery District in March 2018, and the IESO's annual Electricity Summit that took place in June 2018. A common way of capturing the aggregate of the consumer trends that was commonly referred to among all of these conference was by referring them as the "five D's:" decarbonisation, digitization, decentralization, deregulation, and democratization. The following is based on my notes from the presenters, panelists, and discussions had at these conferences; these themes are also explored in the MIT Utility of the Future report (and the five D's are sometimes referred to as three or four D's as they get bundled in different ways).

The first phenomenon, decarbonization refers to the increasing integration and shifting of fuel sources for electricity generation from non-renewables to renewable or at least non-emitting resources (i.e. nuclear) with the objective of achieving grid parity and even overtaking the dominant position occupied by fossil fuelled generation. However, these shifts are challenging planning and operational aspects of the grid as most renewable generating sources are intermittent and must be balanced appropriately through mechanisms such as storage to avoid the need to supplement them with traditional fossil fuels (More Than Smart, 2017; MIT, 2016).

Digitization refers to the proliferation, drastic price decreases, and increased accessibility of Information Communication Technologies (ICT) that enable connectivity and interoperability across the grid infrastructure through the Internet of Things (IoT) (MIT, 2016). This technology is seen as the linchpin of the "Smart Grid," due to the fact that it allows energy resources and other grid assets to gather data, compute analytics, respond to dispatch signals, and be controlled remotely.

Decentralization refers to the observed trend of the distribution grid becoming increasingly active in enabling and facilitating bi-directional power flows rather than simply being a flow-through for transmission-connected generation to loads and end-users (More Than Smart, 2017). This is occurring through increased connectivity of embedded resources such as (rooftop) solar PV for generation or batteries for storage both behind-the-meter and in-front. This enables generation as well as reliability services such as reactive power to flow and be delivered within distribution grid from resources other than the transmission-distribution transformer node connected to the distribution grid to be transmitted to other loads with decreased reliance on the bulk level (however, not quite at the level of a microgrid that can be islanded). Previously behind-the-meter connections were encouraged by the MicroFIT and Net Metering programs in Ontario, however, have since been picked up by utility companies to develop in-front-of-meter assets for reliability purposes. This paper will show that a decentralized grid has significant potential for increasing resiliency among other benefits within distribution grids.

Deregulation can often refer to two things. First, an older development of some two decades now, is the *Electricity Act, 1998,* which restructured Ontario's electricity sector from a government owned and operated, vertically-integrated, monopoly known as Ontario Hydro into a supply chain that more closely resembles a free market by unbundling generation and opening it up to private power producers to offer their bids through a centrally-optimized spot market (also this has since changed) as well as the construction and ownership of transmission lines. Second, deregulation may also refer to recent decisions issued by the Ontario Energy Board, in which they decline to pull into their regulatory purview behind-the-meter assets (and electric vehicle charging infrastructure) opening the door for many opportunities as will be described later in this paper, such as private third party businesses to foray into innovative commercial relationships and the potential to provide services to the grid in addition to the benefits only keeping to the site-host (Stevens, 2016).

Finally, Democratization refers to observation that all of the factors mentioned above are having the effect of providing consumers with previously unavailable optionality in setting up their energy supply and consumption needs and patterns. This is because previously, and dominantly still, the model (in Ontario) is that consumers are billed by the (retail affiliate) of their Local Distirbution Company on a one-size-fits-all pricing structure. Additionally, sources of generation decided on the wholesale level and effectively the only choice a consumer has is through the political process, by voting for a party with a clear issue and commitment to implementing a clear resolution that resonates with the consumer. Although there was limited relief following the breakout of the competitive retail market that offered limited benefits by hedging price volatility by offering customers a fixed price and even clean generation, this has not actualized as ideally and shortly burned out.

Niche – Applied

Recall that the niche is the cradle of radical innovation, that is developments in activities such as technological research and development and innovative business models that do not necessarily conform to the selection criteria – or rules – of the regime and therefore are not aligned with its actors. One example that fits this description that I turn to as a proxy to analyze the niche in Ontario is the Electricity Distributors Association's (EDA) "Power to Connect" Vision Paper and Roadmap. The EDA is a trade organization that represents and advocates for the interests of its constituent members being most of the LDCs across Ontario. The Vision Paper is premised on the recognition that the electricity system is undergoing significant change, specifically citing the landscape factors mentioned above and citing the OEB's comments on the changing role of LDC to the effect of shifting from a mere "delivery route for power from grid to consumers" to a "service platform offering services such as balancing, power quality, storage, and redistributing power from users connected to their systems." (EDA, 2017) Unsurprisingly, the EDA considers the LDCs for various reasons to be the best positioned to take on the leading role in facilitating the transition to a decentralized power system, recognizing however, that it requires a shift in the regulatory framework and change from other actors such as the OEB, IESO, and MOE (EDA, 2017). Thus in this forward-looking paper, the EDA exposits a comprehensive concept for the future role and business model that LDCs must gradually transition into, called the Fully Integrated Network Orchestrator (FINO) (EDA, 2017).

The FINO concept, as envisioned by the EDA, revolves around three main functional elements: a DER enabling platform, DER integration, and DER control and operation (EDA, 2017). With respect to the first component, the DER enabling platform means the "extent to which LDCs will provide an intelligent platform where DER third party providers and customers plug-n'-play" and where the central concern of the LDC will be to "ensure that the distribution network can accommodate DER connections, while maintaining the stability and reliability of the grid." (EDA, 2017). To unpack this somewhat, it is useful to consider some of the enabling technologies and operational processes that are needed to make this possible. A few examples include: Intelligent Electronic Devices (IEDs), which are "microprocessor-based controllers of power system equipment that can also make two-way digital communication possible with other devices;" smart inverter technologies that permit generation management; and Advanced Distribution Management Systems (ADMS), which provide "a single, more efficiently managed platform for operating the distribution network" through "unified operational and engineering data." (EDA, 2017). Thus these technologies, also known as ICTs and IOTs as mentioned in the landscape factors, provide the base capabilities for the DER enabling platform, which is intended to "provide a transport for grid intelligence and enable management and automation of two-way power flows, transactive energy markets, and other energy services." (EDA, 2017).

With respect to the second component, DER integration means "the degree of DER asset ownership by LDCs in their scope of business." (EDA, 2017). Perhaps unsurprisingly, the report supports LDC ownership of DER, a point that I will contest in detail in Part IV, claiming that they are uniquely positioned to take on these investments because they can potentially earn immediate returns on the assets through permissive rate regulation where in contrast private companies cannot access this benefit. Conversely, LDCs may leverage their knowledge of their systems to contract these services out to customers or third party developers, potentially facilitating the development of new energy solutions, idea, and services (EDA, 2017). This is commonly referred to as Non-Wires Solutions (NWS) that will be explored in further detail in Part III and does not necessarily entail ownership of the DER assets. However, lending further support for LDC ownership of DER assets, the report points to Alectra's (PowerStream at the time the report was written and since then merged with Alectra under the latter's name) deployed POWER.HOUSE project, which "uses a fleet of [customer-sited] Solar PVs and energy storage systems to form a virtual power plant that can be controlled to simulate a single, larger power generating facility." (EDA, 2017). I will further elaborate on the POWER.HOUSE pilot project in Part III.

With respect to the second component, DER control and operation means "the degree to which LDCs control and operate DER assets that are connected to their distribution networks." (EDA, 2017). Effectively, this role entails that the LDC "serve as a distribution system operator [DSO] or a mini-IESO" in order to "optimize the value of DERs to the larger system and to all customers" through operations such as "real-time visibility, DER price signaling, and [the use of] new products and services such as virtual power plant aggregation, load management, and grid services"; these functions rely on the capabilities afforded by DER Management System (DERMS) technologies that enable "network visibility, asset monitoring and control, scheduling and dispatch", among other functions (EDA, 2017). The proper functioning of this role inextricably relies on the ability to send appropriate price signals "so that investments behind-the-meter are economic for both the customers and the entire system." (EDA, 2017). Additionally, for this role to function effectively, it is imperative that LDCs are able to coordinate operations with the IESO.

The report also refers to Alectra's POWER.HOUSE as a proof of concept for the operation of an aggregated virtual power plants operated through the use of a DERMS. In Part IV, I will return to the concept of a DSO and elaborate in further details on the variants of this model and their associated issues and solutions.

2.3. **Stability and Dynamics of Regime Transitions:** Ontario context

Given that socio-technical regimes are characterized by self-reinforcing stability, how then do transitions occur? The answer is provided by the literature: "It is the alignment of developments (successful processes within the niche reinforced by changes at regime level and at the level of the sociotechnical landscape) which determine if a regime shift will occur." (Geels, 2004). A transition is effectively a shift from one regime to another. Despite stability that characterizes regimes, there are at best semi-coherent rules that can conflict depending on shifting factors and cause tensions (Geels, 2005). That said, it still remains to be discussed how these developments come about. Not only is it dependent on niche developments but on regime dynamics as well and landscape factors when interpreted and acted upon they exert downward pressures onto the regime, dissolving linkages between regime elements due to shifting paths and coordination that must be reconciled in light of the new factors, giving the opportunity for niche developments to overcome the barriers that may have pervaded earlier (Geels, 2005). I will address this point by mentioning the mechanism of niche-cumulation and the prevalence of tensions within the ST regime.

Recall, socio-technical regimes develop along a trajectory as time goes on. This trajectory is defined by the alignment and coordination of the social actors, groups, organizations, and rules that make up the ST regime (Geels, 2005). This is because the agents operating within the regime, previously considered the engineers who produce technical systems but then expanded to consider a wider array of social actors and organizations, reproduce the rules as they enact them in routine behaviours (Geels, 2004). This is in turn creates deep grooves of path dependency (Geels, 2004). They also rely on the stability of the regime and thus design the trajectory in such a way that it is based on the current rules and thus the trajectories never depart too much from the existing regime. The trajectory and rules of the regime thus create many elements of the selection environment (e.g. no supporting infrastructure, mismatch of rules and user practices, barriers to entry, market will not support price or performance), which explains why it is so difficult for novelty to enter and be retained within the regime. Not only does radical innovation (I use the term to refer to innovation that occurs outside of the regime) need to develop supply chains, maintenance networks, and ensure compliance with existing regulations, but they also need to co-evolve with a market that does not necessarily exist yet (Geels, 2002). Additionally, it needs to gain market traction, which relies on the willingness of users to learn and adapt to interacting with the innovation. As a result, regimes rarely if ever experience an internal overhaul and rely on upwards pressure by niche-cumulation and downwards landscape pressures. When these pressures are aligned they create tensions within the regime, which create space for new nodes and linkages within the network of the regime that can cause a ripple effect and the emergence of a realigned regime (Geels, 2004). Niche-cumulation occurs when niches are increasingly used in "subsequent application domains." (Geels, 2002). In other words, it is the process of widespread acceptance and integration into user practices and other elements of the regime (e.g. new product acquiring market share).

There are three core processes that contribute to niche-cumulations (Geels, 2011): (a) the adjustment of expectation and visions which provide guidance to innovation activities and aim to attract attention and funding from external actors; (b) the building of social networks and enrolment of more actors which expand the resource base and; (c) the learning and articulation on various dimensions such as technological design, market demand, user preferences, infrastructure requirements, organizational issues, business models, policy instruments, symbolic meaning (Geels, 2011). These mutually reinforcing processes create intertia (internal momentum) that help the niche develop closer to the selection criteria but are also aided by destabilization being altered within the regime by observation of the niche but also by the downward pressures of the landscape until there is a match or potential for a match seem to become more likely (Geels, 2011).

Stability and Niche-Cumulation in Ontario

Given that Ontario's statutory framework sets out the network of actors that comprise the electricity sector and their respective roles, formal rules in the form of statutes, regulations, and other forms of delegated rules such the OEB's various codes of conduct and the IESO's Market Rules play a determinative role in both providing stability as well as enabling transitions. This is especially true in the case of a transition to a decentralized power system. For example, since DERs are connected at the distribution level of the grid, the viability of their connection is subject to the OEB's Distribution System Code (DSC) and any other rule that may compel, prohibit, or give discretion to the LDC with regard to connecting a given DER. That said, most customer-installed DERs such as residential rooftop solar PV circumvent this obstacle by connecting behind-the-meter for (partial) self-generation, which is not subject to regulation by the OEB. However, until the passing of the *Green Energy and Green Economy Act, 2009,* all costs and benefits associated with the adoption of behind-the-meter generating systems were confined to the site host. This means that electricity generated by the system could only be consumed on site and could not be injected into the grid or conveyed to another load if it relied on the grid for its delivery. With the *GEA* and subsequent developments, embedded generation could be conveyed into the grid on a remunerative basis through the MicroFIT and Net Metering programs, which were implemented through the legislative process and created formal rules that capture these arrangements (Rivard and Yatchew, 2016).

That said, the transition that is the focus of this paper, leading to the decentralization of the power system, requires much more fundamental change. With the exponential complication of assets connected to the distribution grid such as solar PV, energy storage, electric vehicles (EV) and EV charging infrastructure, not only do opportunities for transactive energy (delivering grid services from behind-the-meter generation) need to be greatly expanded, but changes in the operation of the grid must also be made and the rules need to change to reflect this new reality. As demonstrated above by the EDA Vision Paper, a decentralized power system will require at least a new layer of system operation at the distribution level, which the LDCs are poised to assume the role. However, they cannot make the transition unilaterally because there are regulatory restrictions on their business activities as well as rigorous reviews of their expenditures, especially for determining whether they can earn a rate of return on those expenditures. In MLP terms what this demonstrates is the prevalence of landscape factor exerting pressure on the regime (to better integrate DERs) while the niche is significantly undergoing the process of niche-cumulation.

With regard to the former, the landscape factors exerting pressure on the regime for the better integration of DERs have already been detailed in the section above. However, with regard to the latter the process of niche-cumulation has been evidenced because the EDA Vision Paper and the projects referenced within it such as Alectra's POWER.HOUSE demonstrate core processes (a) and (b) mentioned above where the FINO idea and by implication the transition towards a decentralized power system has articulated a vision that provides guidance on innovation activities and has attracted attention and funding (as per (a)); it has also build a network and enrolled actors to expand the resource baser (as pe (b)) (i.e. the EDA in drafting the report consulted significantly with the members its advocates for, the LDCs of Ontario). With regard to core process (c), power system decentralization in Ontario does not demonstrate significant advancement, lacking specifically in market design, infrastructure requirements, and organizational issues and business models. In the next part of this paper, Part III, I will pick up particularly on these points as I assess Ontario's grid modernization efforts and the intended path it seeks to take to move towards ta decentralized grid, further analyzing the interactions between the niche and the regime in Ontario's unique statutory context for the electricity sector.

PART III: ONTARIO'S GRID MODERNIZATION AS A SUSTAINABILITY TRANSITION

3.1. **Ontario's Grid Modernization:** the road that leads to DER

In Part II, I examined the role of formal rules (i.e. legislation), and to a lesser extent the normative and cognitive rules that are reflected in the legislation, in setting out the parameters and guiding the coordination of activities of regime actors, which through repeated behaviours contribute to path dependency and stability but can conversely be a significant enabler of innovation when it interacts with niche developments. With regard to the niche in Ontario, I commented that it is undergoing through the process of niche-cumulation, which is the process of the niche breaking through to the regime, thus signifying a transition. That said, given Ontario's unique statutory context (i.e. the nature and degree of industry regulations), I put forward that the process of niche-cumulation cannot be unilateral and depends to a great degree on the actions of regime actors, for example to create more permissive regulations. This is consistent with other criticisms of the MLP theory, which characterize the process of niche-cumulation to be too "bottom-up" and thus ignoring some of the greater dynamics that occur between the regime and the niche rather and only narrowly focusing on developments within the niche (Geels, 2011). I echo these criticisms and thus refine my analysis accordingly to address these complexities. Thus, in this part I focus on analyzing Ontario's grid modernization initiatives, that are predominantly driven by regime actors and contribute to those factors that I have identified as lacking in the process of niche-cumulation, which are market design, infrastructure requirements, and organizational issues and business models. Following my analysis of Ontario's grid modernization initiatives, I will revisit the MLP literature with respect to transitional pathways and comment on the implications of Ontario's transitional pathway as well as its structural implications within the normative frame of a sustainability transition.

Ontario's 2017 Long-Term Energy Plan

In Part II, I identified the role of the Minister of Energy as the lead planner for the electricity system as well as having a role in directing the evolution of the industry and sector as its operates in Ontario. This role is fulfilled through the statutory power enshrined in section 25.29 of the *Electricity Act*, which mandates that every three years (per Ontario Regulation 355/17) the Minister of Energy release a Long-Term Energy Plan and that subsequently the IESO and OEB issue Implementation Plans in response to any Ministerial Directives directed to them that flow out of the LTEP. Ontario's 2017 LTEP, entitled "Delivering Fairness and Choice" contains many initiatives related to grid modernization, however, for the purposes of this paper, I focus on the items, Implementations Directives, and their subsequent Implementation Plans that contribute to the integration of DERs and power system decentralization in Ontario, which are primarily captured in Chapter 3: Innovating to Meet the Future and Chapter 4: Improving Value and Performance for Consumers (MOE, 2017).

OEB Implementation Directive and Plan

The subject of the Implementation Directive issued to the OEB can be traced directly to Chapter 3 of the LTEP, which includes content related to modernizing the system, grid modernization, distributed energy resources, and barriers to innovation. The main goal of the Directive is "to accelerate modernization of Ontario's electricity system to keep pace with anticipated technological change and new energy products and services for consumers" recognizing that "[g]rid modernization along with distributed energy resources are identified throughout the LTEP as important vehicles for achieving consumer choice and control." Specifically, with its role as the regulator and contributor to policy development, the OEB is called to create "an environment conducive to distributor investment in "innovative solutions that make their system[s] more efficient, reliable and cost-effective, and provide more consumer choice." The LTEP gives the OEB the task to support the creation of this environment by examining and identifying steps for pursuing opportunities such as "cost-effective smart grid and non-wires solutions; active system management and customer participation; and energy efficiency measures on distribution systems." Alongside these tasks, "the OEB shall consider the issue of the diffusion of benefits that may arise from these and other distribution-system investments" and "assess market opportunities and facilitate those that would reduce costs and provide value for customers, and identify barriers to the development of distributed energy resources, such as energy storage, at scales and locations that provide value to customers and the bulk and local distribution systems."

In response, the OEB's scope of work planned indicates that it will engage in "policy initiatives to advance regulatory processes in support of cost-effective grid modernization and reduce barriers to the development of distributed energy resources." Furthermore, "in carrying out this work, the OEB expects to explore issues… such as diffuse benefit, and the potential for distributors to look to alternative, non-traditional distribution solutions when assessing options for addressing emerging system needs." It will also look to "identify action items and regulatory priorities to be considered by the OEB that can encourage greater innovation by regulated utilities." These points are included in items 1.2 and 1.3 of the Implementation Plan entitled, *Cost-Effective Modernization* and *Distributed Energy Resources,* respectively.

With respect to LTEP item 1.2, the OEB's work plan, *The way Forward for Adaptive Regulation,* seeks to assess whether more holistic regulatory reforms are warranted in Ontario and how they might further enhance efficiency and innovation in the energy sector. It suggests to look to regulators in other jurisdictions that are considering new approaches to remunerating utilities to either supplement or replace the conventional rate-base rate-of-return approach. These include ways of treating traditional capital investments relative to non-capital expenditures that might better encourage the adoption of innovative and least-cost solutions and others that can entail forecasting the evolution of network uses and estimating efficient system expenditures, improving efficiency incentives, and ensuring appropriate sharing of risk. This would result in new ways of setting rates and determining allowable revenues for LDCs that optimize their investment and expenditure portfolios while encouraging LDCs to take advantage of new technology, potentially securing cost-effective benefits for customers in the process. The comprehensive approach to develop reforms includes consideration of non-wires solutions; operational measures to defer capital; active system management and customer participation; and energy efficiency measures on distribution systems (OEB, 2018).

With respect to LTEP Item 1.3, the OEB's work plan, *Enabling Distributed Energy Resources,* seeks to examine alternative way to encourage the efficient placement and operation of DERs, particularly when DERs can supplant traditional distribution system investments, while still ensuring that solutions with greatest long-term value are implemented. The scope of this work will include analyzing both DERs that are installed specifically to provide electricity services and those that primarily serve another function but can be aggregated to provide system benefits. The result is expected to be a compensation framework that enabled innovative investments to move forward when it is economic to do so. The OEB plans to identify opportunities for regulatory reform by considering frameworks for assessing and allocating the benefits and costs of DER investments; how to encourage DER deployment and operation that provide incremental value to consumers and the system, including distinct characteristics of storage; how diffuse benefits and multiple value streams can be appropriately recognized, taking into account seams between wholesale and retail markets; and the role of distributors and other solution providers, including the potential for customer involvement (OEB, 2018).

In executing its Implementation Plan, the OEB notes that it must respect its statutory mandates which are to promote economic efficiency and cost-effectiveness in the electricity sector, as well as, the promotion of conservation and demand management (CDM), the use of renewable generation, and facilitating implementation of a smart grid. Thus its approach to grid modernization and DERs must demonstrably strike a balance within those parameters – between the potential to deliver value to consumers and avoiding significant cost consequences. As the OEB notes, this appropriate balance calls for a strategic approach targeting investments that cost-effectively advance goals such as customer participation, choice and control, de-carbonization, and system resiliency. Where investments may deliver multiple value streams and diffuse benefits, the OEB is to consider how best to ensure that the value and benefits are appropriately measured and compensated, and that associated costs are fairly allocated. That said, the timeline for these initiatives spans for several years into the future, with the resulting actions not meant to come into effect until 2020 (OEB, 2018).

IESO Implementation Directive and Plan

The IESO plays an important role in enabling innovation through “the information it provides, funding and programs it offers, and market-based opportunities it facilitates.” (IESO, 2018). In its Implementation Plan, the IESO identifies two initiatives related to the integration of

DER. The first is to "develop a program to support a select number of innovative renewable distributed generation demonstration projects in order to gain direct experiences with integration of DERs, refine methodologies for assessing value streams, and to inform the evolution of grid systems, processes, and practices." The intention is to "demonstrate opportunities to enhance integration into electricity system operations, planning, markets, and regulations." Virtual Net Metering (VNM) has been identified as the topic for pilot project demonstrations. Under the VNM arrangement "customers are billed on a net-metered basis for eligible electricity generated from a facility that is not connected directly to the customer. The second initiative in the Implementation Plan is to "identify potential obstacles to fair competition for energy storage with other technologies in the delivery of services… through a review of the market rules, industry codes, and regulations… and, where appropriate, propose mitigation strategies… within the current structure of the market." (IESO, 2018). That said, I will analyze the collective effects of these initiatives in the last section of this part, following an explanation of the transitional pathways contemplated by the transitional literature to better ground an analysis of the structural implications of Ontario's planned approach to grid modernization.

3.2. Revisiting Geels: Typology of Transitional Pathways

The transitions literature, in addition to structurally conceptualizing how regimes change over time, goes further to detail the possibilities of transitional pathways that emerge based on the nature and timing of the interactions between the regime, landscape, and niche levels (Geels, 2007). The timing and nature of interactions act determine the type of transition pathway because on one hand the landscape pressures can be either disruptive or reinforcing and on the other hand the niche level, although competitive with the regime it aims to replace, can also be symbiotic with the regime (Geels, 2007). The previous is meant to refer to the nature of interaction while timing is meant to refer to the "maturity" of the niche. This means that the niche must demonstrate significant progress in the core processes of niche-cumulation as mentioned in Part II to become embedded into the regime. This occurs as niche innovations build up internal momentum through learning processes, price and performance increases and support from powerful groups (Geels, 2007). Consequently, the four dominant transition pathways are (Geels, 2007, 2016):

transformation: This occurs where there is downward landscape pressure but the niche is not adequately developed. This triggers gradual cumulative adjustments within the coordination of activities between regime actors implemented from within the regime. Effectively, the regime adjusts its own trajectory by making internal modifications of incremental changes to key elements of the regime mentioned in Part II. Although primarily driven from within, the regime actors may also adopt radical niche innovations and strategic direction that can trigger further adjustments such as organizational capacity, however in a limited capacity.

De-alignment/Re-alignment: This occurs where there is a shock introduced by the landscape pressures but with an "avalanche effect." This means that the direction is uncertain and regime actors are uncertain about "which dimensions to optimize." Since the niche is not adequately developed in this situation either, a vacuum is created where several embryonic niches compete until one becomes dominant and a new regime is created around it. The distinguishing factor about this pathway is the temporal separation of entrant niches and its usual involvement of a major paradigm shift (that can often involve a societal crisis).

Technological Substitution: This occurs where a disruptive niche innovation develops fully but separately of the regime and then breaks through in response to a specific shock when it arises. There is an adaptation process that occurs on a "fit-and-conform" or "stretch-and-transform" basis. This refers to how the niche adapts to the selection criteria of the regime. Radical innovations may be developed and deployed by regime outsiders with normative motivations or by regime actors that diversify from other sectors.

<u>*Reconfiguration:*</u> This occurs where a niche starts off as a symbiotic innovation that is adopted by the regime to solve local problems and subsequently begins to trigger further changes throughout the regime. The presence of landscape pressure is intermittent and can involve alliances between regime actors and new entrants due to a lack of capacity or other constraining factors such as anti-competitive concerns on part of the regime actors; this type of transition can be though of as modular.

These pathways are described as alternatives to the default trajectory created by the default or business-as-usual actions of regime actors, which reproduce the established and entrenched routines that have the tendency to blind regime actors to factors outside of their focus (Geels, 2007). The transitions literature also discusses the possibility of jumps between pathways in a given transition, as noted by Geels: "Transitions may start along transformation via technical add-on and subsequently morph into a reconfiguration pathway as the new technology has wider effects that trigger innovation cascades and learning processes that change actors' views and facilitate wider adjustments and increased adoption." (Geels, 2007; 2016). However, this a two-way streak where the regime in more disruptive paths may start to reject niche developments and regain stability, usually in the presence of reduced landscape pressures. This scenario may start as substitution where new entrants challenge regime actors but subsequently morph into transformation if establish and entrenched firms buy up small firms to control radical innovation.

3.3. <u>Ontario's Transition as *Transformation* Pathway</u>

<u>*Non-Wires Solutions and Alectra POWER.HOUSE as Ontario's Approach to DERs*</u>

When assessing Ontario's grid modernization initiatives collectively, what most prominently emerges as the primary focus of this policy evolution is the desire to adjust the regulatory framework to enable LDCs to deployed Non-Wires Solutions (NWS). NWS is, as Navigant defines it, "an electricity grid investment or project that uses non-traditional distribution solutions, such as distributed generation, energy storage, energy efficiency, demand response, and grid software and controls to defer or replace the need for specific equipment upgrades such as lines or transformers, by reducing load at a substation." (Navigant Consulting, 2018). NWS is also recognized as a process that facilitates the deployment of DERs and thus is an important component in any transition towards decentralization. The basic idea behind NWS is that it is an alternative solution to traditional infrastructure investments - the need for which arises most commonly as a result of aging infrastructure or load growth – at a potentially lower costs, shorter installation timeline, higher customer engagement, and increased environmental benefit (Navigant Consulting, 2018). NWS has the effect of addressing the local constraint or reliability issue by deploying a strategically-sited DER that produces a net load reduction in a load pocket that is downstream from the transmission or distribution constraint. In implementing a NWS project, the utility may offer "targeted and focused customer incentives and drive a marketing campaign to drive faster adoption of demand-reducing technology and utility-funded DERs." (Navigant Consulting, 2018). However, the issue with the regulatory framework, in terms of both restrictions on business activity and rate-setting is that there is an established type of capital investments that LDCs are allowed to earn a regulated on, which NWS may not conform to, perhaps because its benefits cannot yet be demonstrated to have system-wide benefits that justify its expenditure (EDA, 2017). This regulatory uncertainty disincentives LDCs from procuring NWS even though they may be cheaper, more beneficial, and engage customers (EDA, 2017).

As an illustration of this concept and a demonstrated example of NWS deployed in Ontario, I turn to Alectra's POWER.HOUSE (APH) pilot project mentioned in Part II. APH is a deployed fleet of 20 participating residential solar and storage resources that are aggregated through an intelligent software into a Virtual Power Plant (VPP), which has the effect of creating the functional equivalent of a single, larger resource (Alectra Utilities, 2017). The APH project is a collaboration between Alectra and the IESO, among other private entities, and funded by the IESO's Conservation Fund in order to evaluate the costs and benefits of integrating DERs (Alectra Utilities, 2017). The aim of the feasibility study was to optimize the system and assess value streams and revenues generated from benefits flowing to numerous groups (Alectra Utilities, 2017). To the customer, the behind-the-meter benefits included solar generation to offset the consumption of on-peak grid sourced energy, net metering, price arbitrage against time-of-use (TOU) pricing using storage capacity charged off-peak, and on-site back-up for unexpected outages (Alectra Utilities, 2017). To the utility, benefits included participation in markets for grid services such as voltage and frequency regulation, demand response, and operating reserve; the study also contemplated the potential for a flexible ramping product (Alectra Utilities, 2017). To the system, benefits include the deferral of infrastructure investment and the avoidance of greenhouse gas emissions (Alectra Utilities, 2017). The results of study indicate the potential to expand the PH fleet to 30,000 homes by 2031, establishing 140 MW of "local dependable capacity," a measure that deducts the constraints of the system from the nameplate capacity (Alectra Utilities, 2017). Now that I have illustrated the LDC-deployed NWS model that comprises Ontario's grid modernization and, by extension, sustainability transition, I will comment on the structural implications of this approach in terms of Geels' typology of transitional pathways.

<u>Ontario's Transformation Pathway</u>

In this section, I will demonstrate why Ontario's approach to grid modernization, as evidenced by the 2017 LTEP and subsequent Implementation Plans issued by the OEB and IESO most closely resembles a *transformation* pathway with the potential to morph into a *reconfiguration* pathway. Recall, that the defining characteristic of a *transformation* pathway is that the transition is predominantly driven by established regime actors in response to landscape pressures when the niche is not adequately developed. Recall, also, that in Part II, after expositing what rules and actors comprise Ontario's electricity regime and niche, I elaborated that the niche is not yet fully developed because although it demonstrates progress in the core processes of niche-cumulation, it lacks development with respect to market design, infrastructure requirements, and organizational issues and business models. Furthermore, I have also explained why the development of these aspects of the core processes of niche-cumulation cannot be achieved through the bottom-up process of niche-cumulation. The reasons for this being that in order to develop these core processes, DERs must be widely deployed and studied, at least as pilot projects, in order to refine the methodology and framework of how to better integrate them, which cannot happen in the presence of restrictive and unclear regulations because of the nature and stringency of these regulations to the industry actors.

I will spend this section detailing why the core processes of niche-cumulation depend on the activities of regime-level actors. For example, with respect to market design, the IESO is responsible for administering Ontario's wholesale market, meaning that market design is within its purview. This is consistent with its Market Assessment and Compliance Division, which it houses and works together with the OEB's Market Surveillance Panel to progressively make changes and improve the Market Rules and market design. The IESO's Implementation Plan mentioned above, specifically the distributed renewable generation demonstration projects and

Virtual Net Metering pilots would have contributed to this end. However, this implementation item was prematurely cancelled because it depended on the adoption of updated regulations that would enable virtual net metering, which were rejected by a subsequent government from the one that introduced the change (Stevens, 2018). That said, IESO is undergoing a much larger overhaul known as Market Renewal, which is not directly aimed at integrating DERs, but may nonetheless have some impact on them; Market Renewal will be explored in further detail in Part IV. With respect to infrastructure requirements, this can pertain to both physical infrastructure, as well as economic, such as price signalling, and is tied in with market design and thus cannot develop on the niche level. With respect to organizational issues and business models, this ties in directly with the future role and activities of Ontario's LDCs. This may also tie in with infrastructure requirements, since the operational structure of the grid may change if LDCs transition to a FINO role as contemplated by the EDA Vision Paper and gain visibility and dispatch control into their respective distribution grids, more closely resembling the role of the IESO; these ideas will be explored in further detail in Part IV. That said, the EDA Vision Paper also indicates that there are significant obstacles to the LDCs own transitional path to adapt to a decentralized grid as it isolates and makes recommendations as the restrictive and unclear regulations that are on one hand important, given the territorial monopolies granted to LDCs, but on the other hand reinforce stability and by extension a business-as-usual scenario (EDA, 2017); these recommendations will be explored further in Part IV.

Now that I have supported my claim that niche-cumulation cannot develop significantly enough to break into the regime on its own, I will explain how Ontario's grid modernization initiatives address some of these points and thus contribute to a *transformation* pathway. Above I have noted the emergence of a shift towards a LDC-deployed NWS model and pointed to Alectra's

POWER.HOUSE project as an example. The main reason that I put forward that Ontario's approach is a *transformation* pathway is because the changes being implemented, mainly through the legislative and regulatory processes and policy tools that change the formal and by extension normative rules that govern regime actors and coordinate the activities among them is being implemented from within the regime. That said, this mechanism for implementing is a necessity given Ontario's statutory framework for the electricity sector. However, what reinforces my position, is the contemplated result of these changes, which is that expanding the business activity of LDCs and adjusting the regulatory framework for rate-setting, thereby enabling LDCs to deploy DERs vis-à-vis NWS, they remain the dominant actors with respect to the deployment of DER. Thus what results, if this transition unfolds as designed by the changes then in structural terms, the regime continues to be dominated by its established and entrenched actors, with limited adoption from the niche. In this sense, I use the term niche to refer to innovative firms who may be deploying DERs behind-the-meter for customers. The limited adoption of the niche may come in the form of LDCs contracting with third party developers to use their assets, deployed perhaps in front of the meter, to solve local constraints. This can be contrasted with a competitive retail market where third party DER developers may be offering their equipment and other benefits directly to customers of LDCs. However, there is little incentive for third party retailers to participate in a regulatory environment where they do have direct access to generate revenue streams from the energy and ancillary services markets; I will explore this model in greater detail in Part IV. A limited departure of this are the demand response participants who participated in the IESO's auction. However, demand response is perhaps easier to coordinate from an operational standpoint. Thus, ultimately, what emerges is a regime with a slightly modified trajectory due to the adoption of LDC-deployed NWS, which is implemented through rule changes made by regime actors to expand the capabilities of established regime actors. I have noted above that Ontario's approach is a *transformation* pathway with the added potential to morph into a *reconfiguration* pathway; I will explore this idea in greater detail in Part IV while making discrete recommendations as to how to achieve this "jump between pathways."

PART IV: MARKET & REGULATORY FRAMEWORKS FOR A DECENTRALIZED POWER SYSTEM

4.1. Shortfalls of Ontario's Approach in Light of the Sustainability Objectives

In Part III of this paper, I exposited Ontario's approach to grid modernization, as it pertains to aspects of grid decentralization through the integration of DERs. This exposition identified Ontario's approach through an examination of the statutorily enshrined system planning and policy development as it relates to the evolution of the industry, such as the MOE's 2017 LTEP and subsequent Implementation Plans. I concluded that this approach prioritizes the enabling of LDCs to deploy DERs through NWS and I further commented on the structural implications of this approach based on Geels' typology of transitional pathways, where a *transformation* pathway, characterized as being driven by internal adjustments to the regime with the established actors remaining dominant, as being illustrative of the structural implications of Ontario's approach. However, as this paper mentioned in Part I, there is another dimension to this transition being a sustainability transition, which must respect the sustainability objectives established in Part I, and so, it is important to analyze the potential impacts of Ontario's approach on the sustainability objectives; the structural implications mentioned in Part III are also be relevant (i.e. minimizing the potential for new entrants through the *transformation* pathway). Thus in the following section I will analyze the consequences of Ontario's approach in light of the sustainability objectives and put forward that there are several shortfalls that can be better addressed through a *configuration* pathway.

Ontario's LDC-Led Deployment of DERs and Sustainability Objectives

This analysis builds off of the one in Part I, which supports why a decentralized grid with a high integration of DERs respects the sustainability objectives. Whereas the analysis in Part I is focused on DERs conceptually as a technology, this analysis will instead focus on alternative pathways of integrating DERs as there is a broad spectrum of what a decentralized grid means and looks like. The starting position is based on Ontario's LDC-deployed NWS approach and I will recommend alternatives accordingly as the analysis progresses. The majority of the shortfalls that I will conclude are reserved for objectives 2 and 3, covering economic responsibility and distribution effects, respectively.

Sustainability Objective #1: Environmental Integrity

With respect to this objective, there is not much to be said as the approach does not change the nature of the technology nor does the approach have any directly observable environmental impacts that can be commented on. The only thing to be said, as a caveat to the point that predominantly DERs use renewable generation techniques and storage has the ability to displace centralized peaker plants that are mostly gas-fired, is that the life cycles of chemical batteries (as opposed to thermal and mechanical) and solar PV cells in particular can have unsustainable effects upstream the supply chain as the materials and minerals used in the manufacturing of these equipment such as silicon and lithium need to be mined and processed (Hernandez et al., 2014). This point goes mainly to DERs rather the process.

Sustainability Objective #2: Economic Responsibility and Adaptive Capacity

In terms of values encompassed under the economic responsibility objective, the LDC-deployed NWS model is an improvement, although on a limited scale, over the government driven centralized system planning mechanism enshrined in Ontario's statutory framework as mentioned in Part II. This is because, in some respects, it enables the planning process to occur from the bottom-up. In essence, this contributes to "right-sizing" the system because local constraints are resolved using local solutions rather than relying on reinforcement of the bulk system, which is costly and inefficient due to the amount of losses that occur at every stage before the benefits are delivered to the distribution-constrained load pocket (Lovins, 2003); I will not even go on to mention the inefficiency of the procurement mechanisms. That said, the reason that I stated that this was only an improvement on a limited scale is because of the limited applications of NWS; and by limited applications I am referring to the grid services that NWS is meant to provide and its potential to provide substantially more grid services with the necessary market and regulatory design. According to the NWS model contemplated in Ontario, it is meant to target constraints that would otherwise be resolved through traditional LDC investments such as transformers and additional lines to resolve congestion and power quality issues. In this sense, NWS can be a cost and time effective alternative that strategically placed can also offer other system benefits such as resiliency and improves overall adaptive capacity, depending on whether the DERs are owned by the LDC or rather by a third party developer or even customer and on the structure of the commercial arrangement over the control of the asset. In terms of the potential to provide substantially more grid services, I will explore this idea and its implications below as well as in the following sections.

Sustainability Objective #3: Distributional Effects, Innovation, and Individual Choice

Building off of what was said above, as the POWER.HOUSE project reveals, LDCs with greater financial resources and operational capacity such as Alectra have bigger plans for deploying LDCs and providing greater grid services such as secondary services including voltage and frequency regulation and even potentially primary services such as energy, operating reserve, and capacity. However, I question the distributional effects of this approach, specifically in terms of providing consumer choice, creating business opportunity, and innovation; additionally, there is something to be said about the impacts to pricing allocation among consumer groups, especially low-income consumers.

Although large LDCs such as Alectra, perhaps have the capacity to start deploying DERs either among their customers, granted that the permissive regulations are implemented, it remains to be seen how these additional expenditures will be reflected in the LDCs' accounting books. On the one hand, if this falls under the utility's regulated business then these costs will presumably be passed off to the rate-base. On the other hand, if this falls under the utility's unregulated business, through the affiliate, then it is questionable how effective this strategy is given the lack of retail competition and the disparate capabilities of different LDCs to offer DER products. This point on lack of retail spills over into the debate about consumer choice. This is because, as mentioned in Part III, if the focus of the regulatory changes is to expand the scope of business activity and recoverable investments for LDCs, then they remain the dominant actors with geographic monopolies, leaving consumers constrained for choice because they cannot access potentially cheaper and more value-added products such as DER systems and services that can be offered by third party retailers.

Throughout this section I have been working under assumption that there is or will be a lack of retail competition and offerings related to DERs. However, a simple perusing of the Ontario market will reinforce this. The reason for this, I put forward, is that this is due to a lack of market mechanisms that would provide these retailers with access to revenue streams which would afford them the opportunity to finance the systems to customers with a revenue-sharing arrangement because the saving that would come from say a net metering arrangement would be substantially inadequate. I will explore the idea of providing market mechanisms to access revenue streams in the next section in greater detail. That said, this same point on lack retailing also speaks to innovation because presumably unregulated LDC affiliates, if they are to shoulder the costs of deploying DERs will need additional resources and organizational capacity for research and development and without proper channels to revenue streams will not be able to support such developments.

One clear example of a successful segment of the electricity retailing market in Ontario with clear channels to access revenue streams is Demand Response (DR). DR services used to be procured through capacity-style contracts until they transitioned into an auction mechanism through IESO's Market Renewal initiative, where third-party retailers enter into commercial arrangements with electricity consumers to remotely manage their energy consumption and turn it down in events of peak demand and in return split the revenues that are paid out from the IESO (IESO, 2017). Another example, although a more hotly debated policy choice, is the Industrial Accelerator Program (IAP) offered by the IESO, also known as "GA busting." This is mainly targeted at Class A consumers mostly comprised of the industrial and commercial segment, who can reduce the Global Adjustment (GA) component that makes up the rate that they pay for electricity. Both of the GA and DR segments of the retailing market demonstrate (a) that creating channels to revenue streams fosters an environment for third party retailers to compete and (b) that this creates a plethora of options for consumers and an array of innovative services and benefits that regulated utilities are either restricted from providing or do not have the resources and capacity to provide.

This logic of creating business opportunity and fostering innovation can also be applied to assessing the impacts of retail competition on different consumer groups, especially low-income consumers, although a much more tenuous one that requires greater study. The contention here is that on the one hand, if third party retailers are deploying DERs then this exacerbates the "utility death spiral" where revenues for LDCs decrease because less electricity is being purchased from the grid and consequently they raise prices for the other consumers. The assumption here is that low-income consumers may not be desirable customers for third-party retailers and thus they are the ones who are most reliant on the grid and end up paying the higher prices. On the other hand, it is possible that there may be retailers who specifically focus on the low-income consumer segment and may even be able to offer better prices than LDCs. However, both these points require further study and remain inconclusive based on the conjecture of their assumptions.

Now that I have illuminated some of the debates and identified the shortfalls, in my opinion, of Ontario's approach, I will move on to put forward the model of DER integration that I believe better supports the sustainability objectives mentioned that can be brought about through a *reconfiguration* pathway. This *reconfiguration* model that I support, in short, is focused on fostering an environment for retail competition in DER deployment. To phrase as a direct comparison, in what follows, I advocate for retailer-deployed DERs as opposed to LDC-deployed DERs.

4.2. Grid Architecture, Market Mechanisms, and Regulation of Retailer-Deployed DERs

I have identified the retailer-deployed DERs model as being an improvement, in my opinion, over the LDC-deployed DERs model because it better achieves the sustainability objectives identified in this paper. However, neither of these models can occur by themselves due to the statutory frame and restrictive regulations that govern the electricity sector, which have been previously discussed in Parts II and III. Given that this paper is about transitions and Ontario's approach is driven by careful deliberation of how to achieve certain desirable outcomes, this section will present an approach that focuses on the aspects that need to implemented in order to facilitate the emergence of a retailer-deployed DERs transition. Specifically, I will speak to three key areas, which are: (a) the operational architecture of the grid that must be able to support two-way power flows at the distribution level, which is inextricably tied to the future role of distribution utilities; (b) market mechanisms in the form of platforms (and their supporting economic infrastructure) that will provide the channels to access revenue streams; and (c) the regulatory framework for retail competition. In the last section, I will move on to speak to how these changes can be implemented by way of the *reconfiguration* pathway.

Grid Architecture

Citing the Pacific Northwest National Laboratory, grid architecture refers to "the conceptual model that defines the structure, behaviour, and essential limits of a [power] system." (Roberts, 2018). Currently speaking then, Ontario, like most other jurisdictions, has a centralized top-down system where electricity is procured predominantly at the transmission level, sold on wholesale energy markets to distributors and delivered to the customers through interconnections to the distribution network (King, 2016). That said, it is evident why this model cannot work where DERs, being inherently distribution-connected, provide grid services through two-way power flows. In the DER-integrated model, at the very least, visibility is needed to monitor power flows, which speaks to the emerging role of distribution utilities, who currently do not have visibility into their networks but own and maintain them to deliver their obligations as the standard supplier (EDA, 2017; Roberts, 2018).

Chapter 6 of the MIT "Utility of the Future" report, entitled "Restructuring Revisited: Electricity Industry Structure in a More Distributed Future" envisions several alternative models of grid architecture that are better suited for a distributed grid that revolve around transitioning the role of current Distribution Network Owners (DNO) to Distribution System Operators (DSO) that reflect a role that closer resembles that of the Transmission System Operator (TSO) (MIT, 2016). Specifically, with this type of "restructuring", the MIT report conceives that the focus is on "the proper role of electricity distribution utilities, the potential need for a DSO, the establishment of market structures or platforms that enable the provision of multiple electricity services by DERs of all kinds, and the emerging role of DER aggregators and other new DER business models." (MIT, 2016). The purpose of this is "allocate the three critical functions of an electricity market", which are (a) "the provision of a market platform to facilitate transactions"; (b) "the provision of a physical network built and maintained to enable the flow of electricity between the points of production and consumptions; and (c) "the provision of a system operator to coordinate power flows while managing the technical constraints of the grid (MIT, 2016).

One of the MIT's alternative models is fundamentally similar to the FINO model envisioned by the EDA in its Vision Paper. In this this model, the "distribution network owner and operator" (DNO/SO), the three critical functions of an electricity market of distribution network provider (i.e. owner), operator, and market platform are delivered by the utility (MIT, 2016). Effectively speaking, the utility, within its service region (e.g. Local Distribution Area), would maintain the physical infrastructure, operate the network by "actively managing distribution assets and coordinating the dispatch of DERs to provide distribution network services (DNO/SO)," and establishing market and procurement processes involved with system operation (MIT, 2016). The efficiency of this model comes from the gains made from the economies of scope that of the entity's service offerings and responsibilities. This includes leveraging the data gathered through system visibility to determine the locational value of service in order to send the most efficient price signals, and operate optimally competitive and transparent procurement processes for network services, as well as to reveal the price of other products such as NWS (MIT, 2016).

That said, there are a number of challenges associated with this model. One challenge is how to align these different business activities with the traditional role and business model of rate-base regulated utility (MIT, 2016). Overcoming these challenges would include reviewing the regulatory framework for rate-base application decisions especially with relation to capital and operational expenditures in order to level the playing field for competition between contracting DER services and traditional investments (MIT, 2016; EDA, 2017). Another major challenge is the independence between different functions that have the potential to encounter conflicts of interest (MIT, 2016). This is directly applicable to the second and third main functions of a FINO, which involve the ownership and operation of DERs deployed and providing services to the grid. This means that if left unchecked, the FINO could significantly undermine the competition and efficiency of markets if it is involved as a market participant and dispatch decision-maker. However, this can be remedied through legal unbundling, which involves setting up regulatory rules and requires enforcement, or through structural unbundling, which involves separating different functional arms of an entity (MIT, 2016); the separation between the regulated business of an LDC and affiliates is an example of both of these principles as the OEB imposes license conditions on LDCs that include abiding by the Affiliate Relationship Code.

With respect to system planning, matters are slightly complicated in the Ontario context because unlike most other jurisdictions, Ontario LDCs are not Load Serving Entities (LSEs), which means they are not responsible for procuring capacity for changing load forecasts but depend on the IESO to procure (could also be instructed by Ministerial Directives) capacity and purchase it from the IESO-administered markets (Clark, Stoll, and Cass, 2012). This needs to be reconciled with the necessity to provide non-discriminatory and open-access connection of DERs (the cost of which need not be socialized but paid to the LDC instead). It has also been suggested that this may have a cascading effect because as more DERs are connected and offer primary services such as energy and capacity, more DERs will be required to provide secondary services to support network operations through NWS and have the benefit of deferring traditional investments into reinforcing the infrastructure (Navigant Consulting, 2018). Notionally, however, this can be accomplished by factoring in the integration of DER into distribution system planning and accordingly adjust its load forecasts and purchasing made from the wholesale markets while servicing its LDA as the standard supplier.

Electricity Market Platform Design

Our epistemological understanding of what a platform is: a structure used to "create market processes within specific institutional contexts to aggregate diffuse private and contextual knowledge and enable value creation within exchanges through the platform." (Kiesling, 2018). Additionally, this effectively provides a channel for "an open participative infrastructure for those interactions and has the ancillary responsibility to set governing conditions." (Kiesling, 2018). Meanwhile our economic understanding dictates that "platform business models emerge and thrive because of the potential profit in reducing transaction costs to connect people for the mutual benefit as value creation." (Kiesling, 2018). As a prevalent example in the local context that is not to be overlooked is the IESO-Administered Markets, where Ontario wholesale market participants provide bids and offers on electricity services. Other examples although from different industries are securities exchanges and more recently, Uber and Airbnb. It becomes clear, from these illuminating examples, how a platform application could exist in the context of a competitive retail market; although in numerous forms falling on a spectrum.

This variation in form mostly consists at the level of implementation. Building off of what was said above about grid architecture, the question is whether a future-LDCs, with visibility into their respective systems, should also offer a platform as a market mechanism to provide a channel to access revenue streams for competing firms, or should this be left with the current market administrator (i.e. IESO), recognizing several of option in between. The reason for presenting this question in the first place as opposed to simply accepting he status quo is because there are some inherent obstacles in keeping the market structures business-as-usual. For example, in the current IESO-Administered Markets, transactions between the participants occur at the transmission level; for example, generators inject electricity at the bulk level where it is purchased by LDCs and the transaction ends at the interconnection node where it is stepped down to the voltage level of the LDA. Throughout the process, the IESO has full visibility into the power flows. However, with DERs, the paradigm is different, where the assets providing grid services, are being dispatched at the distribution level, where future-LDCs may have visibility into. Thus under the current grid architecture, the platform for participation, since the source of revenue is not in the market of financing out DER systems alone, is the wholesale market, presuming that rules and requirements of market participation are permissive of the characteristics of DERs. An example of this was demonstrated in recent news when Sunrun cleared 20 MW of capacity in ISO-New England's capacity auction (Spector, 2019). Additionally, the introduction of an Incremental Capacity Cuction (ICA) through IESO's Market Renewal notionally make this a viable option in Ontario, granted the Market Rules accommodate the technical and economic characteristics of remotely dispatched and aggregated DERs (IESO, 2017).

However, this debate has spawned the potential of a distribution-level market that can be offered through a platform administered by a capable DSO. If designed properly, a distribution-level market can secure reliable electricity at least cost to consumers (Cramton, 2018). Economically speaking, it also has the potential to achieve short run efficiency, which is making the best use of existing resources; and long run efficiency, which is promoting efficient investment in new resources (Cramton, 2018). On this point, it is worth taking a brief detour to look at electricity market design at a high-level. The MIT report distinguishes between essentially two types of electricity services that can be sold to the grid: energy-related (or primary) and network-related (or secondary) services (Pérez-Arriaga, Burger, and Gómez, 2016). Primary services include electric energy, various operating reserves, black-start capability, and firm capacity; while secondary services include: network connection, reactive power for regulation and power quality (Pérez-Arriaga, Burger, and Gómez, 2016). DERs, especially aggregated in a diverse portfolio, have the potential to provide all of these services. Additionally, the MIT report contemplates that new services may arise in a decentralized grid, such as flexible ramping products that greater DER usage will necessitate but also be able to provide.

There is also something to be said about the structure of electricity markets. Peter Cramton helps break down the process and components stating that the two core elements are a day-ahead market for optimal scheduling and real-time markets for real-time dispatch respecting system constraints (Cramton, 2018). The spot market decides the wholesale price of electricity through the market clearing price, which is based on the transparent offers and bids submitted by the participants. Cramton, however, comments on the practice of using Locational Marginal Pricing (LMP), which varies price due its locational value, recognizing that due to transmission constraints, energy and related services may have different values even at the same time (Cramton, 2018). However, that said, this economic ideal is never met due to the exercise of market power, unpriced externalities such as carbon emissions, and other subsidies that distort the pricing signals. In Ontario especially, there is no day-ahead market and there is no LMP. Instead, there is a commitment process and generators get "make-whole" payments to cover them for the constraint-created discrepancies that occur between scheduling and dispatch and the Hourly Ontario Energy Price (HOEP) is determined only based on time, ignoring location (IESO, 2017). However, the IESO's Market Renewal Project is working to implement both of the measures prescribed by Cramton (IESO, 2017). Although this is a step in the right direction, if that direction aspires to letting market forces prevail, but there are a few other obstacles: Ontario still has largely long-term contract procurement of resources which have a capped and regulated price and it recently got rid of its carbon pricing mechanism and thus price distortions persist.

In light of the above, proponents such as Tabors, Caramanis, et al. argue that these features could be constructed and offered through a market platform as the distribution level (Tabors et al., 2018). As a matter of fact, they argue that it is a necessary component for a competitive retail market to thrive. However, they posit that a transactive platform must have the correct economic infrastructure to support it and incentivize participation, which is best served by the concept of a distribution locational marginal pricing (DLMP) (Tabors et al., 2018). This notion simply extends the logic of the LMP but is computed on a more granular scale at nodes on the distribution system as opposed to the bulk system. The concept of a distribution-level market has gained traction and is actually explicitly supported by the FINO model put forward in the EDA Vision Paper, especially the support of an "LMP+D" that Tabors, Caramanis, et al. describe (EDA, 2017). Furthermore, Alectra together with IBM (and Interac) have demonstrated a proof of concept for an ancillary services market using a blockchain platform that they have collaboratively created. This demonstration was showcased at the IESO Electricity Summit on June 11, 2018.

According to Vikram Singh of Alectra and Curtis Miles of IBM, the proof-of-concept is an "end-to-end transactive platform that can facilitate an ancillary services market." This is meant to "bring market services down to DERs so that no manual intermediation is required to extract, quantify, and settle value." The demonstration exhibits a mobile application, where participants can see the supported network of assets and get signaled when a triggering event causes the platform provider, Alectra in this case, to procure ancillary services from the network. However, there are some notable peculiarities about the Alectra model: in terms of valuing DER services, the blockchain energy network (BEN) includes a financial partner, Interac, which has "tokenized" the value instead of valuing and attributing real currency value to the services, thus isolating it from market pricing structures. Additionally, the market has limited products that "prosumers" can provide bids and offers for, mainly restricted to several ancillary services. Also, the grid infrastructure of the conceptual design presents Alectra as the aggregators for the entire LDA that communicates with the IESO to rely on for market information and thus acting as the connection of how the distribution level market and the wholesale market interact.

Thus if the goal is to incentivize development of BTM DER and participation by those assets in providing grid level services then the important considerations are: What is proper role of the future-LDC with respect to the ownership of assets and market administration? Should it deploy DERs and operate those DERs for the benefit of its own network or the transmission level as well? Should it offer a distribution level market platform or should it simply act as an aggregator of the DERs deployed on its network for participation at the wholesale level? Should it be prohibited from owning assets except for limited circumstances for reliability purposes? If there are distribution level markets, should there be individual markets for each LDA? Should third party retailers who deploy DERs be able to contribute resources located in another LDA in the market of a different LDA? Should these markets be structured as spot markets or limited to other procurement arrangements? On what basis should services be valued and priced?

Regulation of Competitive Retail in Electricity

The EDA Vision Paper supports the position that LDCs are best positioned to deploy DERs on the basis, among others, that "Ontario does not have a retail market for electricity." (EDA, 2017). As a leeway into this section, it is worth debunking that statement. At first instance, the OEB website clearly lists a number of active electricity retailers and has a license category for parties engaging in electricity retailing, which is defined under the *OEB Act.* That said, the retailing market in Ontario has been called a "historical anachronism" that arose out of specific market conditions that were quickly changed. The predominant business model of these retailers was that, once the competitive wholesale market opened, these retailers would procure generation supply through forward contracts to avoid the volatility of the spot markets and adjust the pricing structure to provide a guaranteed locked-in retail electricity price, the value of this being the impression to consumers that they are hedging their risk against rising electricity costs, which was the trend at the time. However, due to policy intervention by way of a retail price freeze and a return to long-term centralized planning and procurement, coupled with prevalent public dissatisfaction with retailers conduct that brought fourth closer regulation of these entities, effectively changed the market conditions so drastically that there was no longer a business case for these types of retailers (Clark, Stoll, and Cass, 2012; Winfield and MacWhirter, 2019). Now retailing is done through the affiliate arm of LDCs.

However, the type of retailing that I present in this paper is entirely different based on the value that they present, which is deploying DERs thus owning physical assets on the grid, and acting as an aggregator thus operating assets through communicative technologies and offering services not only behind the meter, but also to the system as a whole. In practice this would be similar to the POWER.HOUSE project where separate units are aggregated into virtual power plants, or DR aggregators who aggregate loads and submit offers on auction products, these would comprise some of the competitive retailers who would comprise the market, and would in nearly all cases have some third party agreement between the service provider and a customer of electricity products or services. Another possible potential business model would be firms who sell DERs that are primarily not meant to provide an energy service such as a smart thermostat, lights and appliances, and even electric vehicle companies and EV charging infrastructure, to name a few.

The MIT report weighs in the value of having aggregators and retail energy service providers. Firstly, it makes a distinction that not all electricity retailing is aggregation (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). With consumers taking the more prosumer role that requires more active energy management, there will undoubtedly be providers of services such as energy monitoring, advice, and efficiency products (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). It remains to be see what will constitute retailing and what will not for regulatory purposes as EV charging infrastructure and smart thermostats continue to proliferate. With respect to aggregation, where the retailer will deploy a DER asset (or not), operate the asset, and “group distinct assets and engage them in power markets or selling services to the operator," effectively acting as portfolio of assets under management (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). The report further goes on to posit that there are three types of values that DERs can provide: fundamental or intrinsic, transitory, and opportunistic (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). Fundamental or intrinsic value is effectively speaking, the economic value that DERs in an ideal market design can provide and contribute net system benefits (i.e. driving down costs). This includes economies of scale, economies of scope, and overall reduction of transaction costs; the report refers to the efficiency gained by EnerNOC's centralization of computing power.

However, the report states that the maximum of gain of these efficiencies occur when there is only one aggregator (i.e. DSO) and this must be carefully balanced against other values such as competition, which incentivizes aggregators to provide "customized and innovative solutions" as retail markets are seen as better designed to "deliver desired levels of consumer engagement and value added services." (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). Meanwhile, transitory value stems from the effect of DERs that is it provides load to be price responsive and flexible where it used to be considered inflexible due to a lack of control or willingness. This includes the "mobilization of agents" who would otherwise be left out from participating on the power markets due to the "standardized products that operators create." (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). It also reduces system complexity and information gaps, which by providing forecasts for peaking time can help hedge risk and optimal scheduling. However, the report predicts that as the name suggests, this value "wanes over time as technical and regulatory conditions improve." (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016).

Lastly, opportunistic value is when private value outweighs the net benefits flowing to the system and is caused by regulatory flaws and arbitrage (Burger, Chavez-Ávila, Battle, and Pérez-Arriaga, 2016). Arguably, the Industrial Accelerator Program can be seen as this type of benefit, although it is an overt economic policy decision. This is because it enables Class A customers to reduce their contribution to the Ontario Global Adjustment charge, while Class B consumers, who cannot organize or coordinate their consumption in the same way have to pay an increased amount to cover the transferred cost. That said, by the same logic, with a similar policy favouring Class B consumers and a competitive aggregator targeting residential consumers level the playing field. Alternatively, these unequitable benefits are said to persist around a lack of a proper market structure and can conversely be avoided in the presence of one.

Thus although it evidently desirable to have a competitive electricity retailing market with aggregators who deploy DER assets and participate in power markets sharing revenue with the site hosts, there a few areas of regulation that require consideration: Perhaps at the top of the list is the need to have a clear understanding and definition of what retailing entails and what does not. The current definition under s. 56 of the *OEB Act* contemplates the offering or selling electricity, as well as acting or offering to act as a broker with respect to selling electricity. It is a question if this definition needs to be expanded to include other energy services such as monitoring or peak saving as to otherwise encompass business models such as a load aggregator controlling smart thermostats. This would require a consideration of the type of commercial agreement the retailer has and more importantly, what data does the retailer have access to for operational purposes, including the customer's metered data. Presumably any arrangement between a retailer and a customer where the retailer has control over energy management warrants some clear code of conduct and a mechanism for recourse if the customer's preferences are interfered with as the consequences may be grave. Market participation is a separate issue as any participants would be required to register under the existing IESO-administered markets regime or another if distribution level markets should arise. With regards to the assets themselves, any connection requires an impact assessment on the system and the retailers should have to shoulder that cost, especially if the system will inject energy into the system as opposed to a demand response asset. Registration of any facility should also be mandated so the capabilities and the location of the assets are well mapped out and system capacities are understood. However, the most important factor to keep in mind is to stay agnostic as to the business models as to not preclude future innovation.

4.3. *Reconfiguration* as a Pathway to a Competitive Retail DER Market

Verbong and Geels conducted an MLP analysis of the Dutch and European electricity systems, operationalized at the level of generation and infrastructure, and characterized three potential alternatives under the *transformation, reconfiguration,* and *de-alignment/re-alignment* pathways, respectively, with distributed generation as the *de-alignment/re-alignment* pathway (Verbong and Geels, 2010). In my analysis of the Ontario system, I had a different characterization of Ontario's trajectory as a *transformation* with the possibility to jump to *reconfiguration* pathway based on its approach. This is discrepancy is acceptable and inevitable in MLP analyses because of the different actors, rules, and structures that exist between different regions and contexts. Verbong and Geels in supporting their characterization, mostly rely on the assumption that landscape factors, mainly spikes in oil prices from the middle east and gas prices from Russia due to political volatility, will become so extreme that consumers will lose hope in the established system and turn to experimenting with micro-grids (Verbong and Geels, 2010). Communities will turn inwards and become focused on local and regional solutions, which will ultimately yield a primarily decentralized grid with central generation used for backup and balancing purposes. They additionally claim that this is the least likely scenario to materialize due to the fact that it is the most far removed from the status quo (Verbong and Geels, 2010).

In the Ontario context, as I have demonstrated in Part III, there is already a demonstrated desire to support the deployment of DERs. However, this desire is limited to the use of DERs in local and niche solutions rather than a more significant paradigmatic shift. This is why I characterize this approach as a *transformation* pathway. On the one hand, landscape pressures such as actions to combat climate change as well as, and perhaps more significantly, consumer and industry trends are also pushing towards at least partial decentralization. On the other hand, the level of disruption of is limited. What I mean by this is that neither the landscape pressures nor radical niche innovations are sufficiently potent to permeate and significantly alter the regime. For reasons stated in Parts II and III, the process of niche-cumulation, whereby the niche breaks into the regime, cannot fully occur in the Ontario context due to the statutory framework, which explicitly prescribes and heavily regulates the electricity sector. Thus the niche cannot become developed enough to break into the regime. Additionally, due to the technology and market conditions not being developed enough, the adoption of BTM DERs is not significant enough to trigger the "utility death spiral" to such proportions as to force a major shift in the regime. Thus Ontario's approach aims to selectively deploy DERs, mostly through the established LDCs, with a minimal role for third-party developers to participate, which is descriptive of the *transformation* pathway.

That said, there is a potential for a more significant shift towards the use of DERs, however, my vision of a decentralized grid in Ontario differs from the one envisioned by Verbong and Geels. Mainly, I view this shift as leading to a "partial decentralization" where the primary characteristic is not "loosely coupled micro-grids" but rather a high-penetration of BTM DERs that are dynamically competing with centralized assets, still within predominantly the same grid paradigm. The defining feature of this model is a competitive retail market, which is desirable due to its contribution to achieving the sustainability objectives identified in Part I. To get this state, a *reconfiguration* pathway needs to be taken. This is not necessarily drastically different from Ontario's current approach, but rather more comprehensive, detailed, and deliberate, which is why there is a potential to "jump" to this pathway as contemplated by the transitions literature. To make this jump, the *reconfiguration* must focus on making adjustment and recoordinating regime elements that would enable the niche to develop through the process of niche-cumulation. I have already identified these elements that require attention and depend on regime changes as being market design, infrastructure requirements, and organizational issues and business models, or as I have recharacterized them: grid architecture, market platform design, and regulation of a competitive retail segment. The following details specific recommendations for each area:

Grid Architecture – Recommendations

These strategic changes should be designed to foster an industry structure where the natural monopoly components, specifically the distribution network, is maintained, however it should allow a competitive and dynamic marketplace to thrive dominated by a plethora of innovative business models who regularly engage consumers, deploy energy resources, and act as a provider of choice and diffuser of costs. There are several ways to achieve this, depending essentially on whether distributors will provide market platforms for their respective LDA or whether the wholesale market will be the predominant platform for participation administered by the bulk system operator. More importantly, however, is that there are commonalities that are necessary in either scenario. First, grid visibility is paramount for the management of two-way power flows throughout the distribution grid (EDA, 2018). This means that investments need to be made into the system. The EDA roadmap recommends enabling and even incentivizing LDCs to make these investments either by allowing them to pass off these costs through the rate-base or through a centrally funded pool (e.g. IESO Conservation Fund). Second, in addition to visibility there must be well-defined protocol for coordinating the activities of distributed resources with the bulk system operator (More Than Smart, 2017); whether aggregators of resources should be able to do this directly with the ISO or only through the intermediation of a distributor is another question entirely. Third, viable revenue streams should be available to distributors as their role is ever important in the proper management of a decentralized grid, even if they do not own assets. Fourth, as the EDA roadmap suggests, it is important, especially in the Ontario context, to allow LDCs to work together to reduce costs and make the right decisions with respect to buying or making solutions in house (EDA, 2018).

The changes noted above can be implemented through policy and regulatory tools. This refers to the powers of regulators in their frameworks of assessment and decision making, which need to be changed to reflect a new reality and incentivize distributors to facilitate certain outcome. However, more fundamental changes can be made through legislative tools; these changes could include specific restrictions or permissions on business activities of prescribed actors and even industry restructuring. For example, the EDA roadmap recommends amending sections 71(3) and 80 of the *OEB Act,* which restrict distributor ownership over generation assets up to a certain capacity (currently 10MW) and requires filing a notice with the OEB upon such acquisition, respectively. Subsequently, the OEB must assess the acquisition against the potential of anti-competitive effects. I do not necessarily agree with the removal of the restriction on ownership as

I advocate for a competitive retail marketplace in this paper but some limited exceptions subject to section 80 may be warranted for reliability purposes. Other factors that the EDA roadmap considers are clarifications of DERs for treatment purposes, as well as clarification of LDC/FINO rights over ownership and control of BTM assets, again a more contested point where the goal is to design an environment where retail competition – where retailers are largely aggregators – is the goal (EDA, 2018). I align myself more with the position put forward in the MIT report, which is on the point of grid architecture, it favours independent DSOs (MIT, 2016).

The main rationale behind an independent DSO is to avoid the conflict of interests between the entity's network and commercial components of the distribution company, which is a principle widely accepted today and manifested through the division of LDCs from their unregulated affiliates, who handle the retail segment of the market. This rationale is inherently concerned with anti-competitive behaviour and cross-subsidization of distribution businesses, that have a regional monopoly and monopoly ownership over the distribution network, from having an unfair advantage over potential third party providers who must truly compete in the market place without exclusivity rights or the ability to socialize costs through the rate-base. The corollary of this is the statutorily enshrined right to an open-access grid, which is fundamental to a functional DERs market where the value of distributed assets extends from beyond behind-the-meter to provide grid services. That said, applying these principles to the DSO concept is more complex because the now the network component expands to include a market component, which make it all the more vital to keep separate from the commercial component of the business.

Thus there are several tools that can be used to guide the evolution of the industry including policy, regulatory, and legislative. However, the most important thing is to envision which values to prioritize and what industry structure best correspondents to those values and arrange the details accordingly. In this paper, I advocate for the model that best achieves a competitive retail market where distributed resources can compete for the provision of electricity services. However, this vision is underpinned by the necessity for visibility and maintenance of the distribution network to enable monitoring and analysis of historical and real-time power flows, a role the current distributors are uniquely and best positioned to provide. That said, the vision of a competitive retail market would be undermined if the entity responsible for approving connections, managing power flows, and perhaps administering a market, would also own assets that compete in the provision of the same services, unless for some limited circumstances (MIT, 2016). That said, the question of whether DSO should be able to solely operate assets, even behind-the-meter ones is another matter that requires further examination.

Electricity Market Platform Design - Recommendations

Part of the consideration that need to be made for this aspect is how it connects to the future role of distributors, mainly by affecting their planning function and potentially providing a market platform, and partly it speaks to the more detailed matter of the design of the market, regardless of how it is administered. The first part of this matter is more relevant because it can be implemented through policy, regulatory, and legislative tools while the second part cannot and rests with the system operator, whether transmission or distribution, that administers the market and determines the market rules. With respect to market administration, there are two visions presented in this paper. First is that of the “modified status quo,” where the current system operators continue to administer the markets, including capacity auctions but designs the rules to accommodate the operational constraints of distributed resources so that they can compete on even footing with centralized assets. Additionally, there may further opportunity for DERs to provide services through targeted NWS procurement processes by distributors.

Under this model, there would presumably be some intermediation between the owner and operator of the participating DER and the ISO market administrator by way of the DSO as they would be party with the visibility into the network. This would affect distribution system planning as DSO would need to accommodate the integration into DERs into their networks while maintaining reliability and fairly allocating costs. However, this would be that different under the second vision presented in this paper, which is that of the "distribution level market," where the DSOs would shift even closer to the ISO role by providing some platform with structured products that providers can submit their offers on and participants can bid on those services through the structured markets; there can also be interaction between distribution level markets and the wholesale market. With respect to market design, the platform can be operated by the DSO and offer spot markets for energy, ancillary services, reserves, and capacity; DSO could hold a parallel procurement process for NWS. In this way, distributed services could compete with centralized sources but indirectly through different markets that could have varying rules that respect the characteristics and operational constraints of its participating resource types.

Either way, the MIT report emphasizes that the crucial component in any of these events is having the correct pricing and remuneration structures. Specifically, the report recommends a "comprehensive system of prices and regulated charges that applies to all network users." (MIT, 2016). This should be cost-reflective, it should be computed as adequate granularity, and it should be non-discriminatory and technology neutral. The prices should ideally be based on both time of use and location of use through LMP or even LMP+D and not based on the resource type but rather on its patterns of withdrawal, injection, and operational constraints and how that impacts the functioning of the grid; some examples include considerations of load patterns, generation availability and its ramping flexibility and production patterns, and of course transmission constraints such as congestion (MIT, 2016). In light of the above, it should be stated that this cannot be implemented overnight as a matter of fact takes a considerable amount of time to properly design the system with much trial and error involved to properly be able to value DER services and test the assumptions of how participants will behave on the market and what there preferred means of participation are. However, this makes the policy and regulatory agencies all the more important as they play a vital role in enabling these developments to occur to pilot and demonstration projects that contribute to the development of the optimal economic and regulatory infrastructures that must be in place to support these operations and transactions.

Regulation of Competitive Retail in Electricity

Recall, that the retail models envisioned in this paper are drastically different from previous models as DERs fundamentally alter the business model and present opportunities for retailing that previously did not exist, mainly by providing the deployment of assets, aggregation, and remote control and dispatch in response to economic signals and system needs. All of these activities require connection to the network and access to information regarding both the system and the customer meters. Thus there could be some additional category for a license made that would cover these activities, determine how they are accessed or shared, and require compliance with a code of conducted that would cover this sort of activity. The key to this however, is much in line with what was said above is that the overarching goal of a competitive marketplace should be kept in mind when designing the regulatory framework that accommodates this type of interaction. Specifically, to this point, in creating a license or code of conduct, it should not be restrictive as to hinder or prefer any type of commercial arrangements but rather be open to various innovative business models, focusing instead on the protection of data and consumers.

Conclusion

Thus the recommendations provided above are aimed at achieving a *reconfiguration* pathway by strategically adjusting elements of the regime by statutory regime actors through statutorily-enshrined processes that involve policy, regulatory, and legislative tools. These actions are meant to act as the facilitator of niche-cumulation, making it possible for those core processes of niche-cumulation mentioned in Part II to develop as to gradually adopt incrementally elements of the niche and continuously adjust the regime accordingly. This is because given the statutory context and the nature of the regulations, niche-cumulation can develop sufficiently to break into the regime because it depends exclusively on the regime to enable the core process of niche-cumulation, mainly (c) the articulation of various dimensions such as industry structure and organizational issues (i.e. grid architecture), market design and (economic) infrastructure requirements (i.e. electricity market platform design), and business models (regulation of competitive retail in electricity).

PART V: WHERE DO WE STAND IN ONTARIO?

Ontario has infamously experienced drastic policy swings with respect to the electricity sector. In the past two decades, Ontario has liberalized its electricity market by disaggregating the vertically-integrated monopoly that was Ontario Hydro in several successive crown corporations and opened a competitive wholesale market for energy and ancillary services to private investors to participate, as well as competitive retailers offering risk hedging for volatile spot market prices through locked-in rates. Ontario has subsequently restructured this market into the hybrid model with a central load serving entity that is tasked with long-term system planning and correspondingly and effectively drove or out diminished the market for retailing (Winfield and MacWhirter, 2019). This model persisted throughout the introduction of the *Green Energy and Green Economy Act, 2009,* which prioritized long term procurement of renewable resources that get "topped up" by a premium to cover the difference between the price cleared at the wholesale market and the guaranteed price as stipulated in the FIT contract. During this time, the Minister of Energy took over the role of long-term planning through the LTEP exercise replacing the OPA's IPSP and merged the OPA with the IESO, under the name of the latter and the adopting the role of LSE as the counter party to procurement contracts (Vegh, 2016). The current government has repealed the *Green Energy Act,* it repealed Ontario's carbon trading regime, and as previously mentioned rejected to adopting the updated net metering regulations which were key to the IESO implementing its DER pilot projects and would have had the effect of enabling new business models to appear in Ontario's market (Stevens, 2018). In light of this, the question is, where do we stand in Ontario; are we still on track or is the process of partial decentralization in hiatus?

Despite some of the obstacles mentioned above, in my opinion, Ontario's approach is still on the *transformation* pathway and still has the potential to jump to the *reconfiguration* pathway although that jump may be later down the road. The downsides of noted changes are the cancellation of IESO's pilot projects which could have contributed greatly to understanding DERs as to be able to create structured products on the wholesale market that would enabled their participation. Furthermore, the cancellation of the additional revenue that would have come from Ontario's cap-and-trade proceeds would have funded the IESO's Conservation Fund that could further support transitional grid efforts as they funded Alectra's POWER.HOUSE project (Alectra Utilities, 2017). It is well understood that investments that need to be made into the system to transition it forward are expensive and will inevitably drive electricity prices up at least in the short term (Verbong and Geels, 2010); but it should be noted that not making these investments now will drive prices up significantly later down the road. However, on the flipside, we have seen progress pursuant to the OEB's implementation plan, as well as LDCs such as Alectra actively trying to innovate and move forward through initiatives like the blockchain energy network it had showcased with IBM (IESO, June 2018).

On the OEB front, the Advisory Committee on Innovation had released its recommendation letter outlining the perspective that the OEB should take, subject to the approval of the board. The message of delivered by the ACI is telling. In its report, the ACI invites the OEB to contemplate a future where energy services are no longer provided solely by LDCs and instead "to embrace new players in the marketplace" such as third party providers, DER developers, and customers themselves (ACI, 2018). The ACI also cautions the OEB against attempting to predict "what the eventual market structure will be" and encourages it to focus on maintaining the integrity of the sector (ACI, 2018). The ACI is clearly cognizant of the "prosumer" concept and encourages the OEB to invite competition and customer choice into the distribution sector. What is interesting about the report is the possibility of inviting market based solutions into the distribution sector evidenced by discussions of a transactive distribution level market, accompanied by guidelines for commercial relationships governing the performance of non-traditional resources to utilities and customers. The ACI also notes the necessity of enabling LDCs to gradually equip their respective networks with advanced power system management technologies as operational visibility and control are a precursor to any distribution level market (ACI, 2018). The introduction of a "regulatory sandbox" is also an interesting one as it would provide proponents with a forum to test the compliance of their activities in a "safe" environment. If the recommendations contained in the letter are adopted, then not only would the *transformation* pathway be well underway but the jump to a *reconfiguration* pathway would be significantly more likely. However, it would require more action on part of regime actors, take shape.

The last point of consideration is the role of incumbents potentially hampering progress due to vested interests and resisting what they perceive to be a diversion of revenue streams. Geels contemplates this reality in the transitions literature through the introduction of power and politics into the MLP (Geels, 2014). According to the literature, regime actors such as incumbent firms influence policy makers, leveraging their mutual dependency of economic capital for political capital, with an aim to influencing the industry rules through policies that maintain the status quo (Geels, 2014). These actors tend to be well organized and have established relationships with policy makers. Although I could concede that distributed resources competing against centralized assets may be undesirable to the owners of the latter, I do not have enough evidence to support any suppositions. However, I think a more important angle to view this clash between incumbents and potentially new entrants is at the distribution level between LDCs and third-party DERs developers that may exist or appear in the market. This is evident from the EDA's vision paper, which recommends the extension of LDC business activity, updated regulated remuneration frameworks to allow for recovery of new types of investments and expenditures, and the lifting of the restriction on ownership of assets and the ability to control BTM DERs. This is more telling to me about the desire to continue to dominate the retail electricity market through unregulated affiliates and thus control the deployment and integration of DERs. Thus there is evidence on activity on both sides of the equation and it remains to be seen how this dynamic will play out as subsequent governments, established actors, and innovative firms continue to progress in Ontario, however, also in other comparable jurisdictions.

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