The socio-political dimensions of sustainability transitions: Applying discursive approaches to examine energy transitions

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Dane Labonte is the primary author of this dissertation. The primary author collected all data and undertook all analysis and synthesis save for the secondary coder's contribution to intercoder reliability testing in Chapter 4, which was coordinated by the primary author. All chapters were written under the supervision of Prof. Ian Rowlands who provided technical and editorial feedback. Chapters 3 to 5 were developed with the intent to be published in peer-reviewed journals. The manuscript for Chapter 5 was published in *Energy Research & Social Science* in February 2021 (Labonte & Rowlands, 2021), and the manuscript for Chapter 3 has also be submitted to a journal for peer-review. Prof. Rowlands is credited as a secondary author for both articles given his contributions. Additionally, this dissertation has benefited from technical and editorial feedback from all committee members, including Prof. Robert Gibson, Prof. Daniel Henstra, and Prof. Andrew McMurry.

Abstract

In the IPCC's (2018) Special Report on 1.5°C, international climate scientists emphasized that increased climate change is expected to impose considerable, wide-ranging impacts on natural and human systems. The Special Report also offers high-level pathways for social and technological change that could be expected to mitigate the risks associated with climate change. Acknowledging that social and technological systems are inextricably linked, the report refers to these pathways as involving socio-technical systems. Sustainability transitions is an emerging field of research that has centred the importance of socio-technical systems (Geels, 2019; Köhler et al., 2019; Markard, Raven, & Truffer, 2012). Sustainability transitions are understood to be inherently political because various actors involved in these processes may contest the overarching goal and/or approach to achieving that goal (Meadowcroft, 2011; Shove & Walker, 2007). While socio-political dimensions are acknowledged to be important for understanding sustainability transitions, emphasizing these dimensions has remained a challenge in the literature (Geels, 2019).

In this dissertation, the contests to reinforce or to reinvent institutional structures that serve to organize actor behaviour are conceptualized as the socio-political dimensions of sustainability transitions. A theoretical framework, the terrain of discursive struggle, is presented with the aim of conceptualizing the range of institutional structures that might be challenged during sustainability transitions and identifying where discursive approaches may be applied to illuminate those institutional struggles. The primary question of the dissertation is: How and to what extent can discursive approaches be applied to understand the socio-political dimensions of sustainability transitions? To that end, three case studies explore the terrain of discursive struggle associated with energy sector transitions by employing varied discursive approaches to analyze data from different discursive forums with distinct contexts.

The first study investigates how monopoly regime actors – namely, local distribution companies and their representatives in Ontario, Canada – understand and communicate potential innovation in their sector. The second study examines the narratives and framing in newspaper coverage of energy storage technologies in California and Hawaii (United States) over nearly a decade (2010 to 2019). The third study explores how Twitter data can inform the study of the socio-political dimensions of sustainability transitions by leveraging tweets that include #ONpoli (a hashtag for discussing the politics of Ontario, Canada) and that reference

energy and electricity issues. A cross-analysis of the three studies reveals broader conclusions related to the terrain of discursive struggle.

Given the wide-ranging implications of sustainability transitions, the terrain of discursive struggle associated with sustainability is necessarily vast: there are many potential institutional structures that will be reinforced or reinvented during sustainability transitions. The terrain of discursive struggle helps to conceptualize the range of socio-political contests associated with sustainability transitions, but it does not identify those contests that are most meaningful to examine. While discourses construct institutions and discursive struggles can reshape institutional structures, not all discursive struggles are accessible to a researcher. Therefore, researchers aiming to understand institutional change associated with a sustainability transition must focus their efforts on specific discursive struggles that are accessible and that they believe will illuminate meaningful aspects of institutional change. Across the studies, this dissertation makes empirical, methodological, and theoretical contributions to knowledge. Collectively, the studies offer insights regarding the application of discursive approaches to understanding the socio-political dimensions of sustainability transitions.

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As my career moves forward, I hope to apply my learnings to urgent sustainability challenges and one day return the generosity that was afforded to me through this academic journey.

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List of Abbreviations

CAISO	California Independent System Operator
CO_2	Carbon dioxide
DER	Distributed energy resource
EDA	Electricity Distributors Association
EST-F	Energy storage technology focus
EST-M	Energy storage technology mention
EST	Energy storage technology
EST-S	Energy storage technology subsection
GHG	Greenhouse gas
GT	Gigatonne
HCEI	Hawaii Clean Energy Initiative
HSA	Honolulu Star-Advertiser
ICR	Intercoder reliability
IOU	Investor-owned utility
KIUC	Kauai Island Utility Cooperative
LAT	Los Angeles Times
LDC	Local distribution company
MLP	Multi-level perspective
NEM	Net energy metering
OEB	Ontario Energy Board
PI	Principal investigator
POU	Publicly owned utility
PUC	Public Utilities Commission
PV	Photovoltaic
PV+B	Photovoltaic with batteries
RE	Renewable energy
SDG	Sustainable Development Goal
SPEED	Socio-political evaluation of energy deployment

Chapter 1 - Introduction

1.1 Research context and problem rationale

Since the industrial revolution, approximately 2569 ± 275 gigatonnes (GT) of carbon dioxide (CO_2) have been released into the atmosphere from anthropogenic sources, including emissions from fossil fuels and land use change (Friedlingstein et al., 2020). Although the majority of these emissions have been absorbed by terrestrial ecosystems and the ocean, approximately 1046 ± 18 $GTCO_2$ have remained in the atmosphere (Friedlingstein et al., 2020). In December 2020, the monthly average atmospheric concentration of CO_2 reached a level of 414 ppm, an increase of 100 ppm (greater than 30% increase) since measurements began at the Mauna Loa Observatory in 1958 (Earth System Research Laroratories, 2021). Cumulatively, these emissions have contributed to an estimated 1°C of average global temperature increases since the pre-industrial era (IPCC, 2018a). The existing warming has had wide ranging impacts that vary regionally and have affected physical systems (e.g., ocean and atmospheric temperature changes, reduction in glacier ice, changing patterns in precipitation, coastal erosion, and sea level rise), marine and terrestrial ecosystems, food production, and human livelihoods, health, and economics (IPCC, 2014).

Greenhouse gas (GHG) emissions are associated with a variety of human activities; however, a significant portion of the crisis can be understood as an energy problem. Most of the GHG emissions increase over the last 50 years is attributable to the burning of fossil fuels for energy (IPCC, 2014). Globally, an estimated 13.98 $GTCO_2e$ GHG emissions are attributed to electricity and heat production annually (IEA, 2018). Across the sectors identified in the International Energy Agency's (2018) accounting, electricity and heat generation is the most significant source of GHG emissions, producing approximately 42% of all emissions. Since 1990, emissions from this sector have increased approximately 83%. This increase can be attributed largely to a significant increase in electricity generated from coal (the largest source of electricity) and natural gas (the second largest source of electricity) over that period (IEA, 2018).

There are diverse strategies suggested for how climate change can be addressed; however, a major reorientation of the electricity and heat sector away from fossil fuel sources will be a necessary component of any climate solution (Armaroli & Balzani, 2011; Davis et al., 2018; Jackson, 2009; NRCan, 2018; Van Vuuren et al., 2018; J. H. Williams, Debenedictis, et al., 2012). Beyond the calls to replace existing fossil fuel-based

electricity generation with non-GHG emitting generation, there is broad advocacy for other sectors that are highly reliant on fossil fuel energy sources – most notably the transportation sector and space heating, but also industrial processes – to be electrified and powered by non-GHG emitting generation (Glenk & Reichelstein, 2019; NRCan, 2018; J. H. Williams, Debenedictis, et al., 2012). Therefore, the need to increase electricity generation could rise significantly – the transportation sector is responsible for approximately 23% of all global GHG emissions and is a sector with high potential for increasing energy demand in the future (Sims et al., 2015) – as could the need to decarbonize various power sectors. To mitigate the worst impacts of the climate crisis the electricity and heat sectors must undergo a massive transformation. Beyond alleviating the negative outcomes, a massive transformation of energy systems could promote positive outcomes, such as ensuring access to affordable and clean energy, as outlined in the SDG 7 (Sustainable Development Goal) (U.N. General Assembly, 2015).

On the international stage, climate change has been recognized as an urgent threat. The Paris Climate Agreement is an international treaty that "aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty" (UNFCCC, 2015, p. 3), which was signed in December of 2015. The agreement, which was adopted by 196 countries, aims to hold global average temperature increase to "well below" a 2°C increase over pre-industrial levels with the aspiration of stabilizing temperature increases at 1.5°C above pre-industrial levels (UNFCCC, 2015). While the agreement recognizes differentiated responsibilities associated with historical GHG emissions and unequal capabilities to reduce emissions in the near-term, all countries committed to developing national emissions reductions targets that would contribute to the international effort.

Despite international recognition of the threat of climate change, the pledges and policies currently in place are not sufficient to contain warming to below 2°C, let alone 1.5°C (Höhne et al., 2017; UNEP, 2020). While the Paris Agreement was intended to rachet up commitments over time, and it is possible that some countries have submitted conservative emission reductions contributions, it is plainly obvious that much more significant emissions reduction efforts will be necessary to reduce climate impacts (Höhne et al., 2017). The most recent (pre-COVID-19) assessment of existing policies estimated warming would increase to 3.5°C by 2100 (UNEP, 2020).

To date, global emissions have continued to increase year-over-year at an average rate of 1.3% since 2010 (UNEP, 2020). Global GHG emissions in 2019, the most recent year with data available, set an emissions

record: 52.4 GTCO2e (without accounting for land-use change) (UNEP, 2020). 2019 was the third consecutive year in which a new global emission record was set. Due to the COVID-19 pandemic, it is expected that GHG emissions in 2020 will not exceed those of 2019; however, those reductions are attributed to an abrupt decline in emissions starting in March and peaking in April when restrictions to limit the spread of COVID-19 were first put in place, rather than any lasting structural shift that suggests an inflection point has been achieved (UNEP, 2020). It is expected that emissions will rebound as the COVID-19 pandemic is controlled, although the scale of the rebound remains to be seen (UNEP, 2020).

1.1.1 IPCC Special Report on 1.5°C

Following the Paris Agreement, the IPCC (2018) released a Special Report on 1.5°C, which compared the expected impacts of 1.5°C to 2°C of warming. This report offered a contrast between the two warming thresholds mentioned in the language of the Paris Agreement, which are, of course, much below the expected warming based on current policies. The main findings from the report emphasized that the consequences across a variety of natural and human systems will be exacerbated with increased warming; however, even at the lower threshold of 1.5°C, the report concluded that climate change would have multiple negative impacts.

The Special Report suggests that increased warming will be associated with a variety of weather extremes, including extreme hot days, and more common and more intense droughts in some regions (IPCC, 2018a). Other areas are expected to be increasingly at risk from heavy precipitation events, which will lead to greater flood hazards (IPCC, 2018a). Increased levels of global warming will also impact oceans, which are expected to increase in temperature and levels of acidification (IPCC, 2018a). These changes are expected to contribute to greater sea-level rise and the disruption of marine ecosystems (IPCC, 2018a). It is expected that oceanic warming will continue to alter marine species' ranges, and, with 2°C of warming, it is predicted that there will be irreversible losses of marine and coastal ecosystems across the globe, including the near complete collapse of coral reef ecosystems (IPCC, 2018a).

Correspondingly, warming has already impacted terrestrial ecosystems and biodiversity, and these impacts are projected to worsen with 1.5°C and beyond to 2°C. The Special Report documents the expectation that many species across phyla will have their geographic ranges constricted (IPCC, 2018a). At 2°C of warming above pre-industrial levels, it is expected that approximately 13% of terrestrial ecosystems, by area, will transform to new biomes (IPCC, 2018a). That is, the biological communities that currently exist in these areas will be completely altered; there will be a shift from one major ecosystem type to another. These changes are

likely to cause localized species loss and species extinctions, resulting in irreversible loss to biodiversity (IPCC, 2018a).

Beyond surveying the negative effects on natural systems, the Special Report also forecast likely implications for human systems. Increased climate change could have wide ranging impacts on human well-being: reducing food and water security, increasing the number of those exposed to poverty by hundreds of millions of people by mid-century, and driving diverse negative heath impacts (IPCC, 2018a). Although the climatic changes associated with greater levels of warming are regional in nature, these impacts are likely to impact disproportionately those populations that are already disadvantaged (IPCC, 2018a). The report describes climate change as a "poverty multiplier that makes poor people poorer and increases poverty" (IPCC, 2018b, p. 245). Communities that rely on fisheries and subsistence agricultural will be placed at risk by expected climatic impacts, and those in poverty are inherently more vulnerable to potential fluctuations in food prices that may result from changing climatic conditions (IPCC, 2018b). Historically, temperature increases have resulted in agriculture dependent community migration, although the Special Report identifies future migration as a gap in current knowledge (IPCC, 2018a). In addition to potentially threatening livelihoods of vulnerable populations, there are indications – although the relationship is inconsistent – that warming temperatures could increase the potential for sustained conflict (IPCC, 2018a). Impacts such as regional drought increase the potential for conflict, particularly in regions where vulnerable communities rely on agriculture for livelihoods and subsistence (IPCC, 2018b). Global warming is expected to cause wide ranging, and potentially overlapping and cascading, impacts on ecosystems, livelihoods, human well-being, and economies.

Suffice to say, the Special Report presented a broad range of risks associated with even half a degree of additional warming from current conditions and emphasized that most of these risks would increase further with greater warming. While there is potential to adapt to many impacts and risks associated with climate change, the report suggests that our collective adaptive capacity will reach limits in relation to certain ecosystems, sectors, and vulnerable regions with 1.5°C of warming (IPCC, 2018a). In addition, the report advises that, based on current GHG emission rates, global temperatures were likely to reach that threshold of 1.5°C of warming between 2030 and 2052 (IPCC, 2018a). Although this report presented 2°C of warming as the high-end of the comparison, this outcome is in no sense a worst-case scenario. Based on current policies, 3.5°C of warming are expected. To limit warming to 2°C and to *only* have to deal with the dire risks presented in this

report – that is, to face impacts beyond our collective adaptive capacity – will require unpresented, concerted global effort to transform energy systems and human impacts on the climate more broadly.

Beyond laying out the risks associated with increased warming, the Special Report also presented potential pathways for limiting warming to 1.5°C above pre-industrial levels, by the end of the century (IPCC, 2018a). These pathways provide high-level descriptions of social and technical approaches that could limit GHG emissions and eventually reach net zero emissions. In Figure 1-1 a selection of modeled pathways are plotted showing the trajectory of global CO_2 emissions by year that could, with a 50% percent chance of realization, limit warming to 1.5°C compared to pre-industrial temperatures.

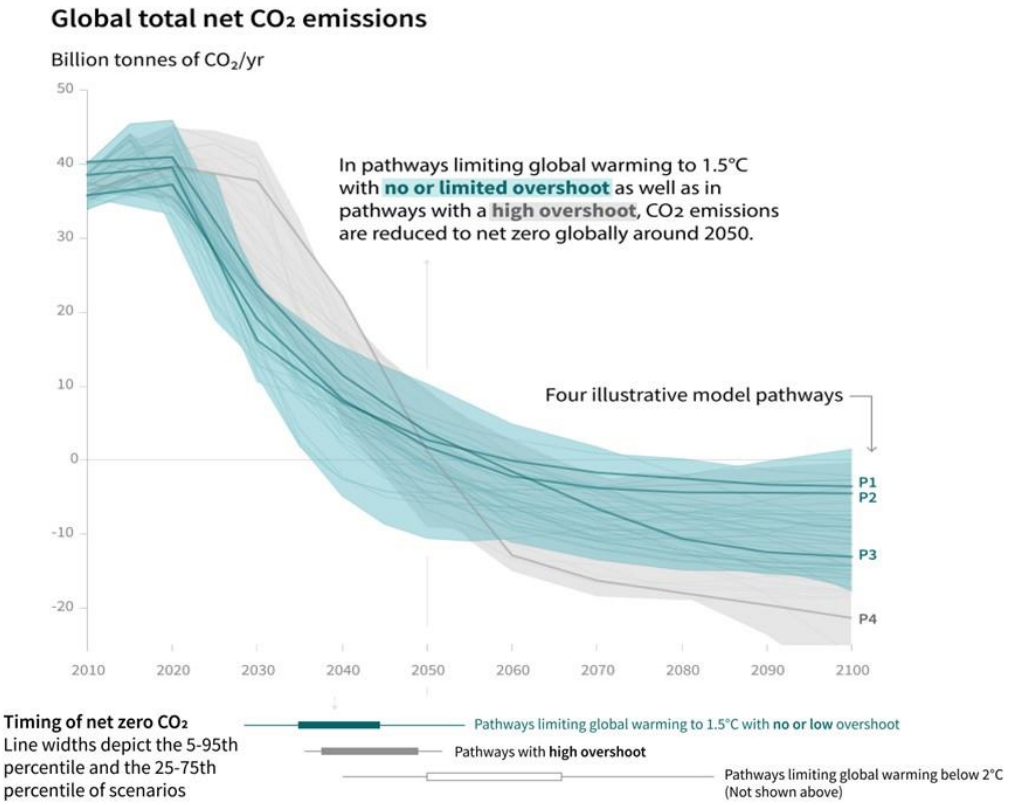

Figure 1-1 - IPCC Special Report pathways to 1.5°C of warming (IPCC, 2018a, page 18)

All the pathways consistent with limiting warming to 1.5°C, as presented in the report, require immediate action and, in particular, a rapid transformation of the global production and use of energy and increased electrification (IPCC, 2018b). Rather than exclusively considering the deployment of technology to achieve the mitigation pathways, the IPCC (2018b) describes the need for socio-technical transitions, acknowledging that technological change is "inextricably linked" to social systems. The Special Report states

that to deploy technology at a commensurate scale to the challenges posed by climate change will require that social institutions, such as markets, rules and regulations, and less formal norms, be reorganized to enable pathways that would be consistent with limiting warming to 1.5°C (IPCC, 2018b). In this report, the IPCC frames the effort to mitigate the wide ranging negative potential impacts of climate change around socio-technical transitions (2018b).

1.2 Socio-technical transitions

Research regarding socio-technical transitions has been growing since the early 2000's (Geels, 2002, 2004; Markard et al., 2012; Rip & Kemp, 1998). This literature explores the long-term transformation of technological systems and the relationship between social systems and technological systems (Geels, 2004; Hughes, 1987; Markard et al., 2012; Rip & Kemp, 1998). Socio-technical systems operate to meet specific societal functions (e.g., energy, transportation, waste management, food distribution) and are composed of three main elements: actors (and actor networks), institutions, and technological systems (Geels, 2002, 2004). These three main elements develop in a complementary fashion to form socio-technical systems. This complementary development is commonly described as the co-evolution of regime elements. As a technological system is deployed to serve a social function, actors and actor networks develop to use and deploy that technology and rules, norms, and values develop to allow that technological system to service the societal funtion. Through this co-evolutionary construction, the social-technical systems' inertia grows and resists change (Loorbach, Frantzeskaki, & Avelino, 2017). Rather than considering technological diffusion in isolation, the socio-technical transitions literature highlights the complementary relationships among technology, actor networks and institutions that influence technological change (Markard et al., 2012). Together the established actor networks, institutions, and technology are referred to as the regime (Geels, 2011; Geels, 2004; Rip & Kemp, 1998).

A core component of the perspective presented in the socio-technical transitions literature is that technological systems are, as the IPCC asserts, inextricably linked to social systems. Therefore large-scale technological change from one dominant socio-technical system to another requires technological innovation in addition to complementary change in social systems, such as the emergence of new actor networks and new social institutions, which facilitate the deployment of new technology. Several early studies applying the socio-technical transitions perspective aimed to describe and illuminate the interactions between social and technical systems in historical multi-decadal transitions across a variety of sectors: energy systems (Raven, 2007; Raven

& Verbong, 2007; van der Vleuten & Raven, 2006; Verbong & Geels, 2007); mobility systems (Geels, 2005b, 2007a); water management systems (Geels, 2005a; Van Der Brugge, Rotmans, & Loorbach, 2005); and even musical innovations (Geels, 2007b). Across these diverse contexts, transitions were described as complex processes in which niche innovations gradually (and sometimes rapidly) established dominance, broadly shifting how that particular social function was achieved in a specific region. The studies emphasized the reoccuring connection between the technological change being studied and the social systems that co-evolved – enabling and reinforcing – with innovations in various sectors.

1.2.1 SUSTAINABILITY TRANSITIONS

Beyond describing historical socio-technical system transitions, researchers identified common dynamics that influence transitions processes and representative typologies to describe transitions (Berkhout, Smith, & Stirling, 2004; Geels & Schot, 2007; Hughes, 1987; Markard et al., 2012; Verbong & Geels, 2010; Walker, 2000). Additionally, researchers considered how knowledge of transitions processes could be applied to achieve desired social outcomes, most notably sustainability (Markard et al., 2012; Rotmans & Loorbach, 2009; Smith & Stirling, 2010; Smith, Stirling, & Berkhout, 2005; Voß, Smith, & Grin, 2009). Rather than simply offering an illuminating lens for understanding historical innovation, there was a desire to apply knowledge about socio-technical systems to shape transitions and achieve important social goals. Sustainability transition emerged as a field of research that aimed to inform socio-technical transitions towards specific objectives and to address social and environmental challenges (Markard et al., 2012). Although the IPCC describes the climate change mitigation efforts (so as to achieve the 1.5°C target) as socio-technical transitions, the fact that the pathways proposed have an explicit goal of limiting warming to 1.5°C in the context of achieving sustainable development goals means that these pathways are more accurately described as sustainability transitions.

In contrast to historical socio-technical transitions, sustainability transitions have a broad normative goal (i.e., sustainability) that is expected to guide what is understood to be a complex process of interactions among technological systems, actors, and institutions. While it is true that previous socio-technical transitions involved actors with normative perspectives driving their behaviour, historical transitions were not guided by a comparable, globally focused, overarching collective normative goal.

One challenge recognized in the literature is that normative goals can be contested by various actors who perceive the problem or the solutions differently, or who have differing incentives and attitudes (Meadowcroft, 2009, 2011; Shove & Walker, 2007). Considering the potential pathways presented in the IPCC

Special Report, all these modelled pathways presume large-scale, historically rapid, multi-sector changes. In application, these modelled approaches to meeting the target of 1.5°C of warming would entail wide-ranging implications and would require collective decision-making and action to achieve. While there may be large aggregated benefit in limiting global warming, distribution of costs and benefits in a sustainability transition will vary greatly across any number of scales: international, national, industrial sectors, regions, individuals (Meadowcroft, 2011). These various pathways involve trade-offs that will impact different actors unevenly. Additionally, given the large number of actors involved in these processes, not all actors will interpret objectives and needs for sustainability transitions in the same way. Because sustainability transitions have a normative goal, which may not be shared by all implicated in the process, they are inherently political: they rely on social decision-making and shared objectives that are open to contestation. To what extent, for instance, should nuclear energy be considered a legitimate contribution to sustainability-based energy plans? Where should solar generation be located and at what scale? How should transmission networks be planned and deployed? How should consultation with impacted communities be balanced with need for rapid deployment of energy technologies? Who should profit from sustainable energy transitions and to what degree? To what extent should the potential for future technologies that could remove greenhouse gases from the atmosphere inform current decision-making? Fundamentally, even with broad collective agreement to achieve the goals set out by these pathways to 1.5°C of warming were achieved, an optimist expectation, the specific trade-offs towards such a goal would remain ripe for contestation. While there are technological gaps in knowledge that may limit the sustainability transitions required to achieve 1.5°C of warming, the far more fundamental gap remains understanding how social decision-making towards such a goal might be built and maintained on an unprecedented scale.

Investigating the institutions – the rules, norms, values – that guide actor behaviour provides a means of understanding the socio-political dimensions of transitions (Geels, 2011). As transitions take place, new rules, norms, and values are established that empower new technological systems and actors and actor networks. However, institutions are socially constructed (Garud, Hardy, & Maguire, 2007; Genus, 2016; Lawrence, Suddaby, & Leca, 2011). The rules, norms, and values that structure how actors operate are constructed, negotiated, reinforced, and remade through conscious and unconscious social decision-making (Farla et al., 2012; Genus, 2016). Thus, one way of understanding the socio-political dimensions of sustainability transitions can be understood as understanding how institutions are evolving in transitions processes.

Discursive approaches provide a means to investigate institutions because institutions are discursive products (Genus, 2016; Hajer, 1995; Phillips et al., 2004; V. A. Schmidt, 2008). Institutional structures are socially constructed, and the various actors in social systems create and recreate these structures through social interaction. By examining the competing discourses that actors share, it is possible to illuminate institutional structures and potentially to identify when institutional structures are being changed. A number of researchers have begun to apply discursive approaches to enhance the understanding of sustainability transitions (Isoaho & Karhunmaa, 2019; Köhler et al., 2019). However, there are a variety of discursive approaches and there are vast potential applications for these approaches when aiming to understand sustainability transitions.

Given that sustainability transitions are necessary to mitigate climate change, that these processes are known to be inherently political, and that understanding of socio-political dimensions of sustainability transitions remains a challenge, there remains an opportunity to further investigate the extent to which discursive approaches can be applied to advance understanding of socio-political dimensions of sustainability transitions.

1.3 Research question

The overarching challenges associated with responding to climate change and developing a sustainable future have mobilized research in diverse scholarly fields. The transitions literature, which provides a foundation for my research, has increasingly moved away from exploring socio-technical transitions more generally to examining transitions towards the broad goal of *sustainability*. This literature has much to offer in terms of conceptualizing the interrelation of technological and socio-political change. However, despite acknowledging the importance of socio-political dimensions in transitions, the literature has not established sufficient means to understand the socio-political change involved in transitions. Discursive approaches present promising means for examining socio-political institutions and institutional change, both of which are critical components of transitions.

My dissertation asks how, and to what extent, can discursive approaches illuminate socio-political dimensions of sustainability transitions? The research in this dissertation applies discursive approaches in a variety of energy sector contexts and contemplates the diverse range of potential applications of discursive approaches across sustainability transitions research.

1.4 DISSERTATION OVERVIEW

This dissertation explores how discursive approaches, through various methods, can inform the understanding of the socio-political dimensions of sustainability transitions. To this end, the research in this dissertation is based on three case-studies that each rely on discursive approaches to examine the socio-political dimensions of energy sector sustainability transitions (or potential sustainability transitions).

The following chapter (Chapter 2) reviews the literature regarding socio-technical and sustainability transitions and assesses how discursive approaches can reveal institutional change in these processes. A theoretical framework, referred to as the terrain of discursive struggle, is presented which aims to conceptualize the range of institutional structures that might be challenged during sustainability transitions and where discursive approaches may be applied to illuminate those institutional struggles. Chapters 3 through 5 cover distinct studies, which apply discursive approaches to explore the socio-political dynamics of various energy sector transitions. In Chapter 3, discourse analysis is applied to identify how monopoly electricity distribution actors understand and communicate the potential for innovation in their sector. In Chapter 4, media coverage of energy storage technology from two jurisdictions is examined to identify the evolution in themes over a decade of technological deployment and to compare how those technologies are framed. In Chapter 5, the framing of energy politics and associated user activity on the Twitter platform is explored. In Chapter 6, the results from the three studies are analyzed to identify broader conclusions related to how discursive approaches can be applied to sustainability transitions research and to consider the collective results. Because the three case-studies have differing subjects and approaches, their collective review and analysis across different dimensions offers a variety of insights regarding the terrain of discursive struggle and how this might inform the understanding of socio-political dimensions of sustainability transitions. The significance of specific research findings and extrapolations to policy implications and future veins of research are described in chapter 7, which concludes the dissertation.

The risks associated with climate change and the broader imperative to pursue sustainability require that energy systems be transformed rapidly and on an unprecedented scale. Through the application of discursive approaches, this dissertation aims to illuminate the socio-political contests that accompany technological transformations.

Chapter 2 - Literature review and theoretical framework

2.1 Introduction

In this chapter, I review the relevant literatures and construct a theoretical framework that underpins my dissertation. In the following sections, I review existing scholarship regarding sustainability transitions and highlight some key concepts in the literature. I first provide background on socio-technical transitions, sustainability transitions, the multi-level perspective, and discuss limitations and trade-offs that have been noted in the literature. Subsequently, I home in more specifically on the socio-political dimensions of sustainability transitions, namely the conceptualizations of collective decision-making, institutions, actor agency, and institutional work. I then describe the relationship between discourse and institutions, and how the examination of discourse can illuminate institutional changes. In the closing portion of this chapter, I consider how discursive approaches might be applied to understand sustainability transitions. This builds a concept referred to as the terrain of discursive struggle, and I then describe how the studies in this dissertation are organized to explore diverse aspects of this terrain of discursive struggle related to energy sector transitions.

2.2 Socio-technical transitions

Socio-technical systems develop when technological systems are deployed to service specific societal functions. As technological systems develop, actors gain experience and knowledge of the system and institutional structures are established to enable continued functioning. As the technology matures, the associated actors and institutional structures advance in tandem. The technological systems influence the associated social systems – the actors and the institutional structures – but, conversely, the associated social systems shape the technological system. An established socio-technical system is referred to as a regime (Geels, 2011; Geels, 2004; Rip & Kemp, 1998). It is composed of three core elements: the technological system, the actors (or networks of actors), and institutional structures – the rules, norms, and values that guide actor behaviour. As socio-technical systems become more established, the technological systems, actors, and institutional structures co-evolve: each element reinforces the establishment of the other associated elements.

The socio-technical transitions literature explores transformation of socio-technical systems, which are typically understood as long-term processes (Geels, 2004; Hughes, 1987; Markard et al., 2012; Sovacool,

2016). Socio-technical transitions are understood to be complex processes; however, there are a number of common characteristics that typically describe transitions. Socio-technical regimes are typically characterized by inertia or path dependence, which develops for several reasons. Firstly once a technological system is established within a regime, some degree of lock-in develops; sunk investments discourage radical change away from the established system (Unruh, 2000; Walker, 2000). In addition to investment, as actors make use of technological systems, rules, norms, and values, and practices develop that create efficiencies associated with the technological systems that is in place; to shift to a new technological system would require developing new rules, norms, and values, and new practices, which would involve time and commitment (Arthur, 1989; Berkhout, 2002; Geels, 2004; Smith et al., 2005). These reinforcing relationships between the technological system, the various actors' experience and commitment to that system, and the associated institutional structures that develop to organize actor behaviour in relation to the technological system describe the co-evolutionary dynamics of regime development. As a result of these co-evolutionary dynamics, socio-technical systems tend to evolve incrementally over time and resist radical regime change.

Despite regimes typically being characterized by stability and path-dependence, the concept of a *transition* is generally defined as a major shift in the orientation of the regime, which includes the reorganization of different elements within the regime; this may include the development of new institutional structures, the integration and empowerment of new technological components, or new actors (Geels, 2010). Transitions are uncertain (Köhler et al., 2019). Because regimes are multi-dimensional, including diverse technological components, actors, and institutional structures, they are subject to complex system interaction that are not always predictable. Additionally, established socio-technical regimes can be destabilized by external pressures or disruptive innovation and thus regimes that were perceived as stable can change, possibly quite rapidly (Geels & Schot, 2007; Verbong & Geels, 2010). As such, transitions are understood as non-linear processes.

Because regimes are dynamic multidimensional systems that are understood to evolve over time, defining *when* a transition has taken place is a somewhat ambiguous. Some researchers have tried to establish quantifiable measures to define transitions based on technology market share, while others have suggested the breaking away from path dependency should be the test of a transition, the development of emergent properties, or *radical* changes in regime structure (de Haan & Rotmans, 2018; Grubler, Wilson, & Nemet, 2016; Sovacool, 2016; Sovacool & Geels, 2016; Svensson & Nikoleris, 2018). All these definitions are challenged in

their own way and can be difficult to operationalize. Across the literature, there is no clear consensus on the definition of a transition; rather cases are evaluated in their specific contexts.

Generally, transitions are discussed as long-term processes that are measured in decades (Grubler, 2012; Markard et al., 2012; Sovacool, 2016). However, the socio-technical system of interest and the context of the regime are understood to influence the potential dynamics of a transition. Grubler et al. (2016) note that complex technical regimes with multiple interdependent technological components and infrastructure, as well as those regimes that are developing 'novel' concepts, rather than applying tested concepts in a new market, tend to proceed relatively slowly and are likely to be measured in decades. Transitions centred on end-user technology that makes use of existing infrastructure, or transitions involving 'spillover' markets, where knowledge from outside markets is applied under new conditions, can occur more rapidly. Additionally, under the appropriate political conditions – often the example of major wars is given, though the marshalling of resources to respond to a pandemic may be a more timely example – resources can be mobilized to achieve specific goals and can direct a transition process with greater urgency (Bento & Wilson, 2016; Grubler et al., 2016; Sovacool, 2016). Although there are some general concepts regarding the pace of socio-technical transitions, in practice, each socio-technical transition will be dictated by the specific, and complex, context of the system being examined.

2.3 Sustainability transitions

Conceptually, the socio-technical transitions lens could be used to describe any socio-technical system change. Increasingly the literature focuses on *sustainability transitions* that have an explicit normative goal of supporting transitions towards sustainability (. Sustainability is a multifaceted concept that includes ecological, social, and intergenerational components. The concept of sustainability is prominently connected with the Brundtland Commission Report, *Our common future*, which defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). Establishing the social needs and ecological limits necessary for sustainability is complex and open to contestation (Connelly, 2007; Meadowcroft, 2007, 2009). Various researchers have attempted to outline key metrics of sustainability while acknowledging deep uncertainty and cross-scale challenges associated with defining ecological boundaries and social needs (Raworth, 2017; Rockström et al., 2009; Steffen et al., 2015). Despite the measurement of diverse metrics, sustainability should be recognized as

an integrated concept (Gibson, 2009); these diverse metrics reflect measures of interrelated and interconnected aspects of a complex system. Given the current state of ecological systems and social equity, achieving sustainability will require major change in socio-ecological systems. Sustainability transitions is one of several research streams that has emerged to understand social transformations in response to sustainability challenges (Blythe et al., 2018; Geels, 2019; Hölscher, Wittmayer, & Loorbach, 2017). Collectively, this broader research agenda has been termed as sustainability transformations (Blythe et al., 2018; Hölscher et al., 2017).

The concept of sustainability transformation is associated with major restructuring of social systems (Blythe et al., 2018; Hölscher et al., 2017). Rather than incremental changes, transformations refer to systems undergoing a qualitative state change (Loorbach et al., 2017). Within the literature there are competing descriptions of sustainability transformation research and subdivisions of research streams contained within (Blythe et al., 2018; Feola, 2015; Loorbach et al., 2017; Schneidewind & Augenstein, 2016). Sustainability transitions research is distinguished from other research streams examining sustainability transformations by established methodological tools, such as the multi-level perspective (MLP) (detailed below) or technological innovation systems (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008), and a research orientation that typically examines socio-technical systems (Blythe et al., 2018; Hölscher et al., 2017); this contrasts with other sustainability transformation research that examines broader socio-ecological systems, for which socio-technical systems would be considered a subsystem (Blythe et al., 2018; Loorbach et al., 2017).

Sustainability transitions research typically focuses on understanding transformations associated with a specific societal function rather than those associated with macro-scale sustainability debates, for example, regarding capitalism, growth, and the nature of socio-ecological interactions, as well as micro-scale sustainability debates, such as individual behaviour change, consumer choice, or individual psychological orientations to sustainability issues (Köhler et al., 2019). Though not without its limitations, the socio-technical perspective utilized in the transitions literature offers a valuable lens for examining energy systems. As such, this dissertation uses the sustainability transitions literature as a foundation.

2.4 The multi-level perspective

The MLP is a central approach used to conceptualize socio-technical transition dynamics in the transitions literature (Geels, 2019; Loorbach et al., 2017; Markard et al., 2012). The MLP is used to identify the dynamics of transitions, such as the relationship between a socio-technical transition and the role of

innovation, or how major socio-political or socio-ecological events can influence regime change. The MLP characterizes transitions using three analytical levels: regime, niche, and landscape or meso, micro, and macro (Geels, 2011; Geels, 2004; Rip & Kemp, 1998).

- The regime, at the meso-level, defines the socio-technical regime as described above. It reflects the incumbent socio-technical system with the associated institutional structures, actors and actor networks, and the material technological system that provides a specific societal function. The actors within the regime include firms, policymakers, and users, and their actions are influenced by the rules, norms, and values – the institutional structures – that have been established over time through the development of the regime. As a result, the regime tends to evolve incrementally and resist radical change.
- The niche, at the micro-level, is interpreted as a space for innovation. Innovations that could potentially compete with the regime to provide the same societal function develop within the niche level. Initially innovations at the niche level are protected from competing directly with the regime technologies. Protected environments commonly develop passively where there is no direct competition with the regime, or they can also be actively created (Smith & Raven, 2012). It is expected that in the early stages of development, niche innovations may lack infrastructure or be unable to compete based on performance or cost, which is why they are protected from direct competition (Geels, 2004; Schot & Geels, 2007; Sorrell, 2018). Over time, innovations at the niche level mature. For example, as an innovative technology improves, actors may begin to form networks and potentially establish enabling institutional structures. As these niche elements develop, the niche can begin to compete with or potentially replace the regime. However, the niche level is understood to be more volatile: innovations sometimes fail; networks do not always form; institutions may not develop to complement technological applications.
- The landscape, at the macro-level, represents the larger socio-ecological system within which the regime operates. The landscape includes the larger political, cultural, economic, and environmental context. While changes in the landscape, either gradual or rapid, have an impact on the regime, the regime actors are perceived to have little influence on the landscape. The landscape provides a macro-level context which is reflected in the institutional elements – the rules, norms, and values – that describe the regime.

The hierarchy of levels in the MLP is used to represent levels of stability. While the niche level may be relatively turbulent – innovations develop then fail and actor networks briefly form then dissolve – the regime is self-reinforcing, and although the system is dynamic, those changes tend to support the existing technology, actors, and institutions. The landscape is governed by entrenched ideas that are not easily influenced by the regime (Geels & Schot, 2007). However, the whole system is also considered to be complex and non-linear; therefore, unpredictable and perhaps dramatic changes are possible (Loorbach et al., 2017). The transition process, as understood by the MLP, is the result of context and timing of interactions among the MLP layers (Geels & Schot, 2007; Schot & Geels, 2007). The landscape can put pressure on the regime to change and create windows of opportunity for niche innovations within the regime. The type, or severity, of the pressure applied from the landscape on the regime and the stage of development of niche innovations during those windows of opportunity have been used to characterize a typology of potential transition pathways (Geels & Schot, 2007). Figure 2-1 provides an oft-cited graphical representation of the MLP on socio-technical transitions.

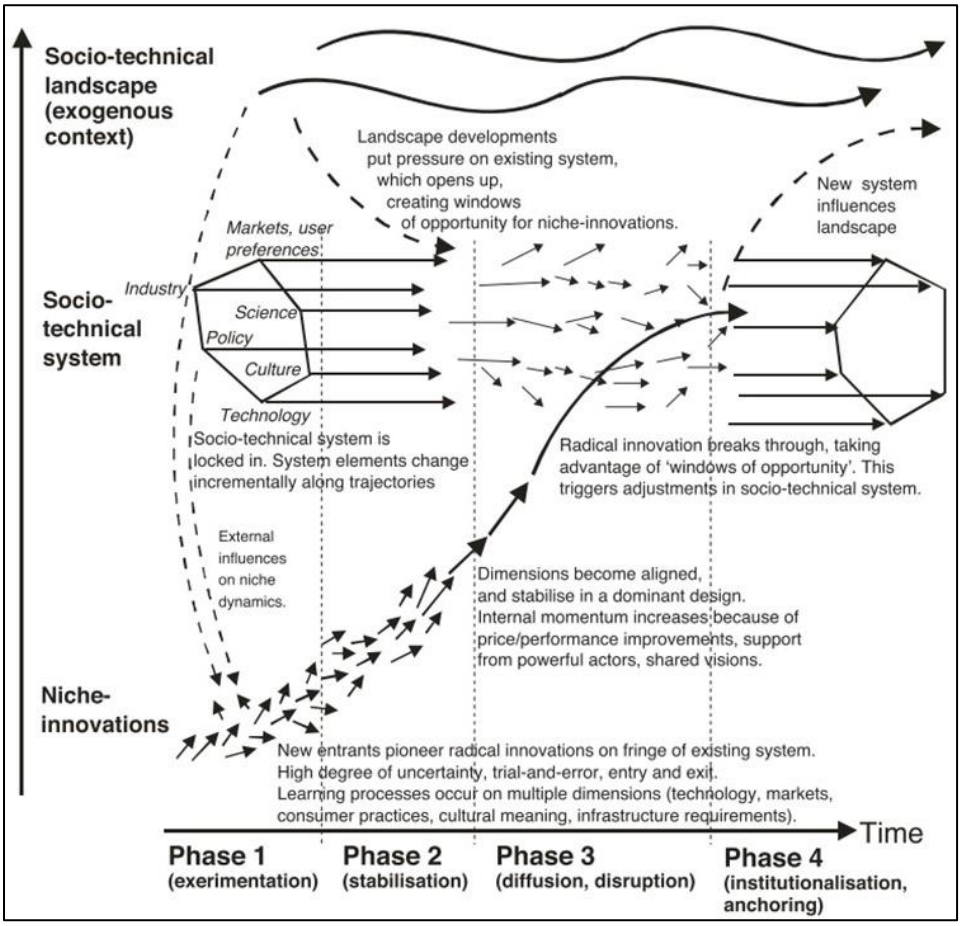

Figure 2-1 - The MLP on socio-technical transition, from (Geels, 2019)

2.5 LIMITATIONS AND TRADE-OFFS

While the MLP has been used extensively in the transitions literature, several weaknesses to this approach have been noted. The MLP is described as a 'heuristic device' that is intended to guide the examination of transitions (Geels, 2012; Sorrell, 2018). Rather than acting as an explanatory theory, the MLP may help to identify patterns or mechanisms of significance in transitions. Although the MLP is widely applicable across diverse studies, the design of the heuristic emphasizes certain mechanisms for change, such as niche innovation, while other components of these complex, decades-long transition processes are, perhaps necessarily, less well examined (Meadowcroft, 2009; Shove & Walker, 2007; Sorrell, 2018) though they may be more common. As such, the MLP has been described as innovation biased (Geels, 2019). Due to the organization of the MLP, transitions are more likely to be described as competitions between established regime actors and niche level innovators and to emphasize specific mechanisms of regime change, often emphasizing the role of innovation.

The heuristic nature of the MLP also means that the regime and niche of a socio-technical system are defined by the particular socio-technical system being studied (Avelino, 2017). The flexibility of the MLP as a tool of analysis has allowed the approach to be widely applied but consistency in defining regime and niche components in transitions vary across studies (Sorrell, 2018). Additionally, the definition of the regime and the appropriate boundaries for such a concept have been criticized for lacking conceptual clarity (Sorrell, 2018; Svensson & Nikoleris, 2018). Because the definition of regime, niche, and landscape are open to interpretation, two or more studies examining the same socio-technical system of interest could define each of these MLP components differently. The boundaries between regime, niche, and landscape are thus conceptually fuzzy.

Another challenge with the MLP relates to adequately measuring the impact of socio-technical system change in relation to sustainability. The MLP focuses on socio-technical systems, and it obscures the interactions with outside systems as landscape interactions, but ultimately sustainability is achieved beyond the scale of a socio-technical system (Avelino, 2017; Rosenbloom, 2020). Because sustainability is multi-dimensional and multi-scalar, determining overall sustainability impacts while focusing on a single system of societal function will always be imprecise. As a result, sustainability transitions research has often assumed the diffusion of certain niche innovations as supporting sustainability objectives without actually accounting for the sustainability outcomes (Geels, 2019).

The MLP and sustainability transitions more broadly tend to focus on ecological rather than social aspects of sustainability (Geels, 2019; Köhler et al., 2019). Prominent sustainability transitions articles have not prioritized equity and justice dimensions of sustainability, for instance (Geels, 2019; Geels, Benjamin, Schwanen, & Sorrell, 2017; Markard, 2018). There have been recent efforts to more explicitly integrate principles of justice within sustainability transitions frameworks and the MLP specifically (Jenkins, Sovacool, & McCauley, 2018; Sareen & Haarstad, 2018). Jenkins et al. (2018) note the 'practical pitfalls' that limit the extent to which justice implications can be fully integrated into the MLP. While it is possible to conceptualize how these considerations could be applied, the MLP may not be well-suited to efforts to embed these concerns; this relates to broader challenges associated with conceptualizing social decision-making, contested objectives, and politics in sustainability transitions frameworks (Meadowcroft, 2009; Shove & Walker, 2007). The MLP's emphasis upon innovation, and framing around socio-technical systems, may simply prioritize the physically-quantifiable elements – the technical systems – and downgrade less easily quantified social elements. Yet, one of the fundamental concepts within sustainability transitions is that the focus should be on understanding socio-technical systems. Therefore, an important consideration for moving the literature forward is how to conceptualize and prioritize investigations of the socio-political dimensions of transitions.

2.6 Politics of sustainability transitions

At the core of sustainability transitions research is a normative goal: sustainability. The study of sustainability transitions aims to contribute to major reorganizations of socio-technical systems in support of sustainability. Ultimately, sustainability transitions will require collective decision-making that influences social trajectories. This will be true in relation to countless potential collective decisions that reshape socio-technical systems in the service of sustainability. Given this reality, the long-standing critique that sustainability transitions literature does not adequately conceptualize socio-political dimensions of transitions is a meaningful gap to explore further (Markard et al., 2012; Meadowcroft, 2009; Shove & Walker, 2007).

The socio-political dimensions of sustainability transitions describe all the potential social decision-making that influences socio-technical transitions; these include *Political* contests involving government actors who establish rules with potential for state sanctions as well as *political* contests involving collective decision-making unassociated with state power. Social decision-making may take the form of formal, deliberative processes, but social decision-making can also emerge relatively unconsciously, because of collective action.

These socio-political dimensions permeate sustainability transitions. Geels (2011), a prominent sustainability transitions researcher and a proponent of the MLP, has suggested that, despite the criticism, these socio-political dimensions are recognized within the literature. One means of conceptualizing these socio-political dimensions of sustainability transitions is to consider the roles of institutions and how these evolve through time.

2.7 Institutions and agency in transitions

The socio-technical transitions literature emphasizes institutions as a key concept for understanding the regime and its interaction with the niche and landscape (Garud & Gehman, 2012; Geels, 2010; Markard et al., 2012). In the papers that have aimed to describe the ontological foundations of transitions, numerous boundedly rational actors – the actors that have limited information and are subject to cognitive biases (Gazheli, Antal, & van den Bergh, 2015; Kahneman, 2003) – are presented as responding to differing contexts and a dynamic system; the rules, norms, and values and cognitive frameworks of the established institutions are described as shaping actor behaviour and limiting what is considered legitimate (Geels, 2011; Geels, 2010). Within the MLP conceptualization, institutions – or the rules, norms, and values that govern the regime – are presented as one of three main components of a socio-technical regime, as well as actors and networks, and the technological system.

As a regime is established, institutions co-evolve with the technological system and the actors to create efficiencies and organization that reinforce the regime (Arthur, 1989; Geels, 2004; Hughes, 1987; North, 1991). The institutions, which facilitate the organization of actors and efficiencies, establish rules that guide actor behaviour and acceptable technological design and operation. While the shared norms and values of the socio-technical regime define acceptable practice and foundational principles that may be less formalized, they nonetheless shape perspectives and influence strategies. Institutions in this sense can refer to formal organizations or firms, but the concept, as it is understood in this dissertation, is much broader in scope; institutions refer to the broad range of ways that shared rules, norms, and values shape legitimate behaviour across social systems (Genus, 2016). The institutional structures of the regime create lock-in and emphasize the path dependence of the regime. However, regime actors are not solely informed by the institutional structure of a socio-technical system. Regime actors will be part of numerous social institutions that will structure their behaviour to varying degrees depending on the context. Therefore, while the institutional structures of the

regime impact actor behaviour and technological deployment, these institutions are not necessarily the sole institutional structure influencing regime actor behaviour.

Given the emphasis on institutional structures in the MLP, there have been persistent calls to further explore the role of actor agency in transition processes (Avelino & Wittmayer, 2016; L. B. Fischer & Newig, 2016; Genus & Coles, 2008; Markard et al., 2012); however, proponents of the MLP have suggested that the MLP already emphasizes agency and actor networks in the transition process (Geels, 2011), thus suggesting that while institutional structures are important for understanding regimes, and transitions, these structures do not fully control actor agency.

More recently, there has been an increased effort to explore how actor strategies and behaviours can reshape institutions. The conceptual understanding of *institutional work* and *institutional entrepreneurship* has been mobilized to explain actor behaviour in transitions (Brown et al., 2013; Farla et al., 2012; Garud et al., 2007; Lawrence et al., 2011; Rosenbloom, 2018). These conceptualizations suggest that while institutions establish rules, norms, and values that structure actor behaviour, those structures are not absolute: actor agency can defy these structures. Because they are socially constructed, institutions can be renegotiated collectively. While institutions establish boundaries that can limit what is perceived as legitimate actor behaviour, within the legitimate space there can be potential for a variety of actor perceptions, values, and strategies. In this interpretation, actors have agency that is structured by their institutional context, but actors can and do use their agency to maintain or challenge the structures that they are bound by (Farla et al., 2012; Garud et al., 2007; Lawrence et al., 2011). The effort put forth by actors to reinforce or reshape their institutional settings offers an opportunity to explore how, or if, institutions are being contested.

2.8 Discourse and institutions

Discourse analysis offers a means to explore *how* institutional work takes place. Institutions are self-regulating social organizations that shape legitimacy for actors. The rules, norms, and values – both conscious and unconscious – of institutions facilitate (and direct) social cooperation by structuring acceptable behaviour and thinking, and they are created and maintained through social interaction. The concept of institutional work suggests that, within those structures, actors have capacity to reshape the boundaries of what is acceptable through 'work' (Lawrence et al., 2011). Institutional structures do not deterministically guide actor behaviour, but rather actor agency exists and operates within the context of institutional structures, which constrain and

enable agency. Institutional work involves actors actively changing the social structures, although these activities may or may not be conscious efforts to reshape institutional structures. Discourse analysis has been championed as a means for examining how institutions are produced, maintained and reshaped; how they are 'worked' (Hajer, 1995; Phillips et al., 2004).

Discourse refers to how actors communicate, share ideas, and present how they understand the world. While some definitions of discourse focus primarily on the use of language, in social constructionist terms, discourse is perceived as the fundamental elements of social organization. Discourse does not just represent how actors express themselves or communicate; discourse projects ideas that impact how actors think and make sense of social and physical phenomenon, and then additionally how those actors reproduce those concepts by articulating them (Mills, 2004). Discourse plays a fundamental role in social organization and understanding of the world.

From a theoretical standpoint, this dissertation refers to Hajer's (1995) definition of discourse. Rather than simply considering language, discourse is defined as "a specific ensemble of ideas, concepts, and categorizations that are produced and reproduced and transformed in a particular set of practices and through which meaning is given to physical and social realities" (Hajer, 1995, p. 44). In this definition, discourse permeates all aspects of social interaction. Both language and practice are influenced by discourses, reproduce discourses, and share discourses. A discourse establishes the appropriate types and the presentations of knowledge that are socially accepted as valid within various institutional contexts. It is through the reproduction and sharing of discourses that actors make sense of competing ideas to understand social and physical phenomena.

Hajer (1995) presents an argumentative-theory for exploring how discourses compete to establish acceptable understandings of the world or quite specific parts of it. Discourses are embedded in and construct social interaction, and competing discourses struggle to frame and describe reality (Sharp & Richardson, 2001). As various actors communicate, they share assumptions and judgements about knowledge and perceptions of the world (Dryzek, 2005). Because discourses contain shared and competing assumptions and judgements, they frame how analysis should be applied to issues or ideas in specific ways. Given the competition to frame and understand the world, discourses can be conceptualized as struggling for superiority, including to define concepts, the relative importance of concepts, appropriate framings, and the exercise of more direct influence in decision-making. I will refer to the competition of discourses as discursive struggle.

How discursive struggle takes place should be understood within an institutional context (Hajer, 1995). The social structures of institutions limit and enable acceptable discursive struggles. Within different institutional settings, ideas will require different presentations to be accepted as legitimate. Phillips et al. (2004) argue that institutions not only shape discourse, but are discursive products themselves, and that the rules, norms, and values that construct institutions are the product of shared institutional discourses. As discursive struggles take place, social structures are adjusted, reframed, reproduced or transformed (Hajer, 1995). Past institutional structures, which establish legitimate discourse, shape the arena for current discursive struggles (Phillips & Hardy, 2011). Since institutions are discursive products, it is possible to examine institutional work – the modifying of institutional rules, norms, and values – through the examination of changing discourse.

However, various institutional contexts will influence the potential for institutional change. While some institutions have formalized and inflexible discursive structures, other institutions may be open to greater internal variability and potentially be more flexible in their discursive structure. To this point, Hajer (1995) uses the example of legal discourse which is highly institutionalized: specific structured approaches to argument are acceptable and the adjustment of legal precedent must follow specific processes. However, not all institutional settings will have clearly defined and authoritative rules and processes.

In Hajer's (1995) conceptualization, discourses are interpreted and reproduced by actors, and while social structures (established by prevailing discourses) shape how actors understand those discourses, the actors have agency and actively select, interpret, and adapt ideas before reproducing them. Although discourses are enabled during social interaction, the sharing of ideas and arguments does not necessarily mean that actors involved interpret those ideas or arguments through the same discursive approach. Additionally, actors sharing ideas and arguments may interpret specific discourses in distinct ways, which may also influence their perception of the ideas and arguments (Hajer & Wytske, 2005). The variation in interpretation and understanding of discourse across actors means that some degree of institutional reshaping due to the somewhat different reproductions by various actors.

2.9 Terminology

As described above, discourse has multiple definitions. One conceptualization of discourse is as a framework of meaning and truth that is constructed socially between and among actors through communication. To this end, I have quoted Hajer's (1995) definition, and it is this definition of discourse

which provides the theoretical foundation for this dissertation. In the context of discourse institutionalism, which offers a conceptual connection across discourse and transitions, institutions are constructed by and products of discourse (Phillips et al., 2004; V. A. Schmidt, 2008). In the theoretical framework presented above, actors are influenced by multiple overlapping institutional contexts which shape their interpretation and reconstruction of discourses. Because the struggle of competing discourses is of primary interest in this dissertation, when I am representing discourse as a framework for meaning and truth, I have aimed to refer to *discourses* since the purpose is to distinguish between competing frameworks of truth and meaning and to identify points of discursive struggle that might inform the understanding of the socio-political dimensions of transitions.

A second definition of discourse utilized in this dissertation refers to conversational exchange and communication. When referring to the general exchange of ideas and opinions in a context, I have endeavored to present the idea of *the discourse*, which invariably represents a broad range of competing ideas and *discourses*. Alternatively, I also refer to *the discourse* in specific spaces or amongst specific actors: media discourse, Twitter discourse, public discourse. In each of these cases, the intention is not to suggest that this space is dictated by a single discourse; rather, each of these spaces offers a venue for an exchange of ideas. Therefore, when describing discourse in these spaces, I make use of the definition regarding the exchange of diverse perspectives, ideas, and frameworks of truth.

2.10 Applying concepts of discourse in sustainability transitions research

As actors communicate, they present how they understand the concepts being shared, and through the analysis of communication (verbal and non-verbal), it is possible to identify discursive elements contained within those communications (Bosman, Loorbach, & Frantzeskaki, 2014; Hajer & Wytske, 2005). However, discourses relating to complex issues are numerous, variable, evolving, and overlapping; therefore, multiple discourses may be apparent in a single communication (Dryzek, 2005; Phillips & Hardy, 2011). When considering sustainability transitions, which tend to be complex, uncertain, and open to contestation, numerous discourses will necessarily be combined and will compete. Because there are numerous and overlapping discourses in relation to complex issues, discourse analysis requires that a researcher scrutinize specific elements of discourse that are deemed relevant to their study (Sharp & Richardson, 2001). Through the

examination of discourse, there is the potential to reveal how institutional structures are being reinforced or challenged.

Institutions are one of three co-evolved components that describe regimes in the MLP. For transitions to take place, institutional structures must evolve and change. Therefore, sustainability transitions require new discourses to emerge and to be embedded into regimes because discourses play important roles in constructing institutions. In the sustainability transitions literature, the institutional structures are commonly referred to as the rules, norms, and values that structure the regime and niche spaces. Genus (2016) instead distinguishes between three forms of rules that create institutional structures: formal/regulative, normative, and cultural-cognitive. For consistency with the literature, I will refer to rules (formal/regulative rules), norms (normative rules), and values (cultural-cognitive rules). In this breakdown, values are included within cultural-cognitive rules, which "are implicated in the values, beliefs and guiding assumptions" (Genus, 2016, p. 529). However, it is useful to recognize each of these as different forms of rules that shape what is perceived as legitimate or appropriate in an institutional setting. When conceptualizing a transition, the reproduction or challenging of these various forms of rules determines how or if the institutional structures evolve. This negotiation (the reproduction or challenging) of institutional rules can be understood as the socio-political dimension – the social decision-making – within sustainability transitions.

Substantive sustainability transitions will require major reorientation of socio-technical systems embedded throughout society and will involve upheavals of institutional structures that contribute to the make-up of those systems. Given the degree of societal change required to achieve sustainability, it is clear that there will need to be significant negotiation of institutional structures. These diverse institutional changes will involve discursive struggles to reshape countless rules, norms, and values of diverse socio-technical systems. There is a vast conceptual terrain of discursive struggle that might inform the understanding of sustainability transitions.

Within the sustainability transitions literature, there has been growing interest in and application of discourse concepts (Geels, 2019; Isoaho & Karhunmaa, 2019; Köhler et al., 2019). Examinations of discourse can be pursued through diverse methods, and the focus of discourse analysis can target different discursive elements, such as expectations, framing, visions, contests, and narratives, that are present in communication being analyzed (Pesch, 2015). In their review of energy transitions research, Isoaho & Karhunmaa (2019) refer to a larger grouping of *discursive approaches* that apply discourse concepts in their analysis. They conceptualize

three categories of discursive approaches to describe how discourse concepts have been applied in the research field:

1. Discourse analysis approaches are analytically focused on understanding the ideas contained within communication that indicate perceptions of reality and legitimate ways of understanding the world.
2. Framing and frame analysis identify which aspects of an issue are made salient in communication.
3. Narrative analysis focuses on identifying prominent stories and consequential elements within stories that provide a rationale for events or ideas.

For conceptual clarity, I use the term discursive approaches when describing the broader group of analysis that applies discourse concepts. Each of these discursive approaches targets a different component of communication and offers a distinct lens on discourse. Given that the socio-political dimensions of sustainability transition include a wider array of potential negotiations of institutional structures, diverse discursive approaches may offer useful tools for interrogating different questions and support investigations of different forms of communication. Thus, when we consider the terrain of discursive struggle associated with sustainability transitions, not only is this conceptual space expansive due to the complexity of the issues being studied, but there are also numerous approaches that might be applied to explore this space.

A researcher analyzing discourse to understand the socio-political dimensions of sustainability transitions has a broad terrain of discursive struggle to investigate, but there are purposeful choices and practical limitations that direct how that terrain is explored.

2.11 Operationalizing the terrain of discursive struggle

The socio-political dimensions of sustainability transitions, in any specific socio-technical regime, will involve negotiation of numerous rules, norms, and values which might relate to broad and narrow issues. In the broad sense, this might include how the goal of sustainability is defined by the numerous actors within a regime, how this goal is contested, and how it is weighted in relation to other societal goals (Meadowcroft, 2011). However, the socio-political dimensions of sustainability transitions also include much narrower norms and values associated with how socio-technical systems evolve and are negotiated. Shove & Walker (2007) highlight the potential for more mundane issues – such as consumer expectations around hygiene or

appropriate indoor temperature – to impact sustainability transitions. This is not intended to suggest that the negotiation of any rule, norm, or value associated with a socio-technical system will be equally impactful in terms of sustainability outcomes; however, acknowledging all the potential changes in rules, norms, and values that may accompany sustainability transitions, highlights the significance of the socio-political dimensions of these processes.

Discourses construct and are constructed by institutional structures that permeate and organize society. Researchers interested in examining competing discourses that influence the structures of sustainability transitions could conceivably study communication and practice in any forums that might be influenced by the discourses that interest them. Given that sustainability transitions will require reorientation of almost all social systems, to some extent, a broad range of potential discursive forums could provide some degree of insight regarding negotiation of rules, norms, and values related to sustainability transitions. Thus, the selection of which forums to study becomes a critical question for researchers pursuing this type of research.

An illustrative example of this concept may be to consider the discourse regarding the concept of sustainability. Undoubtedly, the concept of sustainability has grown in social visibility over the last 50 years (Caradonna, 2017). Although the ultimate impact of the idea's proliferation is certainly debatable, the growth and evolution of sustainability, by its existence and prevalence, has reshaped what is perceived as legitimate considerations that might be reflected in decision-making processes. But there is no single accepted conceptualization of sustainability; rather, different actors construct concepts of sustainability based on distinct ideas, and those ideas have evolved over time (Christen & Schmidt, 2012). For example, an examination of discourse of sustainability across academic literature, corporate boardrooms, activist circles, and United Nations conferences would likely identify multiple, somewhat overlapping ideas, but not a single consistent definition of sustainability. Additionally, within each of those spaces one could conceivably identify discursive struggle regarding the meaning of sustainability, and if any single one of the forums above were examined through time, the boundaries of contested ideas defining sustainability would likely evolve as certain ideas are incorporated, refined, and consensus is built within the space. Across these forums, there would be some space of overlap and likely be some interconnection, but not absolute agreement, and the rate of evolution and the diffusion of ideas across forums would vary. Thus, depending on the forum being analyzed, quite different interpretations of discursive struggle would be identified in relation to the concept of sustainability. These

differing interpretations may all have some validity based on the forum examined, but none would offer a complete presentation of the discursive terrain associated with sustainability.

In the transitions literature, regime actors are those actors most closely associated with the existing technical system and associated institutions that structure behaviour in relation to that system. Examining discourse of these actors can provide insights about the regime itself, but during transitions, regime structures are challenged and transformed. It is not necessarily the case that examination of regime actor discourse will be more useful for understanding transitions dynamics than examining the discourse of broader actor groups or specific non-regime actors. That said, various actors will have different degrees of power to influence decision making and to influence institutional structures that guide transitions processes (Avelino, 2017; Avelino & Wittmayer, 2016; Brisbois, 2019). However, transitions involve changing power dynamics; therefore, examining the discourse of niche actors or those less associated with the regime can highlight contested ideas that challenge the existing institutions. Various discourse forums comprised of different actors can provide useful insights regarding transitions; however, it is critical to consider whose discourse is represented within any specific forum and how this might influence the discursive struggles that are identified.

Researchers cannot practically analyze all discourse relevant to any specific sustainability transition, or even most sub-issues within sustainability transitions, because there are numerous rules, norms, and values associated with any institutional structure of interest, and these structures are continuously reproduced through discourse. By selecting specific forums for analysis, a researcher highlights a certain portion of the terrain of discursive struggle associated with their issue of interest; however, they also ignore other portions of that terrain, which could offer equally valid perspectives.

Additionally, communication needs to be physically captured in some capacity for a researcher to be able to analyze the discursive elements contained within those communications. Most social interactions and communications are not encapsulated in a form that is available for analysis, and therefore cannot be studied. Only a subset of actors involved in a sustainability transition will communicate in ways that are physically captured. Therefore, based on this practical limitation of research, some portions of the terrain of discursive struggle will be more accessible for analysis than others. As such researchers should consider how this might bias their understanding of discursive struggle associated with their issue of interest.

In addition to who is being represented in a forum, the context of the communication being analyzed is critical to understanding the discursive elements contained within those communications. “Discourse is not

only what you say, however; it includes to whom you say it, how, why, and where…" (V. A. Schmidt, 2008, p. 310). The researcher must identify a forum (or forums) that can offer useful insights regarding their research question that acknowledges the actors whose communication is being analyzed and the context within which that communication is happening. Certain forms of communication are recorded and accessible for analysis, and the context of these communications will also influence the perception of discursive struggle that might be observed related to any specific issue of interest.

The terrain of discursive struggle offers insights regarding how various institutional structures are being negotiated collectively. While rules, norms, and values can all be understood as discursive products (i.e., they are established through shared discourse), some of these institutional mechanisms are more clearly articulated than others, most notable the formal/regulative rules (Sorrell, 2018). For example, when considering the institutional structures that impact household electricity use, the voltage requirement for household technologies will be more clearly described than the norms and values that shape what type of technologies customers may favour. Therefore, while all institutional structures may be conceptualized as discursive products, it is not feasible to equally interrogate the negotiation of all rules, norms, and values through discursive approaches.

Given the aforementioned limitations, a researcher must select a discursive forum or forum(s), understand what discursive elements will be captured in that forum, who is represented, and consider which aspects of the discourse will provide insightful understanding related to sustainability transitions. In selecting to focus only on a specific forum or multiple forums, the researcher necessarily neglects representations of the discourse on the same issue that might be perceived in other discursive forums across the terrain of discursive struggle. The discursive struggle captured in a single forum, or even a number of forums, will not provide a comprehensive appreciation of discursive struggle that might be perceived across the terrain of discursive struggle. However, the value of examining discourse for the purposes of understanding the socio-political dimensions of sustainability transitions lies in the appreciation that there is *some* relationship that governs discourses across social systems and that these discourses influence decision-making within the social system.

2.12 Organizing framework for this dissertation

As presented above, there is a vast terrain of discursive struggle that might inform greater understanding of the socio-political dimensions of sustainability transitions. There are diverse rules, norms, and values that might be

reproduced or challenged in sustainability transitions, and there are several discursive approaches that might be applied to interrogate how these institutional structures are being negotiated. A researcher's perception of valuable socio-political insights and practical limitations reduces the scope of the terrain of discursive struggle associated with sustainability transitions. However, given the scale of reorientation of sustainability transitions, the scope of the terrain of discursive struggle that might inform understanding of sustainability transitions remains daunting.

Rather than exploring sustainability transitions more broadly, the studies in this dissertation all analyze discourse related to transitions of energy sector socio-technical systems. While this might be seen as narrowing the scope of the terrain of discursive struggle somewhat, energy systems are embedded throughout social systems and vice versa, and their functioning is critical for maintaining current socio-economic systems (Goldthau & Sovacool, 2012). Given the ubiquity of energy systems, actors throughout our social systems are influenced by, and may potentially be able to influence, energy system transitions (Schot, Kanger, & Verbong, 2016). Conceptually, it is possible to argue that any actor that engages with an energy system has *some* level of influence on its transitions. Discursive struggle to reproduce or reshape the institutions structuring energy system transitions exists, to *some* degree, in relation to all the actors engaging with the system. Even while narrowing the focus to a single socio-technical sector of societal function, exploring sustainable energy transitions through discursive approaches maintains a broad terrain of discursive struggle to explore.

In this dissertation, I pursue three studies that explore the terrain of discursive struggle related to sustainable energy transitions in a variety of ways. It is not my argument that the studies included in this dissertation provide a full account this terrain. However, by pursing a variety of studies, not only will the dissertation provide contributions to knowledge associated with the individual studies, it will also be possible to review the studies collectively and gain further knowledge regarding the terrain of discursive struggle in relation to sustainability transitions. See Table 2-1 for an overview of the studies to follow.

In this chapter, I have reviewed literature related to sustainability transitions, institutions, and discourse with the intent of presenting a rationale for how discursive approaches might inform the understanding of the socio-political dimensions of sustainability transitions. In the theoretical framework presented, discursive approaches provide a means to investigate the maintenance or renegotiation of institutional structures during transitions processes. The terrain of discursive struggles offers a presentation of the vast range of rules, norms and values that might be contested during sustainability transitions. In the

following chapters, I apply discursive approaches to investigate a diverse range of questions related to energy sector transitions in different contexts. These studies are ultimately reviewed collectively to gain a better appreciation of the terrain of discursive struggle.

Table 2-1 - Overview of studies

	Topic of interest	***Discursive forum(s)***	***Actors' discourse analyzed***	***Discursive approach***
Chapter 3	Monopoly sector regime actor (distribution utilities) discourse regarding innovative technologies	Corporate annual reports and interviews	Local distribution companies and representatives from distribution companies	Discourse analysis
Chapter 4	The evolution of newspaper coverage of energy storage technologies through deployment	Leading newspaper coverage from two states	Newspaper coverage	Framing and frame analysis Narrative analysis
Chapter 5	Exploring the potential of Twitter to inform understanding of energy politics	Twitter focused on #ONpoli	The most engaged and the most amplified Twitter users	Framing and frame analysis

Chapter 3- Regime actor innovation discourse: Public presentations and key informant perceptions of innovation in the Ontario electricity distribution sector

3.1 Introduction

The Multi-Level Perspective (MLP) has been widely employed in sustainability transitions literature to describe the dynamics of socio-technical transitions (Köhler et al., 2019; Markard et al., 2012). The MLP frames transitions as interactions between the socio-technical regime – which includes the material technological system, actors and actor networks, and rules, norms, and values – and higher-level landscape pressures, as well as lower-level niche innovations (Geels, 2004, 2011; Rotmans, Kemp, & Van Asselt, 2001). Regimes are characterized by lock-in and path dependence that create relatively stable systems that evolve incrementally. Regime actors, such as policymakers and incumbent industries, are generally expected to resist transitions since they benefit from the existing system (Geels, 2014; Smink, Hekkert, & Negro, 2015). At the niche-level, novel competing technologies and advocates for those innovations are expected to build coalitions to potentially compete with incumbents and re-establish the regime by taking advantage of windows of opportunity that develop when the higher-level landscape exerts pressure on the regimes (Geels & Schot, 2007; Köhler et al., 2019). As such, transitions are often described as contests between the regime and niche or between incumbents and challengers (Geels, 2010; Hess, 2014; Schmid, Pechan, Mehnert, & Eisenack, 2017); however, on-going research in the transitions field has identified a more complicated reality (Geels, 2019). Regime actors may collaborate with niche actors and embrace radical innovations, on occasion (Berggren, Magnusson, & Sushandoyo, 2015; Geels et al., 2016; Heiskanen, Apajalahti, Matschoss, & Lovio, 2018; Penna & Geels, 2015). Researchers have also noted the 'semi-coherence' of regimes in practice; that is, regime actors present heterogenous, dynamic, and conflicting perspectives when explored in detail (Bosman et al., 2014; Fuenfschilling & Truffer, 2014; Rosenbloom, Berton, & Meadowcroft, 2016). Though often positioned as competitive, the relationship between niche-level innovation and the regime in transitions is complex.

In the electricity sector, network infrastructure – the transmission and distribution systems that facilitate the flow of electricity and connect electricity generators to electricity consumers – are expected to play a critical role in decarbonizing energy systems (Armaroli & Balzani, 2011; Markard, 2018; Palensky & Kupzog,

2013). However, parts of electricity systems – and most notably the network infrastructure – have been perceived as natural monopolies (Baldwin, Cave, & Lodge, 2012; Decker, 2015). To avoid inefficient duplication of costly infrastructure, monopoly regulation prohibits new entrants (Decker, 2015; Kiesling, 2009). When considering transitions of sectors that have traditionally been viewed as natural monopolies, the "incumbent versus challenger" perspective commonly used to describe transitions is less relevant since the institutional structures exclude new entrants.

However, monopoly sector regimes are not static. The boundaries of natural monopoly regimes can be contested – different definitions of what constitutes a natural monopoly sector exist (Decker, 2015; Kiesling, 2009). Niche advocates may work to reshape the institutions governing monopoly sectors to create opportunities. Technological innovation can also influence the transition dynamics within monopoly sectors. Therefore, although monopoly sectors are non-competitive, regime actors still need to consider transitions dynamics including regulatory change and technological innovation that may be influencing their sector. By examining monopoly sectors, it is possible to consider transitions processes in the absence of direct competitive threats to regime actors. Given these distinct institutional conditions, regime actor perceptions and responses to innovation in monopoly sectors may offer valuable insights for understanding the complex relationship between niche-level innovation and regimes in transitions.

The purpose of this study is to explore the relationship between monopoly sector regime actors and innovative technologies, and to consider the (semi-)coherence of the regime actors in this space. Employing a discursive approach and Smith & Raven's (2012) framework of niche empowerment, the study examines the public presentations and key informant perceptions of technological innovation in the electricity distribution sector in Ontario, Canada. The firms that operate in the distribution sector in Ontario are known as Local Distribution Companies (LDCs).

In the following section, the study rationale is elaborated, including more detail regarding energy storage technologies that were used as a sample innovative technology, the Ontario electricity sector, and the LDC sector. The methods section follows, which includes a description of how Smith & Raven's (2012) framework is operationalized to identify empowerment narratives. The results section provides an overview of the two datasets collected. A distinct analysis section explores the results to identify empowerment narratives. The paper concludes with a discussion of the findings and a conclusion section.

3.1.1 STUDY RATIONALE

This study uses a discursive approach to examine regime actor narratives regarding innovative technologies. The purpose of the study is to explore the homogeneity or heterogeneity of presentations and perceptions regarding innovation and emerging technology among actors in Ontario's monopoly electricity regime, and to consider how these might influence the understanding of actor behaviour and strategies within transitions. Previous discursive studies have highlighted the semi-coherence of regimes (Bosman et al., 2014; Fuenfschilling & Truffer, 2014; Rosenbloom et al., 2016). This study explores whether the semi-coherence of regimes exist in highly regulated non-competitive sectors.

Niche innovations are often protected in their early development; innovations are shielded from the standard selection environment, either by servicing specialized markets or through active supports (Smith & Raven, 2012). Eventually, if successful, niche innovations attract advocates (actors) and need to be empowered to enter the regime (Raven, Kern, Verhees, & Smith, 2016; Smith & Raven, 2012). Niche empowerment refers to the process by which innovations move from the niche-level and are integrated into the regime-level. Smith and Raven (2012) propose two modes of niche empowerment: fit-and-conform (*conforming*) and stretch-and-transform (*transforming*). Key to the distinction between these two forms of empowerment is the *selection environment* (i.e., the factors considered when evaluating a technology). C*onforming* innovation empowerment refers to technologies that compete with traditional approaches in an unchanged selection environment. By contrast, *transforming* innovation empowerment refers to technologies that compete with traditional approaches in a changed selection environment.

Raven et al. (2016) describe socio-technical narratives as simple stories about the past, present and future performance of a technology. As niche innovations are nurtured, actors supporting these innovations establish narratives regarding empowerment, and as these narratives are reproduced, advocacy coalitions form promoting common narratives for empowerment. By identifying and examining narratives, it is possible to study the development of advocacy coalitions and political contestation in transitions, through the analysis of competing narratives (Hajer, 1995; Markard et al., 2012; Smith & Raven, 2012). Most innovations are expected to follow a *conforming* empowerment process, because maintaining the current selection criteria involves less institutional adjustment than changing the selection environment (Raven, Kern, Verhees, et al., 2016). Smith & Raven (2012) prioritize the *selection environment* for examining how niche innovations are empowered into

(or blocked from) the regime. The narratives regarding niche empowerment provide a lens to understanding the political dimensions of transitions as actors try to (re)define the selection environment.

Within the transitions literature there have been inconsistent definitions used to describe regime boundaries, and the construction of regimes (Sorrell, 2018). However, a prominent description presents socio-technical regimes as having three interlinked components: the material technological system; actors and actor networks; and rules, norms, and values that guide actor behaviour (Geels & Schot, 2007). This study focuses on the material technological systems involved in the local distribution of electricity that are owned and operated by LDCs. The actors of focus in this study are the LDCs themselves; however, the regime can also be conceptualized as including generators and consumers of electricity who impact the distribution system design and operation, transmission companies, regulators and policy makers, and actors such as service providers to the LDCs. A complex array of rules, norms, and values guides the behaviour of this collection of regime actors. Some of the rules, norms, and values impacting regime dynamics are intangible while others are well-documented and enforced by the coercive power of the state (Sorrell, 2018). The cognitive routines and social norms associated with electricity consumption influence the socio-technical dynamics of electricity distribution and may be deeply embedded in how LDCs operate, but their impact on socio-technical system dynamics is difficult to define. In contrast, the Ontario Energy Board (OEB) issues licences to LDCs. The service responsibilities, professional standards, and regulated rate of return for LDCs are formal, written, and well-defined – although still open to interpretation. This study focuses on the formal rules and regulations since they provide a more clearly articulated definition for considering the LDC sector *selection environment*.

The study uses two datasets to explore these themes: publicly available annual reports and confidential semi-structured interviews with key informants from LDCs. LDCs represent a subset of the Ontario electricity regime. The prioritization of their public presentations and LDC key informant perceptions is not intended to prioritize these actors over others in the Ontario electricity regime. Rather, the highly regulated nature of the LDC sector offers a means to consider narratives of innovation empowerment in the absence of direct competition and in a sector with well-defined rules. In considering the narratives employed by these actors, it may be possible to identify competing positions that exist within this subgroup of regime actors. While the coherence of narratives of this subset of regime actors would not necessarily support the concept of overall regime coherence when responding to innovation, the existence of competing narratives within a subset of the regime would reinforce the proposition that there exists a semi-coherent nature of regimes.

The voluntary narrative disclosures in annual reports offer a means for firms to project a public image (Crane & Glozer, 2016; Hooghiemstra, 2000; Stanton & Stanton, 2002). By analysing publicly shared corporate reports, it is possible to explore how LDCs frame their investments, relationship with emerging technology and innovation, and strategies for the future. LDCs are not required to publish annual reports, therefore the information presented in these reports represents voluntary public positioning by these firms. Rather than following a strict guideline for information disclosure, the firms can present their activities as they see fit and are likely to position themselves using positive framing. Therefore, the analysis of these reports is undertaken to evaluate the narrative the LDCs voluntarily share and how they are framing that information regarding emerging technologies and innovations, rather than considering the information shared to be objective presentations of the firms' activities and strategies.

Additionally, semi-structured interviews were utilized to explore key informant perceptions of innovative technologies. Unlike the public presentations gathered from annual reports, the key informant interviews were conducted privately, and participants were offered anonymity to encourage candid responses. The interviews focused primarily on perceptions of energy storage technologies, which could potentially have a transformative impact on the sector (see section 1.2) (Gaede & Rowlands, 2018; Grünewald, Cockerill, Contestabile, & Pearson, 2012). Previous research has highlighted the importance of actor vision and strategies in transitions (Berkhout, 2016; Farla et al., 2012; Funcke & Bauknecht, 2016; Jasanoff & Kim, 2013). Beyond exploring the actors' current perceptions, the study explores their visions for how these technologies should be integrated into the electricity distribution system.

The data collection approach provides a snapshot of narratives rather than a longitudinal sampling. As such, the study cannot describe the development and evolution of narratives in the LDC sector; rather the findings provide a description of the narratives that exist within the sample and determine the coherence of regime narratives that *currently* exist within this subset of regime actors.

3.1.2 Energy storage technologies

There are many energy storage technologies that convert energy of one form to a storable form that is reused as a source of energy at a later time (Aneke & Wang, 2016; Luo, Wang, Dooner, & Clarke, 2015); This category of technologies has diverse operational characteristics and potential applications (Ferreira, Garde, Fulli, Kling, & Lopes, 2013; Gallo, Simões-Moreira, Costa, Santos, & Moutinho dos Santos, 2016; Luo et al., 2015). Energy storage technologies have the capability to provide services across the electricity system from

generation, to transmission and distribution networks, and to consumers. A single energy storage application could potentially provide multiple services to various subsystems within the electricity system (Grünewald et al., 2012; Harold, Taylor, Jones, Mcentee, & Wade, 2014; RMI, 2015). While some energy services offered by energy storage technologies, such as voltage regulation, can be offered by alternative *traditional* distribution technologies, they can also provide novel opportunities in system design and operation and may be particularly useful in integrating variable renewable generation (Poudineh & Jamasb, 2014; Zame, Brehm, Nitica, Richard, & Schweitzer, 2018). Energy storage technologies are not easily classified within a single electricity subsystem category, and as a result, several studies have explored the potential for energy storage to be a transformative technology (Gaede & Rowlands, 2018; Grünewald et al., 2012; Zame et al., 2018). Given their potential transformative nature and diverse applications, the energy storage technologies offered a useful case to explore empowerment narratives regarding their integration into the electricity distribution system.

3.1.3 LDC SECTOR

LDCs own and operate the electricity distribution infrastructure in Ontario. LDCs are required to provide the distribution services within their designated territories, non-competitively, and all LDCs operate under the same regulatory framework; however, there is considerable diversity within the sector. As of 2016, Chapleau Public Utility Corporation had 1,241 customers, while Hydro One, the largest LDC, had more than 1.3 million customers. While Algoma Power Inc. had just over 6 customers per kilometer of distribution line, Kingston Hydro had more than 13 times that density, with 82 customer per kilometer of distribution line (Ontario Energy Board, 2018). The number of full-time employees per LDC range from 3 (Cooperative Hydro Embrun Inc. and Hydro 2000 Inc.) to 4355 (Hydro One) (Ontario Energy Board, 2018). Beyond the numerical descriptors, LDC service areas have been defined by historical events and amalgamations. LDC service areas do not necessarily follow municipal boundaries that apply to other services, and multiple LDCs serve non-contiguous territories; often, these service areas are broken up by rural constituencies, generally served by Hydro One. LDCs throughout Ontario are overseen by the OEB and tasked to build, maintain, and operate distribution systems, and to bill their customers.

While the services offered by LDCs are highly regulated, corporate owners of LDCs – typically municipalities – are authorized to establish competitive affiliate companies, which can operate energy related business including: energy retail, service companies, generation and transmission companies, and communications and billing companies (Mowat Energy, 2016). Although LDCs are limited in their permission

to share information with their affiliates, these corporations offer opportunities to move beyond the highly regulated monopoly service offerings of LDCs. The electrical service meter has been used as the demarcation point for regulated LDC services and competitive services (some exceptions were made in relation to conservation and demand management programs) (Ontario Energy Board, 2012). Provision of behind-the-meter services is not described by monopoly characteristics; therefore, it has generally been expected that affiliates rather than the regulated LDC would be active in this space.

3.2 Methods

LDC annual reports were analyzed to explore public presentations regarding the firms' approaches to technology and innovation. A review of 68 LDC websites (all the LDCs active in 2016) was completed in August 2018. Websites were reviewed manually. Where available, search functions were used for terms "report", "annual", and "news". The data collection targeted the most recent annual report available from the three previous operating years (2015-2017). A total of 20 documents were identified through this search, although not all documents were titled as "Annual Reports". The document title, length, format, and subsections included in the collected reports varied. To improve comparison across the sample, introductory leadership letters, a frequent feature in the reports collected, were selected for analysis. Six of these documents were deemed non-comparable for the purposes of this study because they did not include an introductory letter from the leadership of the organization. Therefore, 14 annual reports were analyzed for the study. All but one of the included reports were from 2017; the other was from 2015.

The analysis of annual reports used leadership letters (i.e., CEO, President, Board Chair, or CEO and Board Chair) and examined their discourse regarding technologies and innovation in the sector and the relationship between these technologies and the LDC. These leadership letters offer an introduction to the annual report documents and highlight priorities that the firms' leadership intends to share with the readers. Where both a Board Chair and a CEO or President letter were included, the CEO or President letter was used because these elaborated on LDC activities and strategies, which were the focus of the analysis, to a greater extent.

The 14 leadership letters were analyzed to identify sentences mentioning technology and/or innovation. An inductive and iterative process based on detailed reading and comparison across leadership letters was used to identify common themes regarding the technology and innovation mentions. The mentions

were read in context of the paragraph, and where identified, subthemes or distinct narratives regarding the theme were also explored and categorized. Subthemes were developed based on language used in relation to the theme; this included consideration for the relationship to the LDC or the purpose of the technology or innovation being mentioned. The themes and subthemes were then analyzed to identify *conforming* and *transforming* narratives (see section 2.1).

While the annual reports offer public presentations by the LDC, 16 semi-structured interviews with representatives from 15 LDCs were also conducted to consider perceptions shared by key informants within the sector. Sixty-three LDCs were contacted to participate in the study (two of the 65 LDCs active in 2017 were inadvertently overlooked in the outreach phase: Chapleau Public Utilities Corporation and Kenora Hydro Electric Corporation Ltd.). LDCs were contacted through publicly available email and phone numbers, as well as through outreach by industry gatekeepers. If unresponsive, contacts were followed up on through the same contact channels. Forty-four LDCs were unresponsive to interview requests, and four LDCs declined to participate in the study.

The 16 interviews took place between March and July 2017 and ranged in duration from 23 to 60 minutes (ORE# 22031). Two of the 16 interviews included two participants from the same organization; the remaining 14 interviews were conducted one-on-one. The semi-structured interviews were based around 16 questions regarding the participant and LDC context, current applications of energy storage technologies in the LDC sector, future potential for energy storage technologies, policy questions regarding barriers and regulatory considerations, and final thoughts (see Appendix A). Interviews were transcribed and analyzed manually.

The analysis focused on three question areas from the interviews: current applications of energy storage by the LDCs, barriers to energy storage technology applications, and the participants' perspective on how energy storage technologies *should* be incorporated into the electricity distribution system. These questions were selected for analysis because they provided insight regarding the LDC selection environment for energy storage technologies. Responses were reviewed as a whole, including conversational interactions with the interviewer and categorized according to common ideas and themes based on an inductive approach. Within a single response multiple ideas and themes could be identified and categorized. The categorized responses were then analyzed to identify *conforming* and *transforming* narratives (see section 2.1).

Table 3-1 provides an overview of the data collection for this study. In total, data from 22 LDCs were incorporated into the study (seven LDCs were included in both annual report and interview analysis; seven LDCs were included only in leadership letter analysis; and eight LDCs were included only in the interview analysis). Although all participants in the interviews agreed to be identified as participating in the study, some participants requested that only generic identification be associated with their responses. As a result, LDCs have been categorized as small (<20,000 customers), medium (20,000 – 200,000 customers), and large (>200,000 customers) for interview analysis. LDC customer numbers are based on the 2017 Yearbook of Electricity Distributors (Ontario Energy Board, 2018).

Table 3-1 - Overview LDCs and data collection

LDC	***Number of customers***	***LDC size***	***Leadership letter***	***Interview participation***
Centre Wellington Hydro Ltd.	6916	S		x
Tillsonburg Hydro Ltd.	7201	S		x
Niagara-on-the-Lake Hydro Inc.	9377	S		x
Lakefront Utilities Inc.	10349	S	x	x
Orangeville Hydro Limited	12365	S		x
Lakeland Power Distribution Ltd.	13491	S		x
Festival Hydro Inc.	21108	M		x
Westario Power Inc.	23373	M	x	
Kingston Hydro Corporation	27582	M		x
Brantford Power Inc.	39622	M	x	x
Thunder Bay Hydro Electricity Distribution Inc.	50844	M	x	
Waterloo North Hydro Inc.	57041	M	x	x
Oshawa PUC Networks Inc.	57584	M	x	x
Energy+ Inc.	64724	M		x
Burlington Hydro Inc.	67122	M	x	
Veridian Connections Inc.	120457	M	x	
London Hydro Inc.	157188	M	x	
Horizon Utilities Corporation	244114	L	x	
Hydro Ottawa Limited	331777	L	x	x
Toronto Hydro-Electric System Limited	767946	L	x	x
Alectra Utilities Corporation	982022	L	x	x
Hydro One Networks Inc.	1320085	L	x	

3.2.1 ANALYSIS OF *CONFORMING* AND *TRANSFORMING* NARRATIVES

Once annual report themes and interview response categorizations were developed, an analysis of *conforming* and *transforming* narratives was conducted based on whether narratives were suggesting a change in the selection environment for LDCs. While changing norms and values for the sector might also constitute a changing selection environment, this study focused on the rules and regulations applied by the OEB to govern LDCs. The OEB has numerous regulatory responsibilities related to electricity distribution in Ontario, including rate-setting, an involved cost-of-service evaluation that incorporates incentive regulation and benchmarking components (for more detail see Mowat Energy (2016)). In terms of considering narratives regarding the regulatory selection environment, the analysis considered topics such as the OEB's role in evaluating LDCs *prudent* investment in new technologies, potential service offerings, rate-setting, and service standards.

The analysis of *conforming* and *transforming* narratives in annual reports and interview responses focused on the regulatory selection environment for LDCs. For the purposes of this study, *conforming* narratives were defined as narratives that portray technologies and innovations competing in the existing selection environment, with no changes to evaluation of technological performance or LDC approaches to investment. *Transforming* narratives were defined as narratives that portray redefining the selection environment for LDCs, such as changing rules regarding how LDCs invest in new technologies; or changing the role of LDCs and the services they offer to customers; or changing how LDCs earn revenue. Alternatively, *transforming* narratives may include narratives that alter the rules excluding other firms from investing in distribution system infrastructure, perhaps opening certain services traditionally associated with LDCs to competition or allowing competitive affiliates to invest in technologies within the distribution network.

When defining the current selection environment, it is important to acknowledge the role of LDCs' competitive affiliate businesses (as briefly introduced above). Competitive affiliates are not constrained by the monopoly LDC regulatory selection environment, and the economic activities of affiliate businesses are excluded from the cost-of-service for the associated LDC. Affiliate businesses, unlike the monopoly LDCs, can offer behind-the-meter services to customers; they cannot invest in distribution assets. Distinguishing between *conforming* and *transforming* narratives depends on identifying and delineating monopoly LDC activities from competitive affiliate business activities. *Transforming* narratives could involve shifting this delineation to

expand the potential activities and investments of monopoly LDCs or to expand the potential activities of competitive affiliates into the distribution system.

In addition to their core activities within the highly regulated monopoly selection environment, some LDCs conduct projects in protected niche environments, such as pilot projects. Protected niche activities are conducted outside of the regulatory selection environment, but they are sanctioned by the regulator to allow for research or testing of new ideas. The distinction between *conforming* and *transforming* narratives depends on how those protected niche applications are empowered into the regime-level selection environment. Therefore, the narrative analysis needs to consider the purpose or aims of these projects, rather than evaluating the narrative associated with the project design or activities.

3.3 Results

3.3.1 LDC Annual Report leadership letters

Table 3-2 provides details regarding the LDC documents collected, including report titles, the LDC size based on the number of customers, and the year of release.

Table 3-2 - LDC Annual Report details

LDC	***LDC size***	***Type of report***	***Year***
Lakefront Utilities Inc.	S	Annual report	2017
Westario Power Inc.	M	Community report	2017
Brantford Power Inc.	M	Annual report	2017
Thunder Bay Hydro Electricity Distribution Inc.	M	Annual report	2017
Waterloo North Hydro Inc.	M	Annual report	2017
Oshawa PUC Networks Inc.	M	Annual report	2017
Burlington Hydro Inc.	M	Community report	2017
Veridian Connections Inc.	M	Joint letter from the chair and president & CEO, and Management's discussion and analysis	2017
London Hydro Inc.	M	Report on financials	2017
Horizon Utilities Corporation	L	Sustainability-based annual report	2015
Hydro Ottawa Limited	L	Annual report	2017
Toronto Hydro-Electric System Limited	L	Annual report	2017
Alectra Utilities Corporation	L	Annual Sustainability Report	2017
Hydro One Networks Inc.	L	Annual report	2017

Through the analysis of leadership letters, five technology and innovation themes were identified. These themes are investing in distribution assets, the launch of new technological systems, discussions of specific forms of innovative technologies, the changing nature of the electricity sector, and innovation as a strategic concept. Table 3-3 identifies which LDC leadership letters engaged these themes. The following section elaborates on each of the identified themes and provides more detail regarding subthemes and context.

Table 3-3 - LDC leadership letter technology and innovation themes

LDC	*Investing in distribution assets*	*New system highlighted*	*Specific emerging technology*	*Changing sector*	*Strategies of innovation*	*Total number of themes identified*
Lakefront Utilities Inc.	x	x			x	**3**
Westario Power Inc.	x	x		x	x	**4**
Brantford Power Inc.	x		x	x	x	**4**
Thunder Bay Hydro Electricity Distribution Inc.	x			x		**2**
Waterloo North Hydro Inc.	x	x		x		**3**
Oshawa PUC Networks Inc.	x	x	x			**3**
Burlington Hydro Inc.	x	x	x		x	**4**
Veridian Connections Inc.	x	x	x			**3**
London Hydro Inc.	x	x		x	x	**4**
Horizon Utilities Corporation		x	x	x		**3**
Hydro Ottawa Limited	x	x	x			**3**
Toronto Hydro-Electric System Limited	x	x	x		x	**4**
Alectra Utilities Corporation			x	x		**2**
Hydro One Networks Inc.		x	x	x	x	**4**
Total	**11**	**11**	**9**	**8**	**7**	**46**

3.3.1.1 INVESTING IN DISTRIBUTION ASSETS

A widely shared theme in the leadership letters regarding technology and innovation related to investing in distribution assets. This theme highlights the traditional activities associated with the monopoly LDC's core business: building, maintaining, and operating the distribution system within its territory. This theme was shared in 11 of the 14 leadership letters. The most common (7) reason presented for these investments was focused on ensuring reliability, although meeting customer needs (3) and expanding capacity (2) were also reasons presented for these activities (some letters highlighted multiple rationales). When

discussing investing in distribution assets, language about renewal, enhancement, and improvement was commonly used.

3.3.1.2 New system highlighted

Many (11) LDC leadership letters highlighted the launch of new systems. The new systems highlighted related to customer communication and customer service (7) (e.g., online services, outage maps, e-billing) or operational systems (4) (e.g., SCADA systems, internal customer information systems, fleet management). The most commonly (10) presented reason for launching these systems was for customer service benefits. Economic and productivity rationales for these systems were also shared in multiple (4) leadership letters (again, some letters highlighted multiple rationales). Generally, the leadership letters presented these activities as a means of improving current offerings and operations.

3.3.1.3 Specific emerging technology

Presentations of activities with specific emerging technologies were shared in nine leadership letters. The emerging technologies that were mentioned included solar and renewable generation (non-specifically) (5); microgrids and smart-grids (4); distributed energy resources (3); and electric vehicles and electric vehicle charging infrastructure (2). Within this theme, diverse technologies were mentioned, and diverse relationships were presented between these technologies and the LDCs. When examining the descriptions of LDC activities with these technologies, several subthemes were observed: active implementation; piloting, testing, and studying; planning; and in relation to a changing sector.

The active implementation of technologies was noted in four leadership letters, and these technologies included distributed generation, electric vehicle charging, and renewable generation. However, in three cases – Oshawa PUC's implementation of distributed generation, Hydro Ottawa's implementation of renewable generation, and Burlington Hydro's implementation of electric vehicle charging – the active implementation was explicitly attributed to the LDCs' competitive affiliate organization. The narrative rationale for implementing these technologies was based on economic value of the projects. The fourth description of active implementation was Toronto Hydro's leadership letter, which described its installation of electric vehicle charging infrastructure at one of its business locations.

The subtheme regarding *piloting, testing and studying* was referenced by four LDCs, which discussed six projects. These projects implemented a range of technologies – microgrid, solar management, renewable

generation, and energy storage – and LDCs presented numerous reasons for pursuing these projects. Oshawa PUC presented its pilots primarily as an effort to lead in the sector and as examples of how the organization "punch well above [its] weight class." In contrast, Alectra presented its efforts related to pilot projects as a demonstration of its commitment to sustainability and to giving consumers more choice. Veridian promotes its microgrid project as an effort to "…modernize Ontario's electricity distribution grids…" and to improve reliability, resiliency and efficiency. Similarly, Toronto Hydro suggested its project using energy storage technology is related to modernizing the electricity grid. Brantford Hydro's leadership letter discussed planning related to the implementation of smart grid technologies; however, few specific details were shared.

The remaining engagement of the emerging technologies theme, by Horizon, London Hydro, and Hydro One, all link to the theme of a changing sector, which is explored in more detail below.

3.3.1.4 CHANGING SECTOR

The theme of the *changing sector* is shared in eight of the leadership letters. The concept of the *changing sector* has some variation across the letters. Three letters presented the change as something happening in the future that is being envisioned and prepared for in advance. London Hydro stated "...we are preparing well for the future changes that are coming fast and furious." However, the more frequent presentation of the *changing sector*, shared in five leadership letters, is of a sector currently changing. For example, Brantford Power referred to the electricity sector as an "ever-changing industry" or Toronto Hydro stated that "the electricity industry is transforming". In this presentation the sector *is* changing, and the narrative suggests the process will extend into the future.

The leadership letters presented varying responses by their organizations in reaction to the changing sector. All the letters mentioning the changing sector presented their organizations as strategizing or responding well; however, the language in some letters emphasized the effort needed or the challenge to respond to the change. For example, some leadership letters emphasized the "challenge" or "pressures" of the changing sector or thank their staff for the effort required to respond to the changes. Westario Power noted, for instance, that it has "stepped up to the challenge in an ever-changing industry…", while Brantford Hydro suggested "…we are offering the best possible service, despite the ever-changing and challenging electricity sector". Although both LDCs are highlighting their progress related to the changing sector, the response is challenging.

Conversely, other comments regarding the changing sector focused on being well-prepared or strategizing for the changing sector with little acknowledgement of the effort or challenge; instead, these comments focused on opportunities. For example, Alectra stated that "we're ready" in relation to the changing sector. Hydro One stated, "In anticipation of [an electricity industry transformation], Hydro One is developing its strategy to adapt our grid investments to reflect this new reality, and to provide new energy services that customers are demanding." These statements suggest that adaptation is necessary, but there is no indication of strain or challenge; rather the LDC will be able to offer new energy services.

Of those leadership letters that mentioned the *changing sector*, all included at least one paragraph with positive (or neutral) framing of the theme. In reviewing the numbers of paragraphs highlighting this theme and the negative and positive framing of the theme (Table 3-4), it is observed that the smaller LDCs mentioned the *changing sector* more often and that they also highlighted negative framing more often than the larger LDCs.

Table 3-4 - Changing sector theme

LDC	***Current or future framing of the changing sector***	***Positive (or neutral) and negative framing***
Westario Power Inc.	Current	- - +
Brantford Power Inc.	Current	+ - - +
Thunder Bay Hydro Electricity Distribution Inc.	Current	- -
Waterloo North Hydro Inc.	Future	+
London Hydro Inc.	Future	+ +
Horizon Utilities Corporation	Future	+
Alectra Utilities Corporation	Current	+
Hydro One Networks Inc.	Current	+

3.3.1.5 STRATEGIES OF INNOVATION

Several of the leadership letters (7) specifically referred to innovation as being a key strategy of the organization. Despite being prominently included in the leadership letters, it is not always made clear what is meant by innovation. In a more concrete invocation of innovation, London Hydro connected its strategy of innovation with its active undertaking of pilot projects. Similarly, Toronto Hydro connected innovation to its commitment to "sustainably power" Toronto and its pilot projects using energy storage technologies. However, the remaining leadership letters highlighting this theme either offered a completely abstract concept – Hydro One have a strategy to become one of North America's leading utilities that prioritizes "1. Optimization and innovation" – or highlighting innovation in relation to new technologies, such as Lakefront Utilities which

stated its "commitment to new technologies to enhance customer choice and allow for more technology and innovation to exist across the grid."

3.3.2 KEY INFORMANT INTERVIEWS AND ENERGY STORAGE TECHNOLOGIES

The participants in the key informant interviews included 12 LDC representatives in executive roles (i.e., CEO, COO, VP, Director, President) and six representatives from management roles. The interviews included representatives from six small LDCs, six mid-sized LDCs, and three large LDCs (Table 3-1). Collectively, participants had experience in most major departments within the LDC sector: engineering, finance, regulatory, customer service, conservation and demand management, planning, metering, and design. The participants' responses reviewed in this study cover three topic areas regarding energy storage technologies at the distribution-level of electricity systems: current applications, current barriers, and future applications.

3.3.2.1 CURRENT APPLICATIONS OF ENERGY STORAGE TECHNOLOGIES

Five of the interview participants identified a total of 14 projects by their LDCs that utilized energy storage technologies. Battery storage technologies were the most prevalent (13) form of energy storage being used in these projects; however, one pilot project made use of compressed air. The battery-based projects included a diversity of sizes and applications for the technology. All the active projects discussed were undertaken either as pilots or learning opportunities that were supported through funding opportunities outside of the standard regulatory approval and review process.

All three large LDCs that participated in this study reported multiple projects that involved energy storage components. In addition, two mid-sized LDCs were involved in individual projects making use of energy storage technologies. None of the small LDCs that participated in this research reported use of energy storage technologies within their distribution network.

3.3.2.2 CURRENT BARRIERS TO ENERGY STORAGE TECHNOLOGIES

When asked to identify barriers to energy storage at the distribution-level that currently exist, if any, several categories of barriers were highlighted in participant responses: economic, regulatory, technological reliability, and cultural barriers within the LDC sector.

Economic (9) and regulatory barriers (8) were most commonly cited by the participants. Comments regarding economic barriers focused primarily on the current cost of technology being too high to allow for

economical applications. This type of barrier illustrated by a participant who responded "The challenges are the economics and the business model given the technology out there." There were some variations within the comments regarding regulatory barriers. Two participants who noted regulatory barriers discussed the need for new revenue models or different regulatory incentives. An alternative narrative regarding regulation and energy storage technologies, shared by six participants, focused on the need for regulatory clarity, such as: "Yes, there's clarity that would be useful as far as how the assets will be treated. Can we confirm that [energy storage] is eligible for rate-based investment or do people feel more that it is an unregulated asset?" This narrative did not advocate for specific regulatory changes, but participants noted uncertainty regarding how these technologies could be used and what investments would be considered prudent by the regulator. In relation to regulation, five participants noted that regulation was not a barrier or that regulators were trying to do the right thing in relation to energy storage technologies.

Three participants highlighted technological reliability barriers to energy storage applications. These participants noted the need for caution when applying new technologies because there is not a proven record, which increases the risk that the technology will not meet expectations. Additionally, two participants noted cultural barriers related to the LDC sector being risk adverse.

3.3.2.3 Future applications of energy storage technologies at the distribution-level

Interview participants were asked if integrating energy storage technologies into the distribution system *should* be the role of LDCs or if other actors should be involved. In reviewing the responses, a gradient of LDC involvement was identified, ranging from those who asserted a competitive market was the best approach to determining whether or not to adopt energy storage technologies to those participants who argued that LDCs were best positioned to capture the value of the energy storage technologies.

The majority (12) of participants emphasized the role for competitive markets to drive energy storage investments. The role of LDCs varied in relation to this process. Five participants in this group suggested the LDCs would be involved primarily in connecting these technologies to the broader electricity system. To the extent that these participants noted LDCs enabling energy storage technologies markets, the activities they highlighted included managing new billing procedures and ensuring proper connection protocols. A participant expressed this position as follows: "There has to be some regulations around safety and how storage is incorporated into the distribution system and how it's operated but beyond that, there doesn't have to be a specific role for the LDC."

Six of the participants who emphasized competitive markets for energy storage technologies also noted potential applications by LDCs within distribution systems. These participants mentioned that there may be applications within the distribution network that would be best aligned with LDC investment and distinguished those applications from behind-the-meter applications that are outside of the regulated [monopoly] utilities service provision. This position is exemplified by the quote "...when you're talking about things like voltage management, that is clearly… or good reliability, those are clearly cases for the LDCs." This participant distinguished LDC investment in these technologies based on the application that aligns with current monopoly service responsibilities.

One participant, while emphasizing the role of competitive markets, highlighted potentially more involved roles for LDCs depending on the scale of the project. Larger projects may require more LDC involvement as they could impact on broader system planning, but small projects could proceed and be connected by the LDC. However, the participant also noted that the LDC may be able to benefit by encouraging distributed energy storage within its distribution area.

Four participants stated their preference for LDCs to lead the application of energy storage technologies. Three of these participants emphasized the LDCs' potential to maximize the value of energy storage by aligning infrastructure needs: "It comes back to how many of those benefit streams can you attract, and I think that the regulated [monopoly] utility has the unique opportunity to get the most of those on behalf of the customers."; "The LDC is in a better position to be able to use [the knowledge of the system conditions] to the benefit of the grid and adding that value to the cost of energy storage."; "…[the LDC] can maximize their infrastructure, and make it run efficiently." One participant spoke to the LDCs' experience related to serving customers, as being an argument for LDCs leading in the energy storage space.

3.4 Narrative analysis

3.4.1 Leadership letter *conforming* narrative themes

The majority of the themes identified in the leadership letters suggested that LDCs were presenting *conforming* narratives in relation to technology and innovation. The two most widely shared themes related to technology and innovation – *investment in distribution assets* and *new system highlighted* – provided little insight regarding *transforming* narratives. These themes presented activities that are well established within the

sector. The discourse used in relation to the themes of *investment in distribution assets* and *new system highlighted* did not suggest transformative change in these functions.

Similarly, the LDC leadership letters that discussed the theme of *specific emerging technology* presented conforming narratives, despite several subcategories identified within this theme. In cases of active implementation of energy technologies, the projects described were being pursued by competitive affiliate business or minor projects unrelated to the core activities of the monopoly LDC. Although several LDCs highlighted activities piloting new technologies that could potentially evolve into new services, the leadership letters did not present *transforming* narratives associated with these projects. Both Veridian and Toronto Hydro highlight the purpose of their projects being related to modernizing the distribution system, which could potentially involve transforming the selection environment. However, neither leadership letter elaborates on the concept of modernization and, lacking detail, neither offers a clear presentation of a *transforming* narrative.

When discussing the *changing sector*, five of the eight leadership letters activating this theme positioned the change as external to the LDC's control or made no claim regarding the role of the LDC changing. This suggests that *the changing sector* is unrelated to the LDC selection environment, and therefore is in line with a *conforming* narrative for the LDCs.

The theme *strategies of innovation* presented *conforming* narratives, as well. This theme was activated in relation to abstract concepts, integrating new technology, pilot projects or identifying operational efficiencies, none of which presented a *transforming* narrative for the LDC selection environment.

3.4.2 LEADERSHIP LETTER *TRANSFORMING* NARRATIVE THEMES

The majority (5) of leadership letters engaging the theme of the *changing sector* presented this theme with *conforming* narratives. However, the three remaining leadership letters that highlighted the *changing sector* theme could potentially be interpreted as presenting *transforming* narratives. Hydro One's leadership letter notes that "…Hydro One is developing its strategy to adapt our grid investments to reflect this new reality, and to provide new energy services that customers are demanding." The offering of new energy services suggests the potential for a changing selection environment for LDCs, however, the language does not elaborate on the details of these services. Without providing specifications on what type of new energy services may be provided, it is not possible to distinguish if they are proposing a *transforming* narrative.

Transforming narratives are more actively presented in two of the leadership letters highlighting the *changing sector* theme. Waterloo North Hydro states "We believe the future of LDCs is the transition to a *Smart & Agile Distribution Platform* that connects generators of all types to customers and facilitates new customer needs." The leadership letter goes on to highlight uncertainty regarding the future, but the language clearly indicates the potential for the role of the LDC to change. Less directly, London Hydro promotes the Electricity Distributors Association's (EDA) vision paper for managing distributed energy resources (DER) in the Ontario electricity sector: *The Power to Connect* (EDA, 2017). In this paper the EDA presents LDCs responding to DER by becoming *Fully Integrated Network Orchestrators* and clearly advocates that the LDC sector should be transformed to include new roles and responsibilities in response to new technologies and the services they can offer to the sector and to customers. While London Hydro does not articulate this narrative directly, its leadership letter states that it is "fully supportive of" the vision presented by the EDA.

3.4.3 Interview *conforming* narrative responses

The key informant interviews considered current applications of energy storage technologies, barriers to energy storage technologies, and how energy storage technologies should be integrated at the distribution-level. While there were several current projects involving energy storage technologies described in the interviews, these were all conducted either through pilot programs or with partnership funding. These applications are best understood as protected niche applications rather than regime-based applications of energy storage technologies. Empowerment narratives may be identified as participants elaborate on why they are pursing specific pilot projects and what they hope to achieve in the future based on the results of pilot project; however, these types of projections from pilot projects were not identified in the interview data.

When discussing current barriers to energy storage technologies, *conforming* narratives were identified by participants highlighting barriers aside from regulation – the current selection environment for LDC capital investments – as being the most important, or by identifying participants specifically stating that regulation was not a barrier to energy storage deployment. Seven participants (three medium LDC representatives and four small LDC representatives) identified the barriers to energy storage technologies at the distribution-level using *conforming* narratives. Some of these participants explicitly stated that regulation was not the issue and instead asserted that the technology needed to mature and prove itself or that costs needed to drop to make the business case viable (Table 3-5). This type of narrative suggests that the technology must

improve to compete within the existing selection environment, rather than assuming the selection environment may change to enable energy storage technology applications.

When discussing how energy storage technologies *should* be integrated into the distribution-level, the majority of participants presented *conforming* narratives emphasizing the competitive market driving investment in these technologies. While suggesting that competitive markets would drive energy storage technology, there were some variations in how participants characterized the LDC role. Those presenting LDCs as connectors of the technology mentioned billing and connection protocols but did not suggest major changes in the role of LDCs. Similarly, some of the participants noted that there may be specific applications of energy storage technologies within the LDC distribution network. Based on the responses, LDC applications would compete with traditional distribution system investments. The responses seemed to indicate that energy storage would compete within the existing selection environment and, where cost-effective, would act as an alternative solution.

One participant who emphasized competitive markets driving energy storage technologies suggested the role of the LDC would depend on the scale of the project being undertaken and that LDCs may benefit from distributed energy storage technologies. The response suggests potential for *transforming* the selection environment; however, the language used did not convey a strong statement regarding regulation or the role of LDCs changing. Given the lack of clarity, this response was grouped with *conforming* narratives, which included similar references to the competitive market.

3.4.4 Interview *Transforming* narrative responses

Transforming narratives were less commonly identified than *conforming* narratives in the interview responses. However, regarding current barriers to energy storage technologies, two participants specifically noted the limitations of the current regulatory environment. The narratives employed by these participants more directly suggested that the selection environment requires transformation to apply energy storage technologies at the distribution-level. These participants identified the regulatory model as the barrier limiting approaches they would like to pursue (Table 3-5).

Transforming narratives were also identified, though less common than *conforming* narratives, when participants discussed how energy storage should be integrated with the distribution system. Participant responses in this category suggested that LDCs were best positioned to capture the multiple value streams

associated with energy storage technologies. For an LDC technological application to capture both customer-level benefits and distribution-level benefits seems to suggest the selection environment for LDC investment would need to change or adapt. While the participants did not provide detailed elaboration on their conceptualization for how LDCs would capture multiple value streams associated with energy storage technologies, certain value streams for energy storage technologies are outside of the current conceptualization of the monopoly LDC selection environment.

Table 3-5 - Examples of conforming, boundary questioning, and transforming narratives regarding the current barriers to energy storage technologies at the distribution-level

***Conforming* narratives**	***Boundary questioning* narratives**	***Transforming* narratives**
"I'd have to say, I think right now, [regulators and policymakers are] trying to limit the barriers for LDC. They're trying to do the right thing." *"I don't know that there are any real barriers from strictly a regulatory point of view. "* *"I think it's the state of the technology more than the regulation."*	*"…there's clarity that would be useful as far as how the assets will be treated. Can we confirm what is eligible for rate-based investment…"* *"Right now, you kind of have two options to get into energy storage. One is that the IESO puts out a program that you bid into. The second is that you have some need within your distribution system and that makes it cheaper than the standard poles and wires and you can get it into your rate base. Those are the two extremes of how you can get DER in right now. I'm wondering if there's something in the middle of those two things…"*	*"…in order to invest in innovation, it's not allowed to ever be in rates, it's not simple, or necessarily encouraged, or understood."* *"The ability to offer services [is a barrier]. So, we have to be thinking about non-regulated [affiliate] business because we can't do that through the utility itself, and that makes us think about a different sort of model going forward. We look to be sustainable energy champions, but yet, we can't be in that business as the utility, we have to do that as a non-regulated [affiliate] business."*

3.4.5 INTERVIEW *BOUNDARY QUESTIONING* NARRATIVE RESPONSES

An alternative narrative regarding current barriers to energy storage technologies focused on the need for regulatory clarity. This narrative was not advocating for specific regulatory changes, but participants noted the need for regulatory clarity regarding how these technologies could be utilized by LDCs and what investments would be considered prudent by the regulator. Rather than *transforming* the selection environment, this narrative presented questions regarding the boundaries of the selection environment. While not necessarily presenting a specific *transforming* narrative, neither do these responses present *conforming* narratives; rather, they acknowledge that the selection environment is malleable and open to transformation,

which could be considered a *boundary questioning* narrative. Six participants identified the barriers to energy storage technologies at the distribution-level using components of a *boundary questioning* narrative.

Table 3-5 provides examples of *conforming*, *boundary questioning,* and *transforming* narratives shared by participants responding to the current barriers to energy storage technologies.

3.4.6 Consistency between barriers and role for energy storage technologies

The review of participant responses did not reveal a consistent relationship between those participants who presented *boundary questioning* narratives or *transforming* narrative regarding current barriers to energy storage technologies and those that presented *transforming* narratives regarding how regulation *should* dictate applications of energy storage technologies. Table 3-6 indicates the current barriers identified by participants, summarizes the responses regarding how the sector should be organized, and shows the narratives associated with participant responses.

3.5 Discussion

3.5.1 *Conforming* and *transforming* narratives

Smith & Raven (2012) note that the existence of competing *conforming* and *transforming* narratives for niche empowerment highlight a space for political contestation regarding transitions. *Transforming* narratives may be expected to empower new entrants associated with the niche actors in transitions literature since regime actors benefit from their incumbent position. However, the transformation of the regime selection environment does not necessarily mean reducing incumbent positions within the regime and empowering niche actors. The *transforming* narratives presented by LDC representatives in the interviews, while presented as a means to maximize the value of energy storage technologies across the system, would potentially expand the LDCs' monopoly powers.

Table 3-6 - Consistency of narratives presented by LDC representatives (NOTE ordering does not reflect previous tables that identify LDCs)

		Current barrier response theme				Narrative	Future regulation	Narrative
LDC size	***Current projects***	***Economic***	***Technological***	***Cultural***	***Regulatory***	***Current barriers***	***Response summary***	***Future regulation***
S	none		x			C	LDC can capture multiple benefit streams	T
S	none	x	x		clarity	BQ	LDCs have experience	T
S	none	x				C	Competitive market and LDC applications	C
S	none	x				C	Competitive market and LDC applications	C
S	none	x				C	Competitive market and LDC applications	C
S	none				x	T	LDCs connecting competitive applications	C
M	one	x		x	clarity	BQ	Competitive market and LDC applications	C
M	one					N/A	Hybrid depending on scale of project	C
M	none				x	T	Competitive market and LDC applications	C
M	none	x			clarity	BQ	LDCs connecting competitive applications	C
M	none	x				C	LDCs connecting competitive applications	C
M	none			x		C	LDCs connecting competitive applications	C
M	none	x	x			C	LDCs connecting competitive applications	C
L	multiple	x			clarity	BQ	Competitive market and LDC applications	C
L	multiple				clarity	BQ	LDC can capture multiple benefit streams	T
L	multiple				clarity	BQ	LDC can capture multiple benefit streams	T

This table compiles all the interview participants responses, including the LDCs' current application of energy storage technologies, current barriers for energy storage technology applications, and the future applications of energy storage technologies at the distribution-level. The niche empowerment narrative identified for current barriers for energy storage technology applications and the future applications of energy storage technologies at the distribution-level are also identified (C=Conforming, T=Transforming, BQ=Boundary Questioning, N/A=Not Applicable). Interview participants did not necessarily utilize consistent niche empowerment narratives when discussion current barriers and future applications of energy storage technology at the distribution-level. Additionally, the utilization of various niche empowerment narratives did not appear to be associated with LDC size or LDC experience applying energy storage technologies.

Alternatively, *transforming* narratives could be imagined that would reduce the monopoly position of LDCs. For example, microgrid operators might be deployed to compete with LDCs and offer new services within LDC territories. Literature regarding the regulation of natural monopolies has historically discouraged this competition – referred to as cream skimming – because the most profitable areas within a monopoly sector would be targeted for competition and the incumbent firm would be forced to service the less profitable customers, which is why monopoly firms are given exclusive access to a customer base and the obligation to service all customers in a territory (Armstrong & Sappington, 2006). However, competing rationales for regulation, perhaps favouring local resilience or integration of sustainability criteria, could potentially weaken the rationale excluding microgrid operators within monopoly territories. The narratives examined within this study by LDCs and key informants, notably, did not include *transforming* narratives that might weaken the LDCs monopoly position.

Given the focus on LDC perspectives and the historical understanding of network service providers as occupying a natural monopoly, it is perhaps not surprising that the identified *transforming* narratives identified expanded the incumbent position within the regime. However, further studies utilizing the *conforming* and *transforming* narrative framework should recognize that *transforming* narratives can create opportunities for niche innovators or they can entrench incumbent positions. In relation to the political contestation of transitions, the impact of *conforming* and *transforming* narratives to empower challengers or incumbents is dependent on the context and the details of the narratives employed.

This study focused on a highly regulated sector, and then used the well-defined rules and regulations that govern the LDC sector to define the selection environment boundary and to distinguish between *conforming* and *transforming* narratives. Nonetheless, distinguishing among empowerment narrative types was analytically challenging because the annual reports reviewed and participant responses did not always address the boundary rules in specific language. Therefore, the analysis necessarily relies on interpretation.

Smith & Raven (2012) predicted that empirical study would complicate the duality of empowerment processes theorized, and indeed the *boundary questioning* narratives identified in some participant responses highlight a new potential conceptual category for empowerment narratives. The identification of *boundary questioning* narratives suggests that boundaries of the selection environment are open to contestation. The foundation of c*onforming* narratives is that the conventional selection environment is established, adequate, and appropriate. Therefore, *boundary questioning* could be considered a pre-*transforming* narrative

highlighting contestation of the empowerment process. *Boundary questioning* narratives do not assume that the selection environment is static.

Raven et al., (2016) propose that *conforming* narratives are likely to be more prominent than *transforming* narratives since transforming the selection environment is more difficult than conforming to the established environment. This proposition was supported in this study. While *transforming* narratives were present in both annual reports and key participant interviews, *conforming* narratives were more prominently identified in the data analyzed.

Contrasting the two datasets analyzed in this study – public documents published by LDCs, and private interviews conducted with LDC representatives – shows fewer *transforming* narratives mobilized in the public presentations than in the private interviews. In the leadership letters, of the 46 themes relating to technology and innovation that were identified, only two incidences clearly mobilized *transforming* narratives. In the interview data, of the 31 responses regarding current barriers and future applications that were analyzed, six *transforming* and six *boundary questioning* narratives were identified in the responses. In both cases, *conforming* narratives were more prominently identified, but *conforming* narratives were relatively less common in the interview data. While the public and private nature of these datasets may provide some insight into the observed difference, it is also true that the data being analyzed in both datasets were quite distinct. In the case of the interview data, participants were being asked questions related to issues of regulation and the application of innovative technologies. As a result, these questions were more likely to have elicited responses for clear interpretation using the *conforming* and *transforming* narrative framework. In addition, leadership letters reflect official public presentations by the organizations, whereas interview data were collected from individuals within LDCs and participants were offered anonymity and asked to provide their individual perceptions. While *transforming* and *boundary questioning* narratives were more commonly identified in the interview data analyzed, there are multiple potential variables that may explain the differences between the datasets.

When considering the theoretical role of empowerment narratives, it is useful to consider the position of LDCs within the regime and their relationship to innovative technologies. Technology advocates are expected to link socio-technical narratives to prominent actors' agendas to develop legitimacy (Raven, Kern, Verhees, et al., 2016). As incumbents in the regime, LDC representatives may be a group of regime actors that technology advocates are trying to sway with narratives that build legitimacy. The commonality of *boundary*

questioning narratives in LDC responses to the current barriers suggest that other actors within the regime (e.g., policymakers, technology advocates, or research and policy institutes) who hold stronger positions regarding how these technologies should be integrated into the distribution system continue to have the opportunity to establish either *conforming* or *transforming* narratives for energy storage technologies within the LDC space.

3.5.2 Monopoly regime coherence

The analysis of LDC annual report leadership letters and interviews with key participants regarding energy storage technologies based on Smith & Raven's (2012) *conforming* and *transforming* framework reinforces the statement that some regimes are of a semi-coherent nature. Even within a well-defined, highly regulated, non-competitive regime, actors shared both *conforming* and *transforming* narratives for empowering new technologies, as well as some *boundary questioning* narratives.

The contrasting narratives identified in this study, which focused only on a narrow subset of regime actors, should reinforce the complex nature of regime actor perspectives, and likely complex regime actor behaviour. While LDCs are important actors in electricity distribution regime, they are not alone in the regime. Other actors within the regime, such as policymakers, regulators, and generators and consumers who use the distribution services also contribute to socio-political contestation of the regime transitions, along with niche actors. While competing narratives regarding niche empowerment were identified within the study's subgroup of regime actors, it is also possible – and likely probable – that competing narratives of innovation for the distribution sector are promulgated by other actors within the regime who were not engaged in this study.

Even small subgroups within regimes may be made up of numerous unique actors with diverse perspectives and visions for the future. When considering sustainability transitions, presentations of how regime actors, and their incentives and behaviours, will influence transition dynamics should reflect and acknowledge the complex reality that even within subgroups of regime actors a diversity of perceptions, attitudes, and visions likely exist. While simple conceptualizations, such as "incumbent versus challenger" roles or "regime versus niche actor" distinctions, may provide starting points for considering transitions dynamics, the reality is likely much more complex.

3.5.3 Monopoly regime relationship to innovation

By examining the LDC leadership letters, it is possible to explore what these monopoly regime actors choose to present to the public. In examining the mentions of technology and innovation, common themes regarding what LDCs presented emerged. As discussed above, the majority of those mentions used *conforming* narratives that did not challenge the existing selection environment. The LDCs studied most commonly chose to highlight their investment in traditional distribution assets for the purpose of enhancing reliability and mentioning new systems to improve communication and operational improvements. These themes reflected activities associated with supplying customers with reliable and efficient services, which represent the LDC's core activities.

The three additional themes identified in LDCs leadership letters – *specific emerging technologies*, the *changing sector*, and *strategies of innovation* – are less associated with the core activities of LDCs; however, all the leadership letters analyzed mentioned at least one of these three themes. Despite being outside of the core activities of LDCs, it is notable that LDCs have chosen to highlight these themes in their public presentations.

The production of *specific emerging technologies* and *strategies of innovation* themes were never identified with *transforming* narratives. However, the LDC leadership letters commonly promoted pilot projects, implementation of emerging technologies (primarily by affiliates), and a pursuit of innovation, often simply as an abstract idea. The commonality of these themes within the leadership letters suggests that LDCs want to promote their embrace of new technologies, and innovation in general, despite occupying incumbent monopoly positions within the electricity distribution regime. While LDCs may be protected from direct competition, there appears to be an interest in highlighting their acceptance and engagement with innovation; this is further reinforced by the LDC interest in acknowledging that the electricity sector in general is changing. If new technologies are emerging and the sector is changing, there is an argument that LDCs benefit by aligning themselves with and promoting their ability to embrace those changes. The major risk to monopoly incumbents is not technological innovation impacting their sector or new entrants, but rather institutional innovation that reduces their monopoly position. If the monopoly incumbents can embrace and utilize technological innovations, there may be less reason to consider institutional changes, potentially threatening monopoly positions, to take advantage of the new technologies.

Interestingly, only one of the LDCs referenced the *transforming* narrative presented by the EDA, which is an industry association that is intended to present a collective perspective for many LDCs. Based on the analysis in this study, the EDA's *transforming* narrative has not been widely shared by LDCs in their voluntary public presentations. The lack of alignment between the industry association and many of the public presentations offered by the sector could have multiple interpretations. The EDA may be favouring a vision for the future that is not representative of the firms within its association, or the narrative presented by the EDA may not yet be gaining support within the coalition but will grow over time. Alternatively, many LDCs may prefer for the EDA to present a *transforming* narrative rather than share these narratives themselves.

The discourse regarding the *changing sector* theme was presented in a number of leadership letters; however, smaller LDCs highlighted this theme more often and noted challenges and effort in relation to managing the changing sector. The data and analysis of this study does not warrant strong conclusions, but the analysis does anecdotally indicate that smaller LDCs with less access to resources may feel greater pressure from sector change. Despite this potential indication in the data, it should be reinforced that all LDCs discussing sector change chose to highlight this theme voluntarily in their public presentation of firm activity and all firms noted at least positive or neutral framing of sector change. Additionally, because of the limitations of the data, no conclusion regarding the explanatory power of this finding should be inferred without more research.

Although size of LDC, based on the number of customers, was used to distinguish between LDCs in the study, there did not appear to be strong relationships between this metric and the types of narratives identified in the analysis. While transforming narratives were not identified in leadership letters in relation to pilot projects, interview participants from LDCs with current pilot projects did appear more likely to employ *boundary questioning* narratives in relation to identifying current barriers to energy storage technology applications. The three large LDCs who participated in interviews for the study had multiple current pilot projects involving energy storage technologies. Only two mid-sized LDCs had current pilot projects, while none of the small LDCs had current pilot projects. However, despite the variation in current pilot projects, representatives from small, medium, and large LDCs all employed *conforming*, *boundary questioning*, and *transforming* narratives.

3.6 Conclusion

This study contributes to a growing body of literature that employs discursive approaches to understand socio-technical transitions (Bosman et al., 2014; Geels & Verhees, 2011; Hermwille, 2016; Isoaho & Karhunmaa, 2019; Roberts, 2017; Rosenbloom et al., 2016). Focusing on the Ontario electricity distribution sector, this study aimed to analyzed LDC public presentations regarding technology and innovation and LDC representatives' perceptions of energy storage technologies to identify *conforming* and *transforming* empowerment narratives being used (Smith & Raven, 2012). LDCs are an important subgroup of actors in the Ontario electricity distribution regime.

The results reinforced the semi-coherent nature of regimes (Bosman et al., 2014; Fuenfschilling & Truffer, 2014; Rosenbloom et al., 2016): heterogenous narratives were identified in both the interview data and public presentations. Even among LDCs, a subgroup of regime actors, who all operate non-competitively under a consistent, well-defined regulatory framework, competing narratives regarding innovation empowerment were identified. Transitions involve complex interactions between the regime and niche-level innovations. Given that regimes include diverse actors, it should not be surprising that some of these actors may perceive and respond to innovation in contrasting ways. The MLP provides a heuristic for describing transitions dynamics, but the findings here add to literature that has highlighted the complex, and sometimes inconsistent, relationship between regime actors and niche innovation (Berggren et al., 2015; Bosman et al., 2014; Fuenfschilling & Truffer, 2014; Geels et al., 2016; Penna & Geels, 2015; Rosenbloom et al., 2016).

The study results support the proposition that *conforming* narratives are likely to be more prominent than *transforming* narratives (Raven, Kern, Verhees, et al., 2016). Indeed, the analysis of both interview responses and public presentations identified greater use of *conforming* narratives. In the analysis of leadership letters, only two mentions of technology or innovation utilized *transforming* narratives. Concerning the interview data, the analysis identified *conforming*, *transforming*, and a third category of narrative referred to here as *boundary questioning*. *Conforming* narratives were most prominent in the responses analyzed but *transforming* and *boundary questioning* narratives were also used to describe the integration of energy storage technologies into the distribution system.

The identification of *boundary questioning* narratives offers a theoretical contribution to the empowerment framework proposed by Smith & Raven (2012). The framework relies on the interpretation of the *selection environment* boundaries. *Conforming* narratives either assume the selection environment is fixed

or suggest the selection environment *should* remain unchanged, whereas, *transforming* narratives suggest that the selection environment *can* and *should* change. *Boundary questioning* narratives acknowledge that the selection environment *can* change, but they do not provide a clear normative judgement regarding whether the selection environment *should* change.

Sustainability transitions are conceptualized as complex socio-technical processes (Markard et al., 2012). Accounting for the socio-political dimensions of transitions has been a noted theoretical challenge (Meadowcroft, 2009, 2011; Shove & Walker, 2007). Discursive approaches offer a means to analyze the competition of ideas within transitions. Where available, annual reports provide a rich source of data to explore how actors position themselves publicly. This study collected a snapshot of data to determine the coherence of narratives used by regime actors. Future research may be able to use data available in annual reports to explore how, or if, key actor narratives, such as those of utilities, evolve though time. Transitions are long-term dynamic processes, so exploring the evolution of narrative positions of key actors may enhance theoretical conceptualizations of socio-political change through transition processes.

Chapter 4 - Narratives and framing of energy storage deployment: Media analysis of California and Hawaii newspapers

4.1 Introduction

To mitigate severe climate change disruptions to social and ecological systems, energy systems must be rapidly and significantly transformed to reduce associated greenhouse gas emissions (IPCC, 2018a). Sustainability transitions research emphasizes the importance of understanding long-term technological changes through a socio-technical systems lens that acknowledges interaction among technology, actors, and institutional structures, such as norms, values, and rules (Geels, 2004; Hughes, 1987; Markard et al., 2012; Rip & Kemp, 1998). Because transitions are multi-actor processes, they are inherently political (Meadowcroft, 2009, 2011; Shove & Walker, 2007); various actors within a transition have competing incentives, problem frames, and goals. While measuring the material changes of technological systems, such as the deployment of a new technology, is complicated in its own right (Grubler et al., 2016; Sovacool, 2016), measuring the socio-political dimensions of a transition – the evolving actor coalitions, power dynamics, and institutional structures – is even more challenging (Avelino & Wittmayer, 2016; Geels, 2014; Kern, 2015; Markard et al., 2012). Discursive approaches have emerged as a means to explore political contestation during transitions, because they analyze competing ideas that influence social and political debates (Bosman et al., 2014; Geels & Verhees, 2011; Rosenbloom et al., 2016).

While the political contestation of transitions is likely to take place in multiple venues, media analysis offers a representation of the public discourse that can identify prominent political debates and how these evolve through time. Media analysis provides a useful tool for examining discourse over long-term transitions because media institutions are continuously producing documents that discuss *newsworthy* topics of public interest and public debate, at least, as deemed by those media institutions (Harcup & O'Neill, 2017; Strömbäck, Karlsson, & Hopmann, 2012). The media, such as newspapers, both influence and reflect broader public discourses. Although media impacts on political debate vary with changing media environments (Cacciatore, Scheufele, & Iyengar, 2016; Valkenburg, Peter, & Walther, 2016), the media have some capacity to frame the political debate and highlight issues as publicly important (Fischer, 2003; McCombs, 2004; Scrase & Ockwell,

2010; Shoemaker & Vos, 2009; Soroka, 2002). News media coverage and the framing of issues can influence the official political debate (Green-Pedersen & Stubager, 2010; Walgrave, Soroka, & Nuytemans, 2008). Additionally, political actors may use media to broadcast their agenda to the public (Brisbois, 2019, 2020; Raven, Kern, Smith, Jacobsson, & Verhees, 2016; Tewksbury, Jones, Peske, Raymond, & Vig, 2000). While there is no direct relationship between media discourse, political positioning, and policy decisions, longitudinal analyses of media discourse can provide insights into the evolving socio-political dimensions of long-term transitions processes by identifying evolving frames in media coverage (Rosenbloom, 2018).

Over the past decade there has been an increased deployment of energy storage technologies (ESTs) within electricity systems, at utility scale and in distributed, behind-the-meter applications (IEA, 2019; U.S. DOE, 2016; Zinaman, Bowen, & Aznar, 2020). ESTs have commonly been championed as an important component within *sustainable* electricity systems (Arbabzadeh, Sioshansi, Johnson, & Keoleian, 2019; Bogdanov et al., 2019; Davis et al., 2018). ESTs offer a useful case for exploring discourse evolution in relation to electricity system transitions because these technologies have multiple potential applications (Ferreira et al., 2013; Gallo et al., 2016; Luo et al., 2015), some of which may be transformative (Gaede & Rowlands, 2018; Grünewald et al., 2012). Additionally, the relative novelty of many of these technologies within electricity systems means that there is some institutional ambiguity regarding their regulation and application (Grünewald et al., 2012; Harold et al., 2014; RMI, 2015; Winfield, Shokrzadeh, & Jones, 2018; Zame et al., 2018), which creates potential for political debate. Previous research has analyzed the media discourse regarding ESTs within Canada (Ganowski et al., 2018) and internationally (Ganowski & Rowlands, 2020).

This study examines media representations of ESTs in the leading newspaper in each of the two leading jurisdictions for deployment of ESTs in the United States: California and Hawaii (SEPA, 2019; Twitchell, 2019; Zinaman et al., 2020). The study is intended to complement previous research by adding greater empirical data regarding media discourse around ESTs during early phases of deployment by analyzing the media discourse in jurisdictions with high levels of deployment of these technologies. In line with past research, the study employs the socio-political evaluation of energy deployment (SPEED) framework to examine media frames associated with EST media coverage (Ganowski et al., 2018; Ganowski & Rowlands, 2020). In addition, this study applies an inductive qualitative reading of EST coverage to identify themes of EST coverage in each newspaper. This study asks: 1) How has discourse regarding ESTs evolved between July 2010 and December 2019 in each newspaper? 2) How does the evolution in coverage of ESTs compare between the two newspapers?

In the following section, jurisdictional and media contexts are elaborated and further details about the SPEED framework are provided. This is followed by a detailed description of the study methods, then a presentation of results, a discussion section that compares results across newspapers, and a conclusion section. Additional information about the coding and data analysis is provided in Appendix C - SPEED frame codebook and Appendix C.

4.2 Background

4.2.1 Jurisdictional contexts

The application of ESTs in the United States is uneven across the country. California is the leading jurisdiction in the U.S. for EST applications: it has the most installed systems, the most installed EST power, and the most EST energy capacity (SEPA, 2019). Hawaii is the U.S. jurisdiction with the second most EST systems and the second most EST energy capacity installed (Hawaii ranks fourth for most installed EST power) (SEPA, 2019). Both states have pursued a number of policies that encourage deployment of ESTs (Twitchell, 2019). Despite both states leading in relation to ES deployment, the electricity sectors in California and Hawaii are quite distinct. An overview of each state's electricity sector is provided in Table 4-1.

In addition to being two leading jurisdictions for EST deployment, California and Hawaii offer both complementary and contrasting jurisdictional characteristics. Both states had established renewable/clean energy goals prior to the study period. Although these types of policies do not directly impact EST deployment, a growing share of variable renewable energy (RE) sources in the generation supply mix can enhance the need for flexibility for electricity systems operation and indirectly encourage interest in ESTs (Twitchell, 2019). In both states, these renewable/clean energy goals were increased during the study period, potentially further encouraging the need for electricity system flexibility. By contrast, California is a much larger and more populous state with a much larger generation profile. Perhaps more significantly, when considering the context for ESTs, Hawaii's geography and historical development has resulted in relatively small independent grids that are operated on each island with electricity grid services. To operate these grids reliably, Hawaii's electricity systems have historically relied primarily on petroleum-fired generation, which has resulted in a volatile and relatively high-cost electricity system that is also associated with high greenhouse gas emissions. The contrasting geographies and resulting electricity system structures create unique rationales for EST deployment in the two states.

Table 4-1 - California and Hawaii electricity sectors overview (California Energy Commission, 2019c, 2019b, 2019a; Centre for Sustainable Energy, 2019; EIA, 2019; Hawaii State Energy Office, 2019, 2020; Paulos, 2018; SEPA, 2019)

	California	***Hawaii***
Population	39.5 million	1.4 million
Electricity sector overview	California has a complex electricity sector with numerous actors. Most Californians are serviced by one of three large investor-owned utilities (IOUs); however, there are also three smaller IOUs, over 40 publicly owned utilities (POUs), four rural electric cooperatives, 21 community choice aggregators, and 20 electric service providers. The California Independent System Operator (CAISO) acts as the market operator and transmission operator for most of the state, with 80% of state demand. Electricity generators, including those owned by the major IOUs, bid into the CAISO market. Some of the POUs and cooperatives also act as system operators within their territories. POUs own their own generation facilities or purchase power through contracts.	Hawaii is serviced by four utilities, all of which are regulated by the Hawaii Public Utilities Commission (PUC). Three of the utilities are subsidiaries of Hawaii Electric Industries, an investor-owned company. Collectively, these three utilities service approximately 95% of Hawaii's population. The remaining utility, Kauai Island Utility Cooperative (KIUC) operates as a cooperative. There are no interconnections between islands; therefore, each of the six Hawaiian Islands with electricity grid services is independently operated. The Hawaiian utilities provide generation and systems operation services, as well as contract generation through power purchase agreements.
Annual in-state generation (2018)	194.8 TWh	10.5 TWh
Generation profile (2019)	46.5% natural gas, 14% solar, 11.3% hydro, 9.4% nuclear, 7.2% wind, 5.9% geothermal, 3% biomass, 2.2% small hydro, 0.2% other, 0.2% coal, 0.2% oil[1]	61.3% petroleum, 11.9% coal, 11.2% solar, 4.9% wind, 4% other, 2.9% geothermal, 2.8% biomass, 0.9% hydro
Notable energy policies impacting ES	• In 2002, a 20% renewable energy portfolio requirement for 2017 was established. • In 2013, an energy storage procurement target of 1,325 MW by 2020 was issued by the California Public Utilities Commission. • In 2015, a 50% renewable energy portfolio requirement for 2030 was established.	• In 2008, the Hawaii Clean Energy Initiative (HCEI) mandated 70% clean energy by 2030. • In 2015, the HCEI mandate was updated to achieve 100% clean energy by 2045. • In 2016, the Customer Self-Supply Program was introduced, which required residential and commercial solar customers to install

[1] Reflects generation in California and within a control area serving California, see California Energy Commission (2019a)

	• In 2016, a program modification to the Self-generation Incentive Program allocated 75% of its budget to ES. • In 2018, California established a 100% clean energy mandate by 2045.	energy storage capacity or to limit energy exported to the grid. • In 2017, the Smart Export program was established to incentivize customers with batteries to supply energy to the grid during periods with low solar generation.
Average residential rate (2018)	US$0.19/kWh	US$0.31/kWh
Average industrial rate (2018)	US$0.12/kWh	US$0.25/kWh
Number of energy storage systems (2019)	9,996	2,969
Installed ES power (2019)	427.6 MW	73.6 MW
Installed ES energy (2019)	966.9 MWh	217.4 MWh

4.2.2 SPEED FRAMEWORK

The SPEED framework offers an approach to analyzing media framing of energy technologies (Stephens et al., 2014, 2008). This framework was developed to offer a jurisdictional-level tool to explore socio-political contexts, such as regulation, institutions, and public acceptance. As media cover various topics certain aspects are made salient within the coverage while many other aspects are not included (Cacciatore et al., 2016; Entman, 1993; Scheufele & Tewksbury, 2007). Media frames refer to those aspects of a topic that are made salient in coverage. The SPEED framework identifies framing categories that are likely to influence discourse regarding energy technologies: technical, economic, political, regulatory and legal, environmental, and cultural (Stephens et al., 2014); however, various energy researchers have adapted these categorizations to their specific purposes (Dusyk, Axsen, & Dullemond, 2018; Stephens et al., 2014, 2008).

Researchers have applied the SPEED framework to analyze media discourse regarding large infrastructure projects (Dusyk et al., 2018), smart-grid deployment (Langheim et al., 2014; Mallett, Jegen, Philion, Reiber, & Rosenbloom, 2018a; Mallett, Stephens, et al., 2018; Peters, Axsen, & Mallett, 2018), wind generation (Stephens, Rand, & Melnick, 2009), carbon capture and storage (Chaudhry et al., 2013; Feldpausch-

Parker et al., 2013), and ESTs (Ganowski et al., 2018; Ganowski & Rowlands, 2020). By categorizing and quantifying media framing, researchers are able to compare public debates, as represented in the media, across jurisdictions, which can provide insights regarding political coalitions, identify contextual barriers and opportunities to the deployment of energy technologies, and potentially inform future policy design approaches and decision-making.

4.2.3 MEDIA CONTEXT

The newspaper media landscapes in California and Hawaii are quite different. With more than 28 times the population of Hawaii, California has multiple daily newspapers covering state and local news with average circulation exceeding 100,000. The *Los Angeles Times* describes itself as the largest metropolitan daily newspaper in the United States. By contrast, Hawaii's newspaper landscape has a single daily newspaper with a circulation greater than 100,000 readers, the *Honolulu-Star Advertiser*, although there are several smaller circulation daily newspapers that tend to focus on regional coverage for a specific island. Given the comparative difference in each state's population size and newspaper landscape, this study focused only on the largest circulation newspaper from each jurisdiction and to explored how EST coverage has evolved in each publication. Previous research has examined leading newspapers to compare state-level discourse regarding early phases of energy technology deployment (Stephens et al., 2009). Table 4-2 provides a brief overview of the two newspapers selected for this analysis.

Table 4-2 - Overview of newspapers selected for analysis (Los Angeles Times, 2020b; MBFC, 2019b, 2019a; Oahu Publications Inc., 2020)

	Los Angeles Times	***Honolulu Star Advertiser***
Editorial leaning	Slight to moderate left-centre	Slight left-centre
News coverage	State, national, and international news; business, science, entertainment, sports, lifestyle, opinion	State and regional news, politics, sports, business, opinion
Daily circulation 2020 (different terms reflect language available from each newspaper)	1,300,000 readers	285,619 reach
Sunday circulation 2020	2,000,000 readers	314,854 reach

4.3 METHODS

4.3.1 DATA COLLECTION

Data collection was completed on January 7th, 2020 using the LexisNexis database. The search included articles from the *Los Angeles Times* (LAT) and the *Honolulu Star-Advertiser* (HSA) that were printed between the dates July 1, 2010 and December 31, 2019, inclusive. The data collection period reflects the fact that the HSA published its first edition on June 7, 2010. The HSA was established when the two competing newspapers, the *Honolulu Star-Bulletin* and the *Honolulu Advertiser*, each with more than 120-year histories, merged (Honolulu Star-Advertiser, 2020). (Auman (2007) highlights the unique history of these competing institutions and their distinct identities.) The LAT has a comparable 138-year history (Los Angeles Times, 2020a).

The following search parameters were used to identify articles of relevance:

> ("energy storage" or "power storage" or "electricity storage") OR (battery AND grid) OR ("utility-scale battery") OR ("vehicle-to-grid" or "vehicle to grid") OR (flywheel or "pumped hydro" or "flow battery" or "fuel cell" or "lithium-ion battery" or "thermal storage" or "thermal energy storage" or "lead-acid battery" or "compressed air" or "power-to-gas")AND (project or facility or system)

These search parameters were informed by the previous research examining newspaper media framing of ESTs (Ganowski et al., 2018). Subsequent modifications were introduced to capture articles describing potential applications of ESTs that might otherwise have been missed, particularly vehicle-to-grid applications and discussions of ESTs not related to a specific project (e.g., battery AND grid).

Once the initial search was complete, articles were reviewed to ensure their relevance to the study. The focus of the study was ESTs that integrate with electricity systems or that substitute for electricity system services (e.g., going off-grid). The collected articles were reviewed, and non-applicable articles were removed from the dataset. Articles that were removed typically referenced battery technology in relation to transportation technology (e.g., electric vehicles, batteries on planes or boats), consumer products, or in the case of the LAT there were several articles related to a battery recycling facility. If articles focused primarily on non-applicable topics but mentioned electricity system integrated ESTs or ESTs substituting for electricity grid services in some form, they were retained in the dataset.

4.3.2 DATA ANALYSIS

The data analysis of newspaper articles was conducted using NVivo 12 Plus software. The articles from each newspaper were classified based on their word count, year of print, ES technologies mentioned, and EST focus to capture the salience of ESTs within each article. The EST focus refers to the salience of ESTs within articles, and the categorization distinguished between articles *mentioning* ESTs (EST-M), including a *subsection* about ESTs (EST-S), or *focused* on ESTs (EST-F). These classifications were based on previous research capturing salience of energy technologies in the media (Ganowski et al., 2018; Ganowski & Rowlands, 2020; Langheim et al., 2014; Mallett, Jegen, Philion, Reiber, & Rosenbloom, 2018b). A detailed description of this classification process is included in the supplemental data analysis document (Appendix B).

For EST-S and EST-F articles, the analysis included a quantification of benefit and risk frames used to discuss ESTs, and an evaluation of the articles' overall valence (i.e., the article tone) regarding ESTs. The SPEED framework (Stephens et al., 2014, 2008) was deployed to identify benefit and risk frames used in relation to ES. The coding in this study focused on frames as *thematic* units rather than *physical* units (Riffe, Lacy, & Fico, 2008). Rather than trying to measure the number of words, sentences, or paragraphs within an article utilizing a specific frame, the coding was based on the *concepts* being articulated. Each SPEED benefit or risk frame can be invoked in multiple ways, which are identified as *concepts*. Concepts can be understood as subthemes within each SPEED frame. Further details are available in the SPEED frame codebook (Appendix C). In addition to capturing the presence of a concept, the coding also quantifies concepts that were revisited and reinforced within an article (See Appendix B).

Each EST-S and EST-F article was also assessed as having a positive, negative, or neutral valence towards ESTs. While the tally of SPEED benefit and risk frames was used to inform the assessment of article valence, the coder did not simply tally the benefit and risk concepts coded, rather the valence evaluation was ultimately a reflection of coder interpretation of the article orientation towards ESTs (Appendix B).

Once a preliminary codebook was developed, intercoder reliability (ICR) testing was conducted to assess the reliability of EST-focus assessments, SPEED frame coding, and article valence evaluations. The primary research and a second coder initially reviewed and discussed the codebook, then each coder practiced coding a small number of articles separately that were then discussed to ensure adequate concept agreement. After each coder was thus familiarized with coding approach, a random sample of articles (n=50) was selected for reliability testing. The ICR testing identifies binary agreement for EST focus assessment of articles and

article valence evaluation; the analysis of SPEED frames identifies the agreement regarding the number of concepts identified in each article. In addition to comparing percentage agreement, Krippendorff's α analysis was conducted using RECAL (http://dfreelon.org/utils/recalfront/) to compare results (Connor & Joffe, 2020; Feng, 2014).

Percentage agreement ranged from 60% to 100% and an average of 88% agreement. The least compatible result was for technical benefit frames, followed by EST-S categorization at 76% agreement. However, the more sophisticated Krippendorff's α analysis identified only two out of 18 measures of agreement to meet standard levels of acceptability. Given the lack of high-level reliability, the subjective nature of the coded and quantified analysis should be acknowledged. While the low reliability agreement presents a limitation to the generalizability of the results, the thorough analysis, though subjective, can still offer valuable insights into the EST coverage in two leading states for these technologies deployment. Further discussion of the ICR testing and potential issues that impacted the agreement are offered in Appendix D.

To further explore the EST coverage, the EST-S and EST-F articles for each newspaper were reviewed chronologically and major topics of the coverage were recorded, including noting applications of ESTs, the value propositions for ESTs presented in articles, and contested positions related to ESTs. The topics collected for each year were reviewed and, using an inductive approach, the articles were read again to identify emergent themes to describe the evolution in EST coverage. Based on the evolution of themes, phases of coverage were developed to describe changing value propositions presented for ESTs and changing conflicts or concerns associated with ESTs. Themes were explored further through post hoc word queries related to terms and phases. A comparative discussion regarding the coverage in each newspaper was taken up in the discussion section, based on the thematic analysis.

4.4 Results

4.4.1 Overall coverage

In total, 590 articles were collected by the search parameters from the two newspapers. After an initial review, 38 articles were removed because they were not relevant to the research purpose. Once this review was complete the dataset included 370 articles published by the HSA and 182 articles published by the LAT. The HSA published 203 EST-M, 59 EST-S articles, and 108 EST-F articles and LAT published 113 EST-M articles, 22 EST-S articles, and 47 EST-F articles. For both newspapers, more than half of the articles collected were

EST-M; these were articles that included the search terms but did not discuss ESTs in much detail (i.e., three sentences or less discussing ESTs).

Figure 4-1 - Number and type of ES articles published per year by newspaper shows the number and types of articles published by each newspaper over the data collection period. The HSA publication of EST articles peaked in 2016, whereas the LAT publication of EST articles has two peaks, one in 2016 and a second in 2019. Through most of the sample period (i.e., 2010-2018) the HSA published more EST articles per year than the LAT, but in 2019 the LAT published more EST articles (43) than did HSA (34). To situate EST coverage within each newspaper's overall coverage, a search for all articles published during the entire data collection period was done using the LexisNexis database. Overall, LAT published 1.82 times more articles (344,864) total than HSA (188,819) during the data collection period.

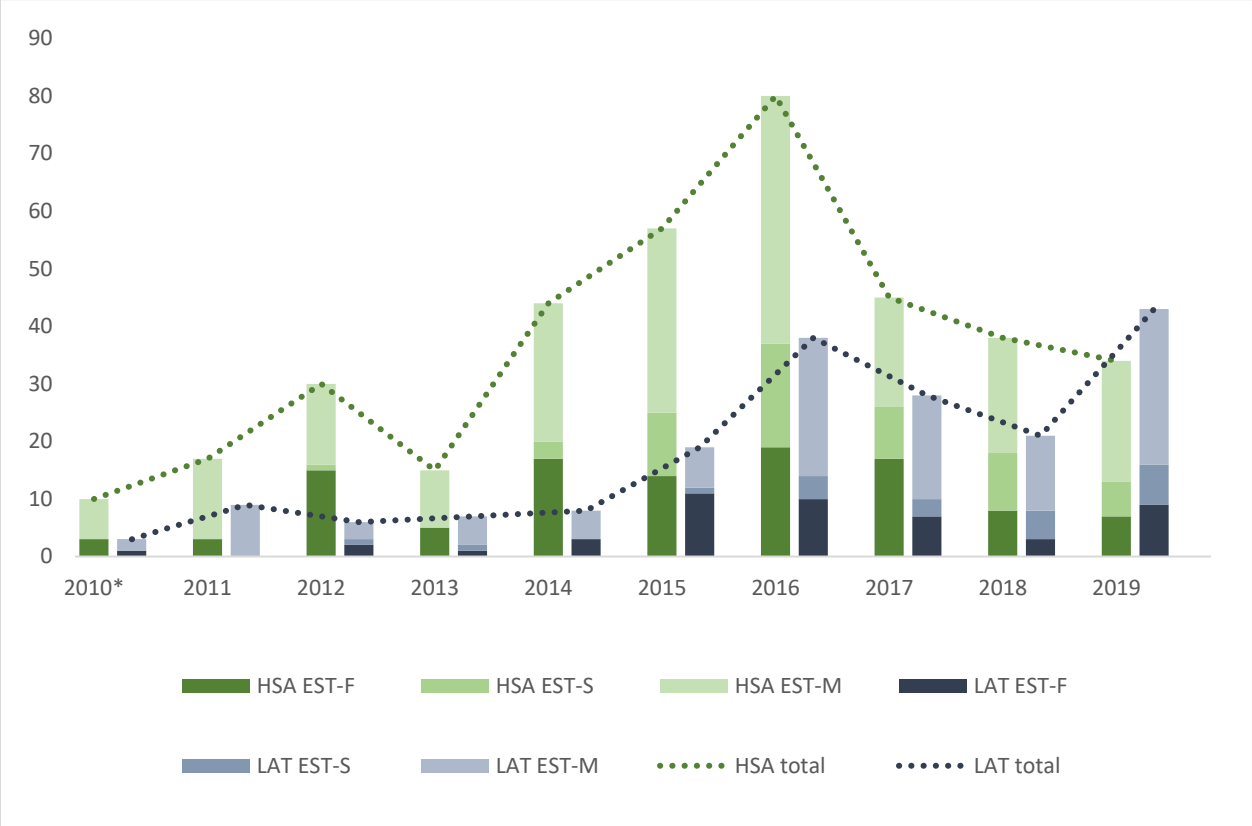

Figure 4-1 - Number and type of ES articles published per year by newspaper
**refers to articles printed July 1, 2010 – December 31, 2010*

EST-S and EST-F articles from each newspaper were used for SPEED frame analysis, valence evaluations, and to identify evolving coverage themes. Figure 4-2 Number of ES articles by ES article word count by newspaper presents the number of EST-S and EST-F articles by article word count from each

publication. Although the HSA published more EST articles than the LAT, the LAT published more long-form articles (35) that were greater than 1000 words and did not publish any EST-S or EST-F articles that were less than 250 words. Of the four article-length categorizes for EST-S and EST-F articles, most of the HSA articles (69) were between 501 and 1000 words and the fewest (16) articles were more than 1000 words.

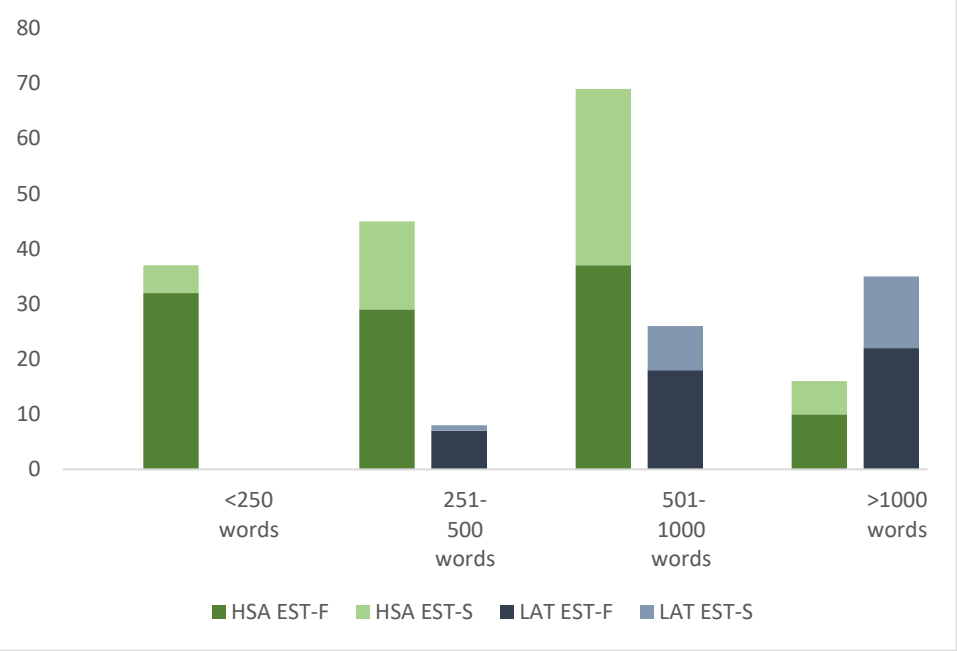

Figure 4-2 Number of ES articles by ES article word count by newspaper

4.4.2 ESTs MENTIONED

Table 4-3 Type of ESTs mentioned by newspaper

Technology mentioned	***HSA***	***LAT***	***Total***
Battery	293	108	401
Pumped hydro	15	9	24
Fuel cell	7	9	16
Thermal storage	8	6	14
Compressed air	4	8	12
Flywheel	7	5	12
Hydrogen energy storage	4	6	10
Vehicle to grid technology	5	4	9
No technology mentioned	60	64	124

Table 4-3 presents specific ESTs mentioned in each article. The majority (401/552) of the articles reviewed mentioned battery technology of some kind, and batteries were the most mentioned EST in both newspapers. Additionally, batteries were the most mentioned EST in each year of coverage reviewed. The next most common EST mentioned was pumped hydro storage, which, however, was only mentioned in 24 articles across the entire period. More (124) articles did not mention any specific EST, than those that mentioned all non-battery ESTs. Fifty articles mentioned more than one form of EST.

4.4.3 SPEED ANALYSIS

A SPEED analysis was conducted to quantify the benefit and risk concepts associated with ESTs in each EST-F and EST-S article. Figure 4-3 presents the total number of benefit and risk concepts coded for each newspaper. Overall, the EST coverage in HSA highlighted a greater proportion of EST benefits. The ratio of benefit-to-risk frames for HSA was 3.1:1 and for LAT was 2.4:1. However, the total SPEED frames coded identified similar patterns of EST presentation at both newspapers. The relative rank of SPEED benefit categories identified in both newspapers followed the same pattern: (most concepts identified to least) technical, economic, environmental, cultural, legal and regulatory, then political. A wide variety of technical benefit concepts were observed in the EST coverage (see the codebook for a non-exhaustive summary). Prominent technical benefit concepts included: balancing RE, improving grid stability, and providing great reliability for grid operators. Comparatively, more technical, cultural, legal and regulatory, and political benefits were noted in the HSA coverage while more economic and environmental benefits were identified in the LAT coverage.

In both newspapers for each SPEED category, fewer risk concepts were identified than benefit concepts. Economic risks were the most identified risk concepts in both newspapers' coverage, but unlike the benefit frames, the relative rank of SPEED risk categories identified did not follow the same pattern for both newspapers. The HSA's risk category rank was economic, cultural, technical, legal and regulatory, and environmental, then political. By contrast, the LAT's risk category rank was economic, technical, political, environmental, cultural, then legal and regulatory. Prominent economic risk concepts observed in the EST coverage included current costs being too high, a lack of market for batteries, and long payback periods. The relatively high emphasis of cultural risks in the HSA's coverage can be linked to a 2012 battery system fire at the Kahuku wind farm (more details provided in the HSA coverage themes section, below).

Figure 4-4 provides a comparison of the SPEED frames identified in the average EST article (includes EST-S and EST-F) from each publication. As described above, the LAT published fewer EST articles than the HSA, but a larger proportion of the articles published by the LAT had a higher word count. The LAT included a higher average number of every SPEED benefit and risk frame than HSA, with one exception: the HSA included a greater average number of cultural risk frames than the LAT, which can be linked back to articles covering the Kahuku wind farm battery system fire.

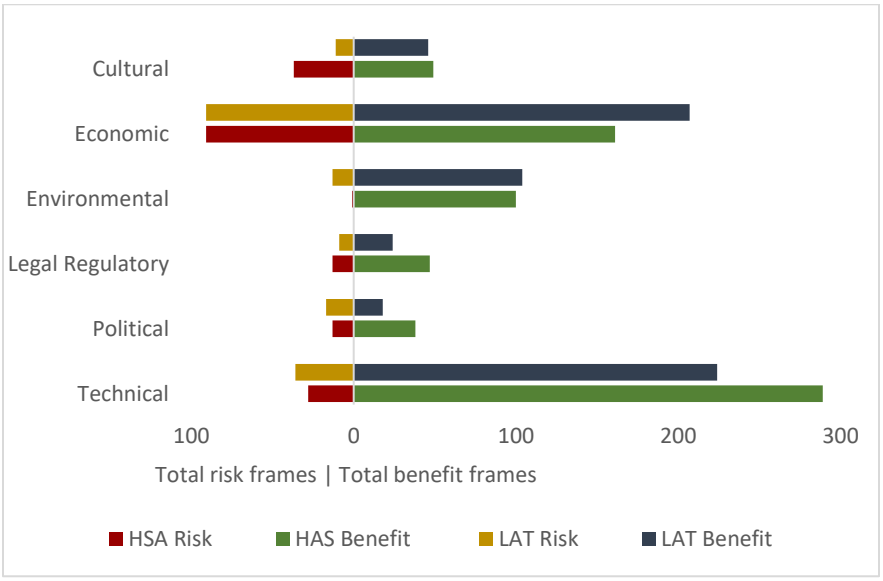

Figure 4-3 Total SPEED benefit and risk concepts by newspaper (HSA n=167, LAT n=69)

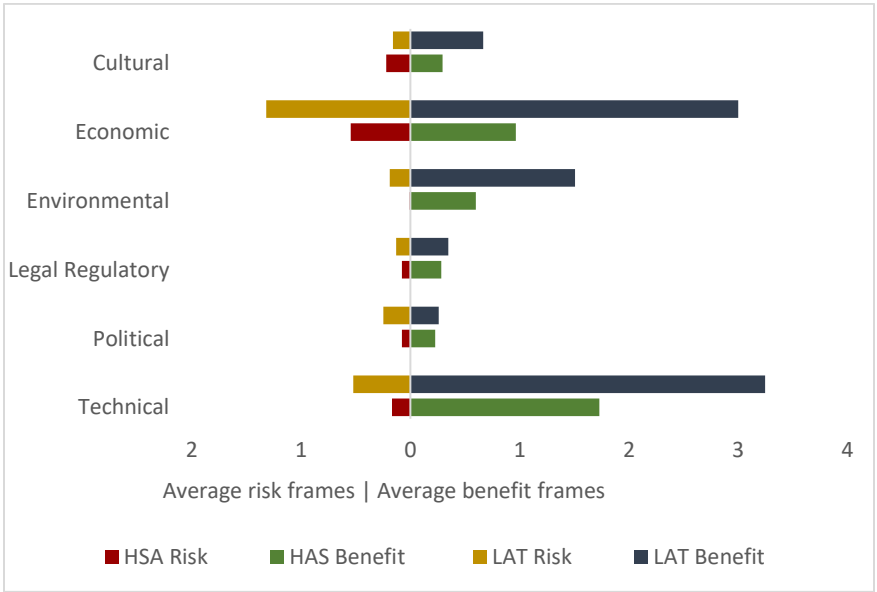

Figure 4-4 Average SPEED benefit and risk concepts by newspaper

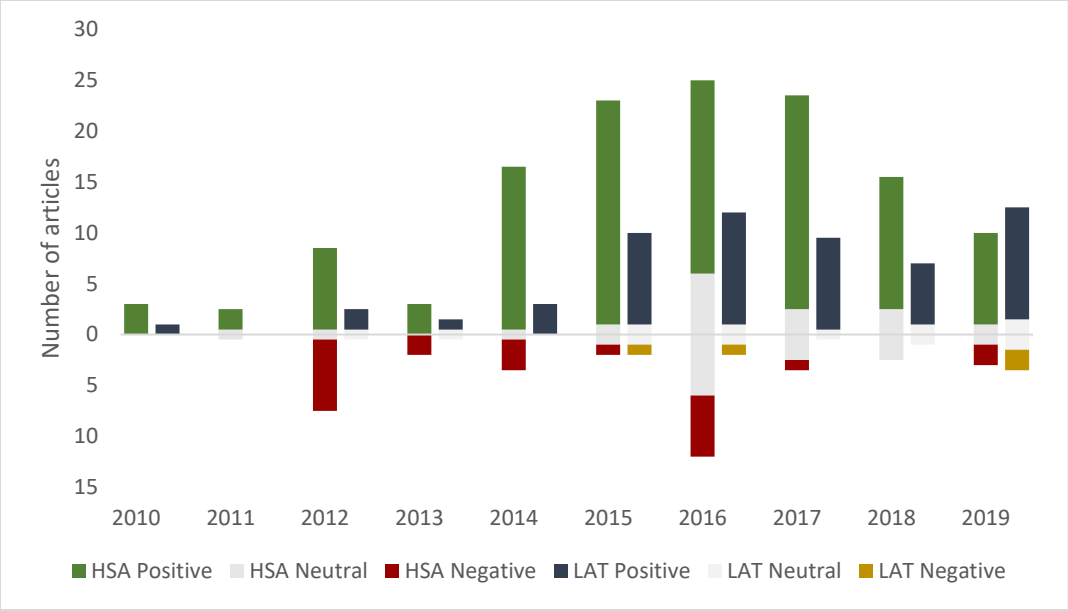

Figure 4-5 ES article valence by newspaper by year

4.4.4 VALENCE

Figure 4-5 visualizes the article valence of EST-S and EST-F articles from each newspaper over the data collection period. For both newspapers, each year was characterized by a larger number of positive valence than negative valence articles. Whereas the HSA published negative valence articles in seven years, the LAT published negative valence articles in only three years. Although the HSA published a greater number of positive valence articles every year, 2012 and 2013 are notable for comparatively high proportions of negative valence articles, 43% and 40% respectively. The year with the HSA's third highest proportion of negative valence articles was 2016 (16%). Comparatively, 2019 was the year with the highest proportion of negative valence articles (12%) for the LAT. Overall, the EST coverage in the HSA was classified as 70% positive, 17% neutral, and 13% negative and in the LAT's EST coverage was 77% positive, 17% neutral, and 6% negative.

4.5 HSA COVERAGE THEMES

Within the coverage of ESTs in the HSA, two streams of EST coverage were identified. The first stream focused on residential and commercial solar photovoltaics (PV) being deployed with batteries (PV+B) and the second stream related ESTs being deployed elsewhere in the electricity grid. Through the analysis of coverage themes within each stream, descriptive phases emerged that represent the shifting coverage of topics, value

propositions, and concerns or conflicts. The phases of coverage do not abruptly end; rather, some overlap in coverage exists.

4.5.1 PV+B PHASE 1: OFF-GRID POTENTIAL, 2014-2015

The earliest coverage of PV+B applications often connected to the potential for customers to move off-grid or suggested PV+B as a potential risk for the utilities' business model. This theme was identified in the HSA coverage as early as 2012, but the media discourse about the off-grid applications concentrated in this phase (10 EST-F, 6 EST-S). During this phase, the popular solar net energy metering (NEM) program was reaching participation limits and newer programs reduced incentives for solar energy produced by customers. Solar companies described growing interest from residential customers wanting to go off-grid or to disconnect from the utility. While some off-grid applications were presented, these customers were described as early adopters. Through this phase of coverage, off-grid applications are described as being too costly for most customers at the moment, but the potential for customers to move off-grid was presented as a future threat to utilities. A portion of the media discourse during this phase suggests that as battery costs decreased the tension with the utilities would grow. The value proposition for ESTs presented with this theme suggested batteries would allow for customer independence and create opportunities to maximize solar generation in the future. The quote below offers a presentation of this theme:

> *"The initial prices for an off-the-grid system are still very expensive, but because of high electricity rates residents can save money over time if they go off-grid, Yost [a solar contractor] said. 'Hawaii has reached a grid-parity, meaning an off-grid system is just as cheap or even cheaper than getting energy from the utility and the reason for that primarily is because Hawaii's electricity is so expensive," Yost said. "Once the technology gets better, if the prices stay high, you will see an exodus of customers who all leave the grid entirely.'"*
>
> (*Honolulu Star Advertiser*, October 5, 2014)

4.5.2 PV+B PHASE 2: BATTERY COSTS HINDER PV+B, 2015-2017

In the second phase of PV+B coverage, the additional cost of battery storage was described as a barrier to customer installation of solar and debates about additional funding mechanisms were covered (16 EST-F, 22 EST-S). In the beginning of this phase, there were stories about solar companies starting to offer battery storage technologies for residential customers. As NEM reached caps for participation, a new solar program was

introduced for residential and commercial customers, the self-supply program, which restricted new solar PV systems from exporting electricity onto the grid. Once the self-supply program launched in 2016, the HSA's EST coverage included periodic updates on PV+B installations. PV+B was presented as offering numerous customer benefits during this period (e.g., storing excess PV generation for later use; providing backup generation during power outages; facilitating growing PV adoption on saturated electricity grids). The primary conflict during this phase was the cost of the technology. The solar sector representatives described the cost of battery storage as a barrier to customer uptake and as a threat to their sector, as well. These concerns are illustrated in the quote below:

> *"A coalition of groups in the solar industry said self-supply isn't a good replacement, in part because batteries are too expensive. 'The utilities pretend that customers can instead choose the self-supply option, but the utilities' own reports show that self-supply is not yet a viable replacement,' said Hajime Alabanza of the Hawaii Solar Energy Association in a statement."*
>
> (*Honolulu Star-Advertiser*, June 23, 2016)

During this period, additional conflicts were identified, potential public funding mechanisms were debated, and battery permitting challenges were described as slowing PV+B deployment.

4.5.3 PV+B PHASE 3: PV+B EXPANSION, 2018-2019

In the third phase of PV+B coverage, most articles discussing PV+B described the varying number of installations; this is a pattern of coverage that was identified beginning in 2016. The HSA tracked and compared the installation of PV on various islands to previous years. While the year-to-year installations of PV varied, in this phase the coverage increasingly highlighted the relatively large proportion of PV installations in the self-supply program or newer programs that also required battery technology. Batteries were most commonly described as providing backup in case of emergency, and opportunities for PV customers to add batteries to their system were mentioned. These elements are identified in the following quote:

> *"Mangelsdorf [a solar contractor] said 'another ray of sunlight this year' will be the accelerating deployment of homeowner-side-of-the-meter energy storage. 'With a potential new customer base of more than 80,000 existing grid-tie PV systems across the islands, the vast majority of them with no battery storage, and perhaps a more acute feeling of vulnerability in*

light of the devastation of other island states such as Puerto Rico, the addition of batteries to even a small initial percentage of that base holds promise,' he said"

(*Honolulu Star-Advertiser*, January 16, 2018)

Although 7 EST-F and 9 EST-S PV+B articles were identified in this phase, the high cost of batteries was highlighted in only two articles (1 EST-F, 1 EST-S). There was much less emphasis on battery costs slowing the PV sector. The coverage identifies few conflicts associated with PV+B during period.

4.5.4 GRID EST PHASE 1: RE STABILIZING, 2010-2013

The first phase of grid EST coverage primarily described large variable RE projects that included battery storage (18 EST-F). The coverage described new projects installed across the state, which were most often wind generation developments with battery storage systems. Notably, a wind development in Kahuku had several fires related to its battery system, including a significant fire that shut down operations in 2012. The most oft-presented value proposition for energy storage during this phase was for stabilizing the output of wind and solar projects, identified in 14 EST-F articles with this theme.

"First Wind hired Xtreme Power to install a 10-megawatt battery system at Kaheawa II that will help smooth out the fluctuations normally associated with wind energy output and allow [Maui Electric Company] to take more of the energy into its grid than would otherwise be possible."

(Honolulu Star-Advertiser, July 16, 2012)

The integration of energy storage was also presented as an opportunity to test new technology. The major conflict during this period related to the safety of battery technology and potential risks associated with the fire at Kahuku (10 EST-F). Four more EST-F articles related to the fire were identified in 2014, and then no more of the HSA's EST coverage mentioned this topic or concern.

4.5.5 GRID EST PHASE 2: RE MAXIMIZING, 2014-2016

During this phase of coverage, there was greater interest by utilities in applying ESTs within their grids to increase the potential for RE. Wind generation projects, including battery systems to smooth fluctuations, continued to be identified in the EST coverage (4 EST-F article noted these types of applications), but these

were no-longer the primary type of grid EST applications highlighted in the coverage. During this phase, coverage of utility pilots, tests, and future projects integrating ESTs into grids began to emerge (11 EST-F, 2 EST-S). ESTs were presented as providing excess capacity for RE on saturated grids and managing variability of generation, particularly related to solar PV. *"Hawaiian Electric Co. officials said Friday they are seeking a contractor to build one or more large-scale energy storage systems that will help the utility absorb larger amounts of solar and other renewable energy on its Oahu grid."* (*Honolulu Star-Advertiser*, May 2, 2014). Concerns regarding the potential lack of cost-effectiveness were identified during the earliest coverage in this phase (3 EST-F in 2014) but not prominently identified throughout this phase. By the latter stage of this phase, projects were presented as supporting the HCEI, and in general few conflicts were presented during this phase.

4.5.6 GRID EST PHASE 3: MAINSTREAM ESTS, 2016-2019

In the third phase of grid EST coverage, utilities across the state began announcing and pursuing EST projects as the lowest cost option to support grid operation. A series of large solar generation projects with utility scale batteries were announced by utilities (18 EST-F, 1 EST-S). The value proposition for these projects were described as multi-dimensional: the projects helped utilities meet their RE goals, reduced fossil fuel reliance, shifted cheap solar generation to meet demand, and provided both cheaper and more stable energy prices.

> *"If approved by the state Public Utilities Commission, the batteries would be the first large-scale power storage systems for the electric grid developed by Hawaiian Electric, though the utility company did test three relatively small 1-megawatt batteries on Oahu, Molokai and Hawaii island about two years ago.*
> *HECO said the two lithium-ion batteries would pay for themselves and save ratepayers money by using renewable power that may otherwise be squandered instead of fossil fuels."*
>
> (Honolulu Star-Advertiser, May 3, 2018)

Few conflicts or concerns were presented in this phase of grid EST coverage. In 2019, a potential tension between centralized large-scale RE generation and a more distributed model was identified, but this was not prominent in the coverage (2 EST-F).

4.6 LAT COVERAGE THEMES

The review of LAT EST coverage did not identify distinct streams of coverage, like those describing HSA's coverage above; however, the examination of EST coverage topics, value propositions, and concerns and conflicts does highlight three phases of coverage. During each of phases 2 and 3, two themes were identified in the phase; these were not distinguished as streams since the themes were not interpreted as evolving into the following phase.

4.6.1 LAT PHASE 1: POTENTIAL OF ESTS, 2010-2013

In general, this phase of LAT EST coverage constitutes relatively few articles, only 4 EST-F and 2 EST-S articles were identified during this 3.5-year period. The articles published discussed potential applications of ESTs, new products, or discussed the sale of a battery company, Ener1. The articles discussed the future value of various ESTs. No clear themes emerged regarding conflicts or concerns in this phase.

4.6.2 LAT PHASE 2: PUC EST MANDATE AND EST MARKET DEVELOPMENTS, 2014-2017

In the second phase of LAT EST coverage, two major themes of coverage were identified. The first theme relates to the 2013 mandate imposed on IOUs to install 1,325 MW of EST capacity by 2020 (11 EST-F). The EST mandate was discussed in relation to specific projects and broad changes happening in the sector, such as increasing deployment of RE. EST coverage highlighting the role of this mandate to move projects forward, drive innovation, or establish a market for future ESTs were prominent between 2014-2016, particularly.

> *"The state is stepping in to boost market demand. The California Public Utilities Commission in October 2013 set a target for utilities to bring 1,325 megawatts -- more than half the capacity of the closed San Onofre nuclear plant -- of additional storage online by 2024. As a result, 'storage is going to move quickly,' said Tim Derrick, general manager of advanced solutions for renewable energy giant SunEdison. 'The old model of electricity generation is dying,' he said. 'Grid 1.0, that is dead. We're hastening the evolution of Grid 3.0.'"*
>
> (*Los Angeles Times,* October 11, 2015)

Beyond 2016, the EST mandate was not identified in the EST coverage. Articles highlighting this theme also mentioned the ability of ESTs to balance or help integrate RE, some mentioned state RE goals, and still others

mentioned efforts to reduce greenhouse gas emissions associated with fossil fuel use. The primary concern presented in relation to this theme surrounded costs and the transfer of higher costs to ratepayers, as a result of the EST mandate.

The second theme identified during this phase was coverage of private businesses in the EST sector and their involvement in the developing EST market. Coverage with this theme discussed the market for commercial and residential batteries (13 EST-F, 5 EST-S). All the articles identified with this theme mentioned, and most primarily focused on, the announcements and activities of the company, Tesla, based in Palo Alto, California, which, during this period, developed a large lithium-ion battery production facility, and expanded into the EST market. While EST coverage within this theme also discussed other companies in the sector, most related activities to Tesla in some way, such as highlighting competition between Tesla and Sonnen (a German battery company that led worldwide sales) in the residential battery market. Conflicts and concerns associated with this theme included potential risk to utility business models (in the future), lack of market for backup resident ESTs, and cost concerns.

> *"Elon Musk, the star chief executive of the electric car company Tesla Motors and the rocket company SpaceX, staged an elaborate event last month to unveil a new product. Not a sleek new luxury car. Not a rocket that can ferry people to Mars. A home appliance -- a battery - - that can be mounted on a garage wall and ignored.*
> *The reason for all the excitement is because of what batteries like these might someday do. They may make the electric power grid more robust and able to handle increasing amounts of wind and solar power. In conjunction with rooftop solar systems, batteries may help homeowners reduce their electric bills."*
>
> (*Los Angeles Times,* May 21, 2015)

4.6.3 LAT PHASE 3: RE GOALS AND WILDFIRE RESPONSE, 2017-2019

In the third phase of coverage, two themes were identified. First, California's expanded RE goals increased in prominence in EST coverage. While RE goals were mentioned in the LAT's EST coverage as early as 2014, during this phase the RE goals were more prominently highlighted as factoring into electricity sector decision-making. EST projects were presented as alternatives to new investment in natural gas generation (9 EST-F, 9 EST-S), because they were more consistent with RE goals. In addition to helping to ensure reliability,

large-scale batteries were championed as quick to deploy and potentially providing multiple services to the electricity system with increasing RE integration. A conflict in coverage presented natural gas generation, described as more economical and valuable for ensuring reliability, versus "environmentalist"-championing EST alternatives, which were better aligned with the state's RE goals.

> *"That plan faced pushback from environmental activists and from one of Garcetti's appointees to DWP's board of commissioners, Aura Vasquez. At a board meeting last month, Vasquez pressed utility staff to look beyond gas plants and embrace batteries and other new technologies as a means of providing reliable power."*
>
> (*Los Angeles Times,* February 12, 2019)

A second theme within the EST coverage during this phase, which emerges in 2018-2019 in particular, related to using ESTs rather than traditional electricity system design to manage wildfires (2 EST-F, 2 EST-S). A major wildfire in 2018 was blamed on one of the IOU's, PG&E's, transmission system. To avoid similar liabilities, pre-emptive public safety power shutoffs were used when wildfire risk was high in 2019. These shutoffs resulted in major blackouts for extended periods of time. Within the EST coverage, the potential to deploy ESTs and local microgrid technologies emerged as an alternative to pre-emptive power shutoffs or upgrading traditional transmission systems, whose design and disrepair created risk in fire-prone areas. In relation to this theme, ESTs were promoted as an important component of microgrids and potential source of backup power during shutoffs. A noted conflict in this theme's coverage was a tension between large utilities and those advocating for more decentralized models. Concerns regarding the high cost of battery technologies were raised in the coverage, but this was contrasted with the alternative possibilities of shutoffs and fires. Additional concerns presented related to diesel generation remaining necessary for resilience during multiday shutoffs and the potential for unequitable deployment of ESTs for resilience.

> *"But there's growing opportunity for the technology in fire-prone California communities facing preemptive power shutoffs, said Peter Asmus, a microgrids expert at Navigant Research. Microgrids are still relatively expensive, but Asmus sees a financial case for them at fire stations, water utilities and emergency shelters.*

Microgrids that incorporate solar power and batteries could be especially valuable, Asmus said. Unlike diesel generators, the solar panels will never run out of fuel, and they can recharge the batteries each day."

(*Los Angeles Times,* March 17, 2019)

4.7 Discussion

4.7.1 Comparing EST coverage

The HSA published more EST-S articles than the LAT for all years between 2010-2018. In 2019, the LAT published a greater number of articles that were included in the data collection. Given that the LAT published 1.82 times the number of articles than HSA during the data collection period, EST coverage was a greater portion of overall output by the HSA than the LAT. However, the LAT EST coverage included more longer-form articles. As described above, LAT is a larger publication with greater readership. Although it was not analyzed in this study, it seems plausible that the differences in article lengths observed between the two newspapers reflects that the LAT has more resources in general and as a result publishes more longer form articles, rather than describing anything specifically related to EST coverage. However, this disparity in article length does impact the number of potential SPEED concepts included in coverage. Given that the LAT's EST coverage tends to include longer articles, it may explain why each EST article in the LAT included more SPEED frames on average.

4.7.2 ESTs mentioned

Reviewing the full coverage collected from each newspaper, battery technology was, by far, the most mentioned EST in both publications; this results complements analysis of Canadian and U.K. coverage of ESTs (Ganowski & Rowlands, 2020). Although there are multiple types of batteries, these technologies were grouped because specific electrochemical compositions were not always shared. That being acknowledged, most articles mentioning batteries seemed to refer to lithium-ion batteries. Reflecting on the coverage in more detail, some longer form articles focused primarily on large projects applying other technologies, such as pumped hydro projects or compressed air projects, or speculated on the potential for vehicle-to-grid storage applications, but these technologies were not covered with great frequency. Battery technologies was mentioned in a wide range of contexts: numerous battery storage projects were discussed; Tesla's business developments in the battery

storage space were covered; battery technologies were mentioned in relation to distributed solar markets; and battery technologies were mentioned in relation to policy debates.

In contrast to some of the other forms of energy storage, battery technologies are modular and can be widely deployed throughout electricity systems. Importantly, the disproportionate coverage of battery technologies mirrors the distribution of actual EST installations, which has been dominated by deployment of lithium-ion batteries (SEPA, 2019). Additionally, the diverse technical characteristics and potential applications for ESTs mean that some technologies are likely to generate greater public interest. For example, batteries designed and marketed to residential customers are likely more engaging to general newspaper readers, than, say, flywheel technology, which has most commonly been utilized for regulating power quality within electricity systems (Amiryar & Pullen, 2017). During the period of coverage analyzed, both states effectively saw the birth of distributed, behind-the-meter battery storage markets. From the perspective of the newspapers, there was likely to be greater reader interest in battery technologies, which were developing a broad market, rather than other forms of ESTs, which are primarily deployed by grid operators or developers offering services directly to grid operators.

4.7.3 SPEED ANALYSIS

The overall SPEED analysis identified comparable patterns of EST framing in both newspapers: benefit frames were more prominent than risk frames, benefit frames were ranked in the same order of prominence in each newspaper, and economic risk frames were the most prominent risks identified in each newspaper. Notably, previous studies applying the SPEED frame to examine media coverage of smart grid technologies, which also consider a range of potential technologies (including ESTs) with varying potential applications, in Canada and the U.S. have identified different framing patterns (i.e., the order and ranking of SPEED frames identified) than identified in this study (Langheim et al., 2014; Mallett, Jegen, et al., 2018a; Mallett, Stephens, et al., 2018). The recent studies of EST newspaper coverage have identified a consistent pattern of framing which is distinct from newspaper framing of other smart grid technologies. In addition to highlighting common patterns of media representation in these two newspapers, the results in this study also conform with previous research that has employed the SPEED framework to assess EST coverage in newspapers. While acknowledging the framing analysis here was determined to be relatively subjective and that coding processes across studies are likely to have varied, too, both previous studies of EST coverage identified similar SPEED frame patterns for EST coverage (Ganowski et al., 2018; Ganowski & Rowlands, 2020). The

analysis of Canadian, U.K, and now, U.S. news media appears to indicate a trend in coverage associated with ESTs. Both of the previous studies and this one identified local context influencing the coverage; however, the trend in EST framing across these studies may reflect the characteristics of ESTs specifically.

Technical benefit frames were the most identified frame in EST coverage across these studies. ESTs offer a variety of potential technical services, both behind-the-meter and providing grid services. Given this range of potential applications, EST coverage has the potential to reference numerous benefit concepts, which may provide some explanation for the large proportion of technical benefit frames identified. Traditionally, with the exception of pumped hydro storage where geographically possible, electricity systems have had little capacity to store energy; systems operators have constantly had to match electricity supply to electricity demand, and the increasing deployment of variable RE generation has complicated this process, to some degree. The novelty of EST services, such as offering non-geographically limited storage, may also contribute to the media utilizing technical benefits frames in EST coverage.

In contrast to technical frames, which were much more likely to be presented as benefits, economic benefit and risk frames were both common in EST coverage. Many of the economic benefit and risk frames collected in the codebook are oppositional to each other, which is not the case for technical frames or environmental frames. For example, the economic benefit frames identified include a growing market, job creation, and many installations occurring, but the economic risk frames contend that the cost is too high, the market does not exist, and that the payback period is too long. Part of this tension may be explained by the fact that the market for these technologies was being established during the period of analysis and the cost for common battery technologies decreased significantly over time (Kittner, Lill, & Kammen, 2017; SEPA, 2019). More broadly, it has also been observed that negative economic trends are particularly prominent in news coverage (Langer & Sagarzazu, 2017; Soroka, 2002), which may also influence EST coverage. The changing dynamic associated with cost was identified in the themes of coverage and will be discussed further below.

4.7.4 Valence

Overall, the valence of EST coverage was predominantly positive for both newspapers. However, unlike the SPEED analysis, which presented similar patterns in overall framing between the two newspapers, the valence evaluation indicates more negative coverage in the HSA. The majority of the years analyzed in the LAT had no negative valence articles, whereas there were at least some negative valence articles in most years of the HSA's EST coverage. The LAT's coverage is more in-line with previous valence evaluations of EST

coverage (Ganowski & Rowlands, 2020), which identified 6% negative valence. The years with the greatest proportion of negative valence articles in the HSA were 2012 and 2013 when a significant number of articles discussed the Kahuku wind farm fire. Beyond that two-year window, however, EST coverage in the HSA was predominantly positive. Even a major fire incident only created a short period of negative coverage.

Both the SPEED analysis and the valence evaluation highlight EST coverage that was largely positive, but these two analyses were not completely aligned. The EST coverage in the HSA had a higher ratio of benefit-to-risk frames than did the LAT; however, the HSA's EST coverage had a greater proportion of negative valence articles. It is difficult to clearly attribute the differences in these two analyses. The valence evaluation was meant to complement the SPEED frames analysis and did not simply quantify the benefit and risks frames to determine the article valence, therefore the non-alignment of the two analyses is not inconsistent with the methodology. Part of the discrepancy between these analyses may be explained by the overall coverage or different editorial practices at each institution; the LAT had a higher proportion of long-form articles, which may more easily lend themselves to exploring "both sides" of the issue, highlighting some benefit concepts and some risk concepts. It may also be the case that the local context, particularly the Kahuku fire, influenced coverage and skewed the overall valence of the HSA to appear more negative. While the SPEED frame analysis identified a greater number of cultural risk frames in the HSA coverage associated with the Kahuku fire, the coverage of this incident was predominantly confined to two years of coverage and was less notable when examining all frames in the totality of the HSA EST coverage. In contrast, the valence evaluations from 2012 and 2013 indicate the shift in EST coverage during this period.

4.7.5 Comparing phases of coverage and identified themes

When reviewing the HSA's EST coverage, two streams of articles emerged. One stream of coverage focused primarily on battery technology in combination with solar PV for residential and commercial customers. The other focused on EST more widely deployed throughout electricity grids. The LAT's coverage did not include differentiated streams in the same way. Although some articles in the LAT touched on similar applications of battery technology, and often mentioned PV+B applications, there was not a comparable, consistent focus of coverage on these applications. As noted in the jurisdictional context, Hawaii has higher residential electricity rates, the highest in the country. High electricity rates and generous incentives resulted in rapid deployment of solar PV in the state (Lee, Glick, & Lee, 2020). The high levels of variable solar generation

led to restrictions on solar installations and then in 2016 the launch of the PV+B programs, which prohibited PV installations from sending electricity onto the grid.

The HSA's PV+B stream of coverage highlights an interesting evolution of themes as these technologies are deployed. In the earliest phase of coverage, PV+B was presented as a future risk to the existing utilities: angry with high rates and the utilities' opposition to distributed solar growth, customers will disconnect and go off-grid once battery prices drop. This narrative of customer disconnection through PV+B quickly faded in the next phase, however, when program changes were proposed and then required most solar PV customers to have battery capacity. The narrative of customers disconnecting and going off-grid with PV+B was not identified in any of the HSA's coverage after 2015; instead, the high cost of battery technologies was described as placing increased financial burden on customers wanting to install solar PV. During this phase, many solar industry representatives were concerned about new battery requirements hurting their industry. By 2018, two years after the program began, battery cost concerns received very little attention. By the final phase of PV+B coverage, no thematic conflicts or concerns were widely identified. From one perspective, this evolution in narratives could describe utilities co-opting a potentially competing innovation, but it may also reflect overly optimistic technological expectations for ESTs, or a re-evaluation of the services provided by electricity grids. Despite early predictions that batteries would offer an alternative to utility supplied electricity, at least for the period examined in this study, PV+B was not able to provide equivalent capacity and reliability to grid connected electricity services at a comparable price; therefore, the application of PV+B was integrated into existing electricity services through policy design.

The second stream of coverage in the HSA shows an evolution in broader application of ESTs throughout the electricity grids in Hawaii. In the earliest phase of this stream, ESTs were being applied at the site of RE developments, especially wind turbine developments. In the second phase, pilot applications were pursued to test applications, as well as to support RE goals. ESTs were being pursued to expand the capacity of electricity grids to integrate more variable RE. In the final phase, large solar PV and grid-scale battery projects were being pursued because they were the most economical approach in addition to reducing fossil fuel dependence. By the final stage, these projects were presented as being the best option, based on numerous criteria, rather than batteries being needed to ensure reliability from variable renewable generation sites or pilot projects applying ESTs to test their capabilities (but potentially not being cost competitive). In Hawaii, independent electricity grids are operated on each island and the overall electricity generation is largely based on petroleum-fired power plants, which is high in cost and susceptible to large price fluctuations. Given this

context, ESTs paired with RE offers economic benefits, greater potential to project costs into the future, and a reduction of fossil fuel generation, which supports the HCEI. While the HCEI is highlighted in relation to the EST deployment at grid scale in phases 2 and 3, the goals were not presented as primary driver of EST deployment in the HSA's EST coverage.

In contrast to HSA's coverage, the LAT EST coverage did not have differentiated streams of coverage based on the types of EST application. In the first phase of LAT EST coverage, there were few EST articles published. In contrast to the Hawaii, LAT did not cover EST deployment during this earliest phase. Instead, what coverage there was, was mostly future focused on potential applications of ESTs.

It was only in the second phase of the LAT coverage that stories about EST deployment emerge, and these continued into the third phase. One of the main distinctions between these two phases of coverage was the changing policy rationales presented as driving EST deployment. As stories of EST deployment began to emerge in the second phase, a strong link was made to the California PUC EST procurement mandate which required the large IOU in the state to meet EST capacity targets by 2020. While it was not the only reason presented for these projects, the EST mandate was highlighted regularly between 2014-2016 and then no longer mentioned in EST coverage, despite the mandate targeting installed EST capacity by 2020. In the third phase of LAT coverage, debates about substituting existing and future natural gas generation with RE and ESTs became more prominent. While natural gas remained the more economical source of generation, the California clean energy mandate was mobilized to champion EST alternatives.

It is notable to compare the HSA's coverage of the self-supply program, which required many customers to purchase battery systems and drove EST coverage in the PV+B stream, and the LAT's coverage of the EST procurement mandate. Based on the data analyzed, the LAT did not provide coverage that highlighted policy debates in advance of the EST mandate being passed. This contrasts with the HSA's coverage of changing solar PV program requirements that incorporate batteries. The HSA covered these program requirements in advance and highlighted concerns about increased costs associated with battery technology that were raised by proponents of the solar industry. While the LAT's coverage of projects pursued to meet the EST mandate featured cost concerns, there was no debate in the LAT about these concerns in advance of the EST mandate being established. It is possible that these differences simply reflect different editorial choices; however, a competing explanation may be the policies impacts on the general public. The self-supply program imposed direct costs on any customers who might be considering installing solar PV but could be expected to

help constrain cost increases for the full customer base since the utilities would not have to expand grid capacity to manage the additional solar PV output. In contrast, the California EST mandate had direct impact on the large utilities' decision making and only indirectly on customers. Ultimately the cost of the utilities' decisions would be passed on to all the customers, a point that was often noted once the EST mandate was established, but the impact on any individual customer is much more diffuse. In both cases, policy choices that impacted EST deployment were important themes in EST coverage; however, the policy choices with direct customer impact, and therefore likely to generate greater reader interest, were more clearly debated in the coverage in advance of implementation.

Another point of comparison between the two newspapers' EST coverage relates to each state's RE targets and clean energy mandates. Both states had RE goals in place prior to 2010, and each state instituted, during the study period, similar, ambitious mandates targeting 100% clean energy by 2045. (Hawaii did this in 2015 and California in 2018.) Both policies were described as driving some EST deployment; however, the associated narratives around the clean energy mandates were distinct. In Hawaii, the HSA references to the clean energy mandates were connected to narratives of reducing fossil fuel consumption and increasing energy independence, but only very rarely with concepts of climate change or environmentalism. This was contrasted with the LAT coverage, which, especially in the third phase of coverage, identified the clean energy mandate as driving a contest between environmentalists mobilizing the mandate and those who were supporting natural gas development. In the LAT's coverage, there were regular references to climate change, global warming, and the reduction of greenhouse gases emissions.

The distinctions between each newspaper's coverage could reflect editorial choices, but it may also reflect the different energy contexts and different fossil fuels ESTs are being deployed to replace. In Hawaii, petroleum-fired power generation leads to high and volatile costs; the deployment of RE and ESTs has the potential to provide economic benefits, which seem to be mobilized, at least in HSA's coverage, instead of, rather than in addition to, potential environmental benefits associated with reducing fossil fuel generation. In the LAT's coverage, RE and ESTs were being pursued to replace more economical natural gas generation; consequently, proponents of RE and ESTs needed to advance the climate related benefits, because short-term economic benefits did not as readily exist. Certainly, a more holistic cost-benefit argument including climate impacts would have provided more context and bolstered the argument supporting RE and ESTs in Hawaii, too, thus it remains curious why this dimension of coverage was lacking in HSA coverage.

A final point that distinguished each newspaper's EST coverage related to Tesla's activities in the EST market, and especially the focus on the company's CEO, Elon Musk. Tesla was involved in several high-profile activities related to ESTs during the study period (e.g., the building of a large *Gigafactory* to produce lithium-ion batteries, the launch of a battery for the residential market, and a number of grid-scale battery projects) which were covered in both newspapers. However, the EST coverage in the LAT, particularly during the second phase, was much more driven by Tesla's activities. Whereas the HSA rarely discussed Elon Musk, even when covering Tesla, the LAT actively connected most of their Tesla coverage to discussions about Elon Musk. Tesla is a California-based company, so perhaps that explains the different focus of coverage between the two newspapers. In both newspapers, multiple companies were profiled in the EST coverage; however, Tesla was noteworthy in its apparent ability to attract media attention about product announcements and business activities. The activities of this business were a major thematic component of LAT's overall EST coverage.

4.8 Conclusions

This study aimed to assess and to cross-compare how newspaper discourse regarding ESTs evolved in California and Hawaii as these states increased deployment of these technologies between 2010-2019.

Although the study analyzed articles discussing a range of ESTs, the majority of coverage was about battery technologies. Certain large-scale projects, such as pumped hydro projects, generated some media coverage, but these types of projects were only discussed in a relatively small number of articles. Most EST coverage in both newspapers discussed battery technology, primarily lithium-ion batteries. This focus of EST coverage mirrors the fact that batteries were the most deployed EST in both states and may also reflect the greater potential for reader interest because a market for residential batteries was developing during the study period.

The bulk of coverage in both newspapers described ESTs positively. This was true when examining the overall tone of the articles and more detailed analysis of the benefit and risk frames within articles. Both newspapers' overall EST coverage employed similar benefit and risk frames. The most observed benefit frames were technical, then economic, followed by environmental, albeit somewhat less prominently. Economic risks were the most common negative frames. The results from this study are consistent with previous research and suggest media coverage of ESTs, at least during this early period of deployment, appears to be characterized by relatively consistent framing. If the costs for battery technology continue to drop, as has been predicted (O.

Schmidt, Hawkes, Gambhir, & Staffell, 2017), the economic risk frames may become less dominant in media discourse. As ESTs become more widely deployed the framing of media coverage may shift as novel technical benefits become more commonplace or the economics of the technology improve. It is also possible that risk frames, that have not previously been reported, will become salient in the media discourse. While potential future concerns cannot be predicted, in the Hawaii context, a major battery system fire occurred early in the study period, but risk frames associated with this incident did not linger in public debates or media coverage for very long. Although there is no reason to believe these patterns of media framing are fixed, current research suggests ESTs are predominantly framed positively in media discourse.

A more detailed reading of the EST coverage from each newspaper found quite different themes of coverage, despite both newspapers framing their EST coverage in similar ways. Hawaii's independent island grids, high electricity costs, high deployment of distributed solar PV, and reliance on petroleum-fired electricity generation created a unique context for the deployment of ESTs. Despite being a smaller media organization, the HSA published a larger number of EST articles and dedicated a larger portion of their overall coverage to EST coverage than did the LAT. The media discourse in Hawaii reflected a considerable evolution in the application, value propositions, and conflicts and concerns associated with ESTs, both in relation to the PV+B applications and the EST applications throughout electricity grids. While the LAT's EST coverage also evolved throughout the study period, there was less distinct focus on PV+B applications. In the earliest stage of the study period, there was little EST coverage in the LAT. Later, the EST applications covered were presented as driven by specific policy choices: the mandate that IOUs procure EST capacity, then the state's clean energy goals created greater potential for RE and ESTs to compete with natural gas projects. The EST coverage in the LAT also showed greater focus on specific EST companies and personalities within those companies.

Based on the analysis in this study, the EST policy with direct economic impact on the public – namely, changes in solar PV programs that require battery investment – was debated in advance of implementation, whereas the policy with in-direct, diffuse impacts on the public – namely, the California EST procurement mandate for IOUs – was only included in EST coverage after its implementation. Having only analyzed two newspapers' EST coverage in different jurisdictions, it is not reasonable to draw a firm conclusion from these results. However, this finding does support prior research indicating policy decisions perceived to have direct impact on readership receive greater media attention than those impacting businesses (even though these may have broad public implications) (Langer & Sagarzazu, 2017). The contrast in how these EST policies were covered does present an interesting question for future research. Although California was the first state to

implement an EST procurement mandate, several other jurisdictions have since followed suit. A comprehensive analysis of media discourse across these states might illuminate whether the different coverage of EST policies is primarily an artifact of the newspapers included in this study or if there is a more notable trend in media discourse regarding EST policy.

Transitions are long-term processes that follow distinct pathways in different jurisdictions. News media provide useful means for examining the evolution of discourse as emerging technologies are deployed because they offer a record of the public debates through time. However, the media discourse representation of public debates is also influenced by editorial decisions of specific media institutions. There are limitations on applying the analysis of media discourse to understanding the socio-political debates that accompany transitions.

In some cases, where there is a richer pool of media, it may be possible to combine interpretations from many news media organizations and create a more diverse representation of the public discourse. However, the modest breadth of Hawaii's print media landscape (i.e., one major newspaper) limited the potential to pursue an approach that combined coverage from multiple newspapers. Nevertheless, Hawaii's unique energy context and leading deployment of ESTs created a useful case for examining the evolution of discourse related to ESTs. While the focus of this study was only on the leading newspaper in California, there is a rich media landscape in the state. Future research may explore a range of newspapers from the state to identify whether the changing themes identified in this study reflect the broader media discourse in the state. As the leader in EST deployment, a broader examination of EST media discourse in California may provide useful insights for other jurisdictions. Given that changing policy rationales were identified as important themes in this study, there may be value in examining other media organizations' coverage of these policies.

In this study, Hawaii's media discourse identified greater shifts in EST applications and conflicts than were seen in California's coverage, even though California's EST deployment is more advanced. Hawaii's energy system context (e.g., geographic contention, generation profile, and electricity system costs) is unique, but the evolution in media discourse provides some hopeful indications regarding the political conflicts associated with EST deployment. Over the relatively short period of this study, EST moved from niche applications, to diverse demonstrations, and then increasing deployment. Media discourse through this process was not without conflict. However, the conflicts identified early on, particularly in relation to cost or tensions with existing interests, appeared to be largely resolved by the later phases of analysis. Although the evolution in

Hawaii's media discourse is not predictive of how public debates will evolve elsewhere, the evidence reviewed here suggests that many conflicts that arise in relation to the deployment of ESTs have the potential to be resolved relatively quickly in the context of long-term transitions.

The transformation of energy systems to mitigate the most disruptive climate change risks will likely require major deployments of new technologies. Although pathways towards energy system transitions vary greatly across geographic and political jurisdictions, areas that lead in-terms of policy choices and technological deployment can provide insights for others. As these processes take place, social and political conflicts are likely to arise as multiple actors within our social systems negotiate this significant collective change. Exploring the evolution of public debates associated with technological change may provide insights into obstacles to avoid and tensions to address.

Chapter 5 - Tweets and transitions: Exploring Twitter-based political discourse regarding energy and electricity in Ontario, Canada

5.1 Introduction

Sustainability transitions involve multiple actors with competing understandings of the problems at hand, the targets for change, and the strategies to pursue (Meadowcroft, 2009, 2011). While socio-political factors are widely acknowledged to influence sustainability transitions, there have been frequent and recurring calls to identify how these factors impact transitions in practice (Avelino & Wittmayer, 2016; Eyre, 2013; Köhler et al., 2019; Meadowcroft, 2009, 2011; Shove & Walker, 2007). Through the analysis of competing narratives and the contestation of ideas and framing, discursive methodologies have been applied to studying the socio-political dimensions of sustainability transitions (Bosman et al., 2014; Fuenfschilling & Truffer, 2014; Hermwille, 2016; Isoaho & Karhunmaa, 2019; Köhler et al., 2019; Pesch, 2015; Roberts, 2017; Rosenbloom, 2018; Rosenbloom et al., 2016).

Media analysis applying discursive approaches has been used to provide a perspective on public debates regarding specific policies or issues in relation to sustainability transitions (Brown et al., 2013; Fuenfschilling & Truffer, 2016; Geels & Verhees, 2011; Isoaho & Karhunmaa, 2019; Roberts, 2017; Rosenbloom, 2018). Media discourse has a complex and indirect relationship to public discourse and public perceptions of political debates (Gamson, 1989; McCombs, 2004; Soroka, 2003). Therefore, media analysis can only offer one representation of the public discourse (Cacciatore et al., 2016; McCombs, 2004; Soroka, 2002). The recent development and growing use of social media platforms offer a novel space for analyzing public discourse based on user contributions. Additionally, these emerging platforms are increasingly being used as sources for news (Shearer, 2018; Shearer & Matsa, 2018). What narratives, ideas, and frames are deployed in relation to sustainability transitions on these new platforms, and what might they tell us about broader public discourse related to sustainability transitions?

Whereas only a small number of actors actively produce traditional media content, social media platforms, which are typically free to users, offer broad access to a space for users to broadcast their opinions

and perspectives. However, despite the relatively-easy access to social media platforms, only a subset of the population engages with these platforms, and a subset of those users actively participates in any given topic of interest (Bruns & Stieglitz, 2012; Jansen, Zhang, Sobel, & Chowdury, 2009; Tedjamulia, Dean, Olsen, & Albrecht, 2005; Wojcik & Hughes, 2019). Although the analysis of social media discourse has its own limitations for gauging broader public discourse, the distinct characteristics of these platforms create an alternative data source that may offer unique insights to sustainability transitions research by establishing new forums for analyzing the broader public discourse.

Twitter is a social media platform, referred to as microblogging, which allows users to share short comments (i.e., up to 280 characters), embedded media, and links (J.-H. Schmidt, 2014). In 2017, there were 330 million active monthly Twitter users globally generating an estimated 350,000 tweets per day (Forbes, 2017; Leetaru, 2019)[2]. Given this large volume of data, researchers are working to understand the data's value and how they can be used productively. Researchers studying climate change, for instance, have embraced Twitter data to explore public sentiment and to describe actors, messages, and media promoted in climate debates (Cody, Reagan, Mitchell, Dodds, & Danforth, 2015; Kirilenko & Stepchenkova, 2014; Newman, 2016; Olteanu, Castillo, Diakopoulos, & Aberer, 2015; Pearce, Holmberg, Hellsten, & Nerlich, 2014; Veltri & Atanasova, 2017). A similar approach is not prevalent in relation to research of sustainability transitions and energy issues, although applications of Twitter data have increased in recent years (R. Li, Crowe, Leifer, Zou, & Schoof, 2019), particularly in relation to nuclear power (Arlt, Rauchfleisch, & Schäfer, 2019) and the 2011 emergency at the Fukushima Daiichi power plant in Japan (Binder, 2012; N. Li et al., 2016).

The analysis of Twitter data offers a new means to gauge public discourse, and thus has the potential to contribute to understanding the socio-political dimensions of sustainability transitions. The research presented here will examine Twitter data surrounding energy issues in the province of Ontario, Canada. This study is primarily exploratory given that Twitter data have not been prominently utilized in sustainability transitions research. Exploratory methods are useful when researchers "have little or no scientific knowledge about the group, process, activity, or situation they want to examine but nevertheless have reason to believe it contains elements worth discovering" (Stebbins, 2011, p. 5). The study aims to 1) describe prominent characteristics of Twitter discourse regarding energy politics in Ontario, 2) identify prominent themes within

[2] Although Twitter is the most prominently used microblogging platform in North America, Weibo, a similar microblogging platform, has a larger global user base, but is primarily used in China (Liu & Zhao, 2017; J.-H. Schmidt, 2014).

the Twitter discourse regarding energy politics in Ontario, and 3) consider the potential value of Twitter-based discourse for understanding sustainability transitions.

The following section provides details regarding the study design and a conceptualization of Twitter data. This is followed by a methods section, which describes the data collection procedures, the processing of data, and the methods of analysis. Next, the paper provides a results section and then a discussion section. The conclusion section reflects on the main findings and the broader potential for Twitter-based research to contribute to the sustainability transitions research.

5.2 Study design

The study is designed to characterize the Twitter-based discourse related to energy issues in the province of Ontario, Canada. Ontario has been a leading jurisdiction for a number of progressive electricity policies: early adoption of smart meter technology, feed-in-tariff funding to support renewable generation, and establishing forums to promote smart grid policy (Winfield & Weiler, 2018). Many of these progressive policies have complicated social acceptance histories that were often associated with the Ontario Liberal Party, as well as increasing electricity costs (Mallett, Jegen, et al., 2018b; Morrow, 2016; Rosenbloom & Meadowcroft, 2014; Rowlands, 2007; Stokes, 2013; Winfield, 2017; Winfield & MacWhirter, 2019). The Ontario Liberal Party governed Ontario from 2003 and remained in power during the study period; however, they were subsequently voted out of power in the 2018 provincial election.

While traditional media have been used to explore the discourse surrounding major electricity events in the province (Rosenbloom, 2018), there has not been an investigation of social media data. The *big data* characteristics associated with Twitter (and social media, in general) are in tension with discursive methodologies, which interpret the ideas and meanings embedded within communication (and practice) through in-depth reading and consideration for context (Hajer, 1995; Phillips & Hardy, 2011). Some automated approaches to data analysis, such as sentiment analysis, analyze the components of language within communications (e.g., specific words, punctuation) to estimate emotion, but these approaches are challenged to interpret the nuance of natural language (Cambria, Poria, Gelbukh, & Nacional, 2017; Sulis, Farías, Rosso, Patti, & Ruffo, 2016). In terms of considering *discourse*, automated approaches cannot offer equivalent analysis to manual interpretation of communications, which has been described as a *small data* approach (Pal & Gonawela, 2017). Manual interpretation of big data has practical limitations related to resource requirements

and potential to summarize findings. Additionally, data collection can limit the potential for researchers to appreciate the full context of a tweet, which might conceivably require reviewing a user's history of Twitter interactions, use of language (McCulloch, 2019), and their network. To be sure, balancing big data qualities of Twitter data and in-depth analysis of *discourse* on the platform is not without challenges and limitations, but manual interpretation can offer a distinct perspective on themes that would be missed through automated analysis.

To balance the limitations of automated analysis for examining discourse and the practical constraints associated with manual interpretation of big data (or *biggish* data[3]), a mixed methods approach was pursued for this study. Quantitative descriptors of the Twitter discourse were combined with a focused analysis, applying manual interpretation, to quantify prominent themes identified in the tweets collected. Rather than dedicating resources to analyze each tweet in the dataset, the manual interpretation focused on tweets produced by two groups within the dataset: those of the most engaged users (those tweeting the most) and those of the most retweeted content (those tweets most amplified by other users). Through this approach, the study aims to summarize key features and prominent actors discussing Ontario energy and electricity issues on Twitter.

5.2.1 Conceptualizing Twitter data

As a social media platform, Twitter creates a digital space where users can share short messages and media. These messages are referred to as *tweets,* and they can be made publicly or privately. While private messages are a feature of Twitter, because they are not publicly available, these tweets are not usually included in Twitter analysis (J.-H. Schmidt, 2014).

Twitter-based discourse is influenced by the platform, the technology, and its users (Bruns & Moe, 2014). The limited character space influences the types of messages that are shared on Twitter and has led to abbreviations and the development of hashtags for organization (J.-H. Schmidt, 2014). Tweets are collected on users' pages; however, Twitter is structured around mobile applications and *following* (J.-H. Schmidt, 2014). The Twitter interface is broadly organized to make the most recent information the most readily accessible (with some algorithmic tweaking), which influences how information is shared and consumed on Twitter.

[3] Bruns notes "…the boundaries of what is 'big' in 'big data' have remained notoriously undefined – one not entirely tongue-in-cheek definition, however, is of 'big data' as anything that exceeds the maximum of 1,048,576 data rows that are allowable in current versions of Microsoft Excel." (Bruns, 2018, p. 6)

Following on Twitter does not need to be a reciprocal relationship (Kwak, Lee, Park, & Moon, 2010). As a result, there are some indications that users are more likely to select users to follow based on topics of interest and to use Twitter as a source for information and opinions, rather than – or in addition to – following family and friends and using the site for social networking (Jansen et al., 2009; Kwak et al., 2010).

In terms of understanding Twitter conversations, Bruns and Moe (Bruns & Moe, 2014) have conceptualized three overlapping layers of conversations: meso, macro, and micro. The meso-layer of conversation describes the most common level of communication on Twitter. At the meso-layer, users share tweets with their network of followers. While it is possible for other users to view these tweets, the user is only actively directing the message to their network.

At the macro-layer, users can include *hashtags* in their tweet by preceding a keyword with the '#' symbol. While the tweet is still only directly shared with followers, by including a hashtag a user is adding a searchable marker that contributes to broader conversations on the platform. Bruns and Moe (2014) describe the macro-layer of communication as *ad hoc* public forums that develop for the discussion of specific topics.

At the micro-layer, users can direct tweets to another user by preceding that user's name with the '@' symbol. While the tweet is still publicly shared and sent to the user's entire network of followers, the use of the @ symbol indicates a narrower intent for the message.

Twitter offers users a space to contribute to public discourse, and to share thoughts and opinions with one's followers and into the *ad hoc* public space, but it also facilitates certain interactions among users that create opportunities for feedback. Users can *like*, *reply to*, or *retweet* a tweet. Likes allow users a means to indicate approval for a tweet through a single click; they also serve to save the tweet for their later review. Replying to a tweet allows users to have a conversation about a tweet with the original *tweeter*, or other users replying to the same tweet. Replies are grouped together to allow for a multi-user conversation. Retweets allow a user to share a tweet with their network of followers. Conceptually, a retweet allows a user to spread a tweet to their own meso-layer network as a means of encouraging their network of followers to see the contained information. It is also possible for other users to then interact with the retweeted content.

5.3 METHODS

The research for this study is based on Twitter data collected from September 2, 2017 to January 12, 2018, inclusive. To reduce the data to relevant tweets, #onpoli – a prominent hashtag for Twitter discussions related to Ontario politics – was used in addition to three keywords: electricity, energy, and hydro.[4] (The term "hydro" is often used interchangeably with electricity in Canada.) The sample for this period includes 7,840 tweets, by 2,841 unique users. The timeline was selected in anticipation of the release of the 2017 Long-term Energy Plan, a major policy document for the province that was eventually released on October 26, 2017. Because the exact release date for the Long-term Energy Plan was not announced in advance, the collection of data before the release was required. Data from before and after the Long-term Energy Plan release were included in the study to provide greater contextualization of Twitter-based discourse regarding energy and electricity in the province.

Given these collection parameters, it should be recognized that the Twitter data included in the analysis represent only a subset of the Twitter discussions related to the topics in question. More specifically, the tweets collected represent an unknown subset of the total tweets related to energy issues in Ontario during the collection timeframe. Some users who are interested in and tweeting about these issues may not include #onpoli in their tweet and will be excluded from the sample, which is a known limitation in hashtag based approaches (Bruns & Stieglitz, 2014b). However, there is value in focusing on tweets that are being made at the macro-layer of conversation (i.e., using #onpoli), since these users are directing their tweets towards a broader conversation (the *ad hoc* public space) through the use of a hashtag and noting the political nature of their message, which suggests that these tweets are intended to contribute to political discourse. Thus, though the data analyzed in this study should be understood as a subset of the Twitter discourse regarding Ontario politics and electricity and energy issues, the dataset will nevertheless be referred to as Ontario Twitter energy politics for the sake of simplicity.

5.3.1 REMOVING REPETITIOUS TWEETS

In total, 7,840 tweets (3,490 original, 4,350 retweets) from 2,841 users were collected in the dataset. However, user activity in the sample was highly skewed. The top two users contributed 10% of the collected tweets, 425 and 368 respectively. Upon review these users were repeatedly tweeting the same content with very

[4] Data collection can be understood as tweets including "#onpoli" AND ("electricity" OR "energy" OR "hydro").

little variation; both accounts were for radio stations and appeared to be linked and automated. All tweets from both users included the text "… J Reno – Hydro Bills #onpoli #hiphop #hits…" as well as an attached image depicting a cartoon of the former premier of Ontario, Kathleen Wynne, sitting in front of piles of money with the words "hydro bills" written above and signed J Reno. Because of the repetitive nature of the content, these users significantly impacted the dataset. While these users contributed significant numbers of tweets to the dataset, they were not regularly shared by other users. The combined 793 tweets of this nature, account for 22% of all original (i.e., non-retweet) tweets in the complete dataset, but they were retweeted only 37 times, less than 1% of retweets in the total dataset.

Automated Twitter accounts, referred to as bots, are a common source of noise in Twitter data (Gaffney & Puschmann, 2014; Howard, Bolsover, & Bradshaw, 2017; Woolley & Howard, 2016). Given the potential for these repetitive tweets to skew the data analysis, reviewing data and removing bot activity is a recommended approach to managing Twitter data (Gaffney & Puschmann, 2014). The dataset was reviewed and tweets that were contributed by a single user with little variation (e.g., inserting "…" into a tweet that was otherwise unchanged) or no variation were removed. On the other hand, if a user retweeted content that they had previously shared, those tweets were not removed since the retweet format indicates that the tweet is repetitious. A total of 894 tweets from 24 users were removed from the dataset through this process. The majority of the removed tweets (788) were from the two users mentioned above, leaving five original tweets from these users in the dataset. The third most prominent user in the complete dataset, described as a Canadian news, analysis, and opinion magazine, had 47 tweets removed (45 of its unique tweets remained in the dataset). An additional two users – an Ontario-based current affairs TV program and a user with no stated affiliation – had 15 and 14 tweets removed. The remaining 19 users with tweets removed contributed 30 repetitive tweets in total, with 15 of those users only repeating a single tweet. Approximately 11% of the original sample collected was repetitious content and thus removed; however, most of the repetitious content was contributed by a small number of very active (presumably) bot accounts. The analysis in this paper focuses on a dataset of 6,946 tweets, which does not include repetitious tweets. Figure 5-1 provides an overview of the data collection and processing sequence.

5.3.2 High activity analysis

High activity days were defined as dates with more tweets than 1.5 times the interquartile range of daily tweets collected (including original and retweet content) across the 133 days of the study. To summarize activity and identify topics of interest on high activity days, a random sample of 20% of the original tweets and

highly retweeted content were reviewed to establish a preliminary context for Ontario Twitter energy politics on the days being examined. The sample of tweets and embedded or linked media were reviewed to identify if the tweet referenced or reacted to a specific topic (e.g., an event or energy issue). Topics identified in less than 10% of the sample for a specific high activity day were considered non-prominent and not included in the analysis. When identifying common topics during high activity days, there was no attempt to distinguish sentiment.

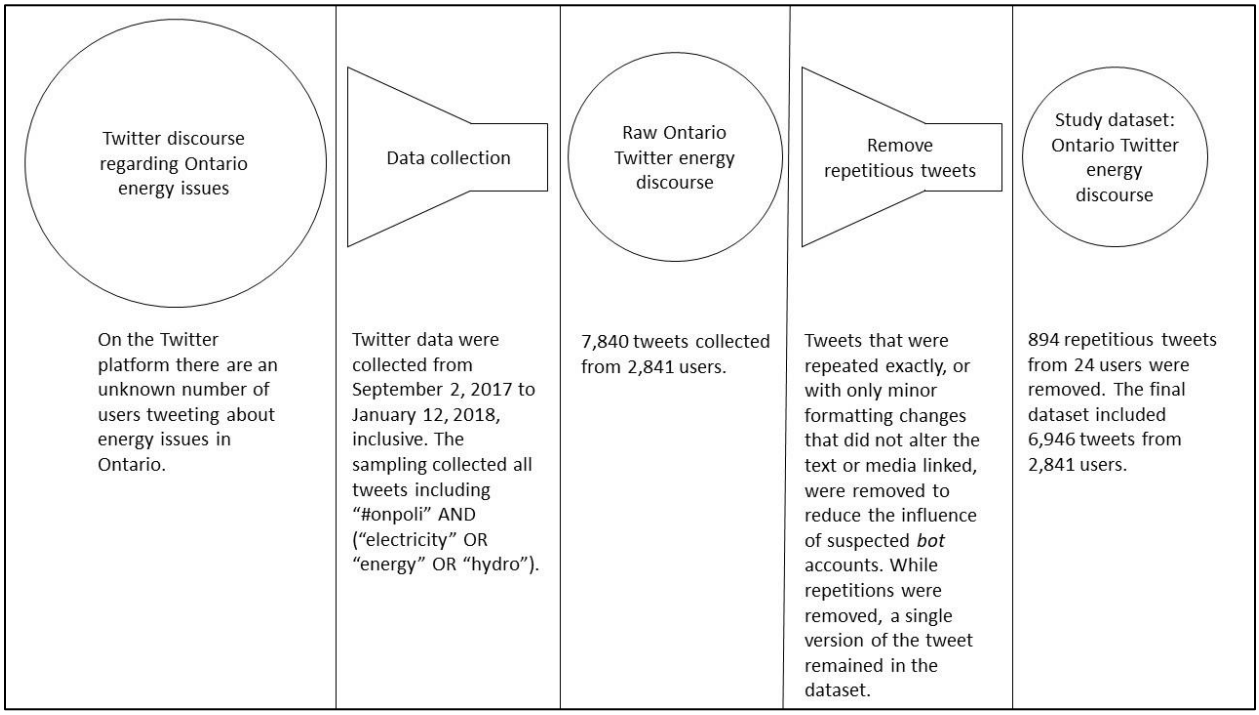

Figure 5-1 - Data collection and processing

5.3.3 FOCUSED ANALYSIS OF THE MOST ENGAGED USERS AND THE HIGHLY RETWEETED CONTENT

The *most engaged* users were defined as the 28 users (the top 1%) who contributed the most tweets (sum of original tweets and retweets) to the dataset. Highly retweeted content was defined as original tweets that received 10 or more retweets.

The users in the first group and the users producing the tweets in the second group (some of which overlap) were categorized based on affiliations presented in their user descriptions. The categories were developed based on common self-reported descriptions of occupation or affiliation. The categories included *news media* (journalists, news media accounts), *no affiliation* (individuals that do not state an official role in their description or note that their tweets are their personal opinions), *policy researcher* (individuals identifying

themselves as policy researchers or policy consultants, or accounts for research organizations), *political* (politicians, official party accounts, and individuals identifying their official party affiliation), *political advocacy* (individuals describing themselves as advocates associated with an organization, organizations without official political affiliation but describing themselves as having a political mission or describing themselves as an advocacy organization), *other institutions* (non-political government organizations, private energy organizations, government communications consultants). To be sure, relying on self-reported descriptions is not without limitations, but the categories provide a first approximation of different user types and affiliations that were used to inform further analysis.

A qualitative assessment of tweets from these two groups was conducted to identify descriptive themes within the Twitter discourse being analyzed. The analysis was based on language used within the tweet and a review of embedded media. If external links were included, analysis took into consideration the title and subtitle of articles or other media but did not include reading of full articles. A preliminary review was conducted using an inductive approach to identify prominent themes and issues associated with energy issues within the Twitter discourse. Based on this review, a highly partisan discourse was observed. Rather than identifying specific topics or energy issues that anchored the Twitter discourse, energy issues discussed varied throughout the study period, but there were consistently references and framing of political actors in tweets.

The tweets from the two groups were reviewed a second time and coded based on political actors identified (explicitly or implicitly) in relation to an energy issue, either as the provincial governing party, the provincial non-governing parties (Ontario Progressive Conservative Party, Ontario New Democratic Party, and Ontario Green Party), or other actors. Each reference to one of these actor groups was then identified as having positive, negative, or neutral framing with regards to the *energy issue* discussed in the tweet. While partisan framing was the most noted theme in the dataset, negative economic framing was included as a subcategory of negative frames used in relation to energy issues because it was also perceived as a secondary theme that emerged in the qualitative assessment. A detailed explanation of the coding process is included in the codebook (Appendix E). To situate the prominence of partisan framing and negative economic themes, additional analysis was conducted to quantify tweets mentioning energy issues that are commonly associated with sustainable energy transitions: electricity generation technologies, climate change, and the Long-term Energy Plan.

5.4 Results

5.4.1 Describing Ontario Twitter energy politics

In total, 6,946 tweets were included in the complete dataset. Of the three keywords used for data collection, "hydro" was the most prominently used (3,885 tweets), followed by "energy" (1,730 tweets), then "electricity" (1,081 tweets), an additional 734 tweets did not include any keywords within the text but were captured in the dataset because they linked to content with at least one keyword. Table 5-1 - Overview of data collected provides an overview of the collected data (464 tweets included two keywords and 10 tweets included all three keywords). Approximately 37% of the total dataset was original tweets, rather than retweeted content.

Table 5-1 - Overview of data collected

Dataset	***Total***	***Electricity***	***Energy***	***Hydro***	***Linked keyword***
Complete	6,946	1,081	1,730	3,885	734
Original tweets	2,596	373	783	1,361	294
Retweets	4,350	708	947	2,524	440

In total, 2,841 unique users contributed to the dataset. However, contributions to the dataset by individual users were uneven. Users were segmented using a 1/9/90 categorization that distinguishes users based on their level of engagement (i.e., sum of original tweets and retweets contributed) in Ontario Twitter energy politics (Bruns & Stieglitz, 2012). The *most engaged* 1% of users in this sample directly contributed 16% of the total tweets. The next 9% of *highly engaged* users contributed 31% of the total tweets. The remaining 90% of users, the *least engaged*, contributed 52% of the sample. Rather than amplifying other users' content through retweets, the *most engaged* users were more likely to contribute original tweets (60%), than either the *highly engaged* (46%) or the *least engaged* (23%) (Table 5-2).

The number of tweets collected per day varied across the collection period of 133 days (Figure 5-2). An average of 52 tweets was collected each day, with a maximum of 456 tweets collected on Tuesday, October 17, 2017 and a minimum of five tweets collected on Saturday, September 16, 2017. Eleven days, which include clusters around three periods and two lone dates, were identified as high activity days (defined as 1.5 times the interquartile range). The high activity days occurred in three clustered time periods (i.e., October 17-19, 2017; October 26-27, 2017; and November 22-25, 2017), as well as two individual dates (i.e., September 26, 2017; and

December 5, 2017). While the October 17-19 cluster and the October 26-27 cluster were mostly each focused on a single topic of interest, the November 22-25 cluster included a number of different topics of interest that varied through the days. Additionally, the two individual dates with high activity included multiple topics of interest. In contrast, the top four most active dates of Twitter engagement (i.e., October 17, 2017; October 26, 2017; October 18, 2017; October 27, 2017) appeared highly focused on single topics of discussion. Although an in-depth exploration of the specific topics discussed on high activity days is beyond the scope of this study, a brief summary of activity and topics of interest during the high activity dates is included in Appendix F.

Table 5-2 - Contribution to dataset based on engagement categorization

	Number of users	***Percent of users***	***Max tweets in group***	***Min tweets in group***	***Average number of tweets***	***Total tweets contributed***	***Percent of total tweets***	***Percent original tweets of group's total tweets***
Most engaged	28	1%	84	21	40.25	1,127	16%	60%
Highly engaged	256	9%	21	5	8.54	2,185	31%	46%
Least engaged	2,559	90%	5	1	1.42	3,634	52%	23%

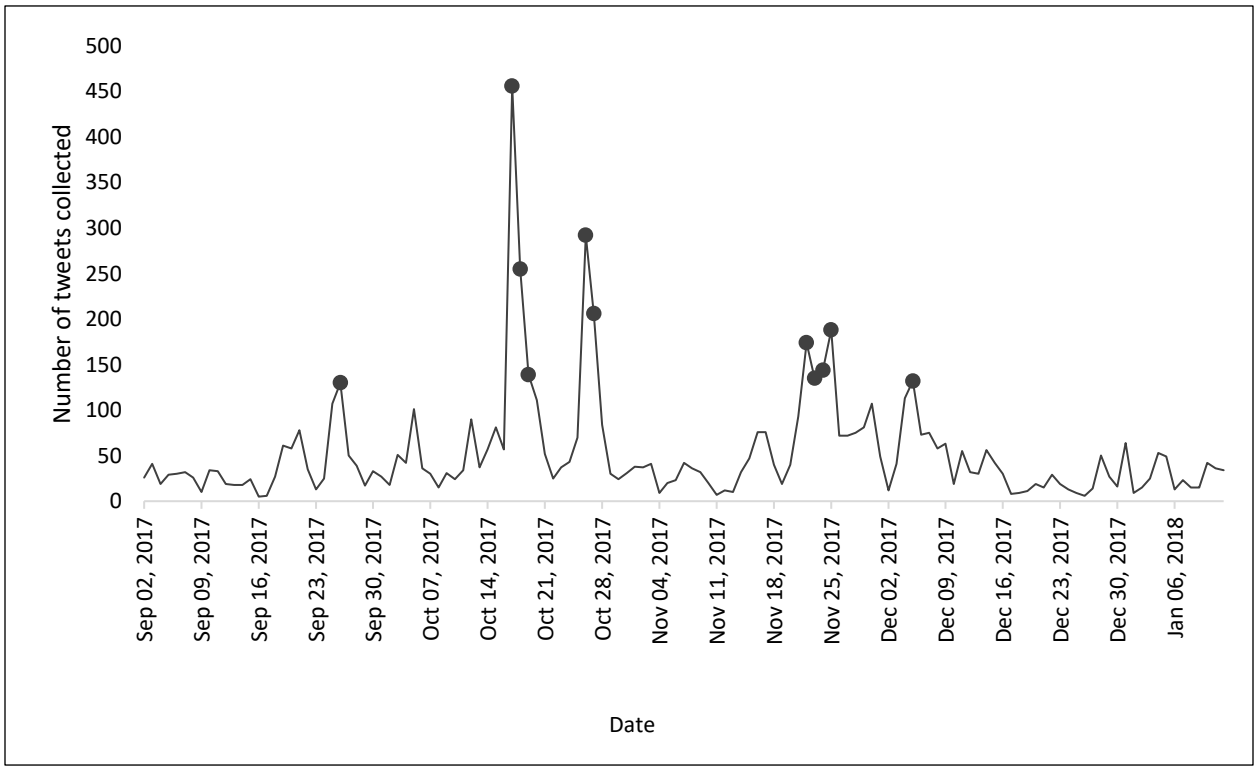

Figure 5-2 - Number of tweets collected per day (dates written are Saturdays). High activity days indicated with markers (●)

5.4.2 COMPARING THE MOST ENGAGED USERS AND THE USERS GENERATING HIGHLY RETWEETED CONTENT

Collectively the *most engaged* 28 users contributed 1,127 tweets, which represents 16% of the total dataset. The highly retweeted content included 106 tweets (4% of the original content in the dataset), which comprised original content from 46 users. In total, these 106 tweets were shared 2,822 times and represent 41% of the total dataset.

Figure 5-3 indicates the user affiliation categorizations of the *most engaged* users and the highly retweeted users. In comparing the two user groups, the *most engaged* users were primarily (50%) users with no stated affiliation, although political users accounted for 25% of the group, with less representation of political advocacy users (11%), news media users (7%), and policy researcher users (7%), whereas the highly retweeted users group was less dominated by a single category of users. Political users (28%) and news media users (26%) were the largest categories of users producing highly retweeted content; however, political advocacy users and users with no stated affiliation each made up 15% of the category, as well.

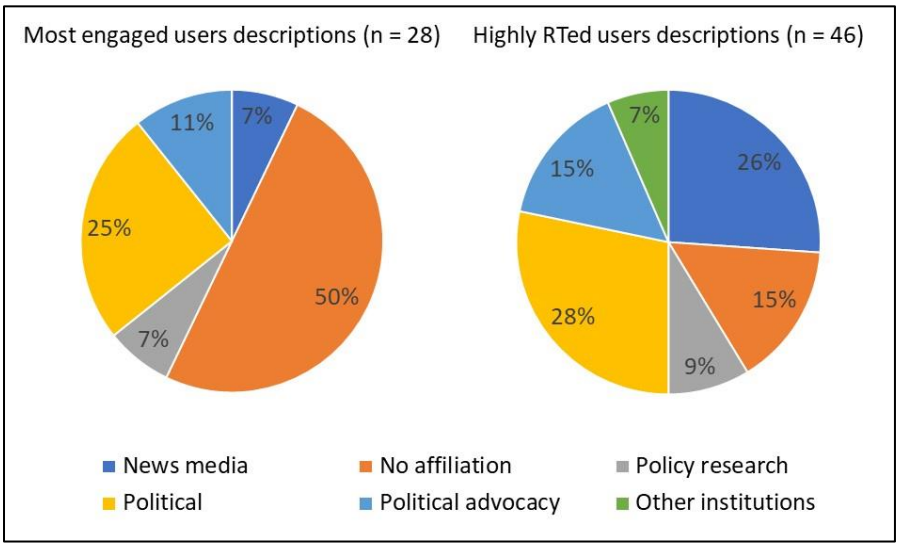

Figure 5-3 - Affiliation of users based on profile descriptions for the most engaged users and the most retweeted users

Nine of the *most engaged* users shared highly retweeted content and were included in both groups. Although users with no stated affiliation were prominent in the *most engaged* users analyzed, only one of these users was highly retweeted. Two news media users were included in the *most engaged* user group, but neither was highly retweeted, despite media organizations being more represented in the highly retweeted users group. When considering political users, four of the seven users that were *most engaged* were also highly retweeted.

Both of the policy researcher users in the *most engaged* group were highly retweeted, and two of the three political advocacy users were also highly retweeted.

5.4.3 FOCUSED ANALYSIS OF THE MOST ENGAGED USERS' TWEETS AND THE HIGHLY RETWEETED CONTENT

The review of most engaged users' tweets and highly retweeted content for themes identified a highly partisan discourse in the data. For comparison, Table 5-3 identifies the number of tweets by the most engaged users that reference some issues of potential interest when evaluating sustainable energy transitions, including various forms of electricity generation, renewable energy deployment, climate change, and the Long-term Energy Plan. Of these topic areas, the Long-term Energy Plan and broad discussions of renewable energy received the greatest number of tweets. While some tweets discussing the Long-term Energy Plan touched on policy issues or projections, all these tweets included negative frames of the governing party (39) or were neutral announcements about the Long-term Energy Plan (7). An equal number of tweets (46) referenced renewable energy (or clean energy or green energy) as a category of technologies: the majority of these tweets (34) included negative frames of the governing party, four tweets included partisan framing referencing other parties, while six included no partisan framing. It is possible that the partisan nature of the discourse may reflect the data collection process; perhaps users engaging with energy issues associated with sustainability transitions are less likely to use this study's specific data collection keywords. However, based on the data reviewed, Ontario Twitter energy politics does not focus on issues related to electricity generation, renewable energy deployment, climate change, or long-term energy policy. Rather, Ontario Twitter energy politics is better described through an analysis of partisan framing.

Table 5-3 - Tweets (original and retweets) by the most engaged users (n=1,127) discussing alternative sustainable energy transitions issues of interest (note: tweets may include more than one listed topic of interest)

Sustainable energy transitions issues of interest	***Number of tweets***	***Percent of most engaged users' tweets***
Climate change	11	0.98%
Coal generation	11	0.98%
Long-term Energy Plan	46	4.08%
Natural gas generation	14	1.24%
Nuclear generation	26	2.31%
Renewable generation	46	4.08%
Smart meters	16	1.42%
Solar generation	14	1.24%
Wind generation	19	1.69%

Table 5-4 shows the political actors referenced and how these actors were framed in relation to energy issues by the *most engaged* users. The most prominently mentioned political actor group was the governing Liberal Party. When the governing Liberal Party was referenced, they were overwhelmingly referenced in negative terms. The *most engaged* users referenced the governing Liberal Party negatively in 77% of their tweets. Figure 5-4 - Percentage of tweets negatively framing the governing party by the most engaged users (n=28) shows the percentage of tweets including a negative framing of the governing party by the number of tweets of the *most engaged* users in the dataset. The majority of the *most engaged* users (24/28) negatively framed the governing party in 60% or more of their tweets. The remaining four *most engaged* users negatively framed the governing Liberal Party in less than 40% of their tweets. In contrast, an equal number of the *most engaged* users (four) negatively framed the governing party in every one of their tweets. A large portion (78%) of the negatively framed tweets by the *most engaged* users referencing the governing party highlighted economic issues. The negative economic framing primarily focused on electricity issues, including the high cost of electricity, perceived wasted spending by institutions in the electricity sector, the cost of the recently released *Fair Hydro Plan*, rising electricity costs impacting jobs, and energy poverty or customers not being able to afford their electricity bills.

Table 5-4 - Actors referenced and framing of the most engaged users' tweets (n=1,127)

Tweets of most engaged users	***Positive framing of energy issue***	***Negative framing of energy issue***	***Neutral framing***	***Unclear framing***
Tweets referencing governing party (explicit[5])	4 (0)	875 (655)	7 (7)	2 (0)
Tweets referencing non-governing party	125	30	3	0
Tweets referencing other organizations or non-political actors	1	145	17	1

Non-governing provincial parties were mentioned in approximately 14% of the *most engaged* users' tweets. Non-governing provincial parties, in contrast to the governing party, were more frequently referenced in positive terms. Tweets that referenced other actors or organizations without identifying a provincial political party made up 14% of the *most engaged* users' tweets. These organizations and actors were primarily framed

[5] Explicit tweets mention either the governing Liberal Party, individual politicians from the Liberal Party, or refer to the Ontario government. See codebook (Appendix E) for more details.

negatively (88%). A large portion (45%) of those tweets referenced government institutions that are not overtly partisan, most notably Hydro One, the publicly owned (recently partly privatized) electricity transmission and distribution company in Ontario.

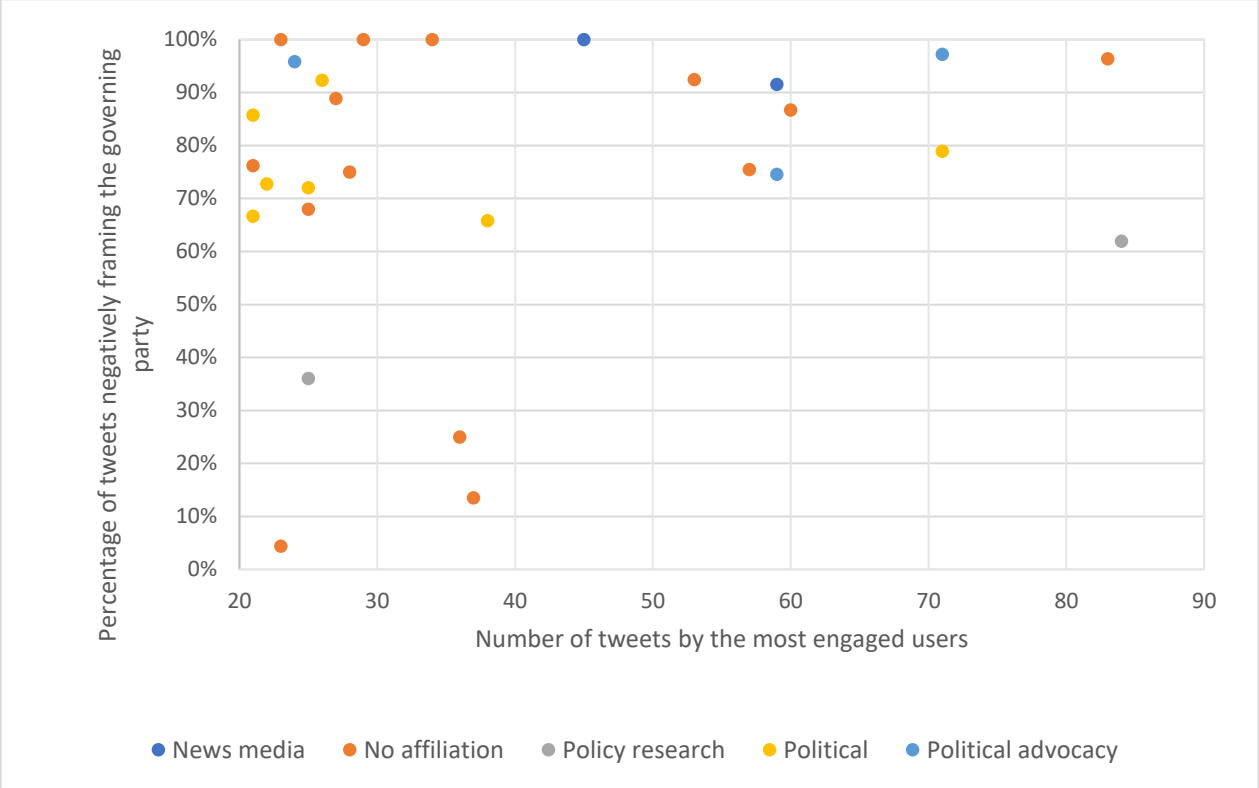

Figure 5-4 - Percentage of tweets negatively framing the governing party by the most engaged users (n=28)

Similar frames and party alignment were observed in the highly retweeted content. There were 106 tweets from 46 users that received 10 or more retweets. The majority of the tweets, 89 (83%), included references to the governing Liberal Party, and 84 of those tweets included negative framing of the governing party, whereas only five had positive framing. In addition, tweets with negative framing of the governing party were more amplified in the dataset. The 84 negative tweets were retweeted 2,347 times (average ~28 retweets each) whereas the five positively framed tweets were retweeted 55 times (average 11 retweets each). Sixty-one of the negatively framed tweets (74%) referencing the governing party highlighted economic issues. The negatively framed tweets referencing economic issues were on average retweeted approximately 31 times each, whereas the negative tweets referencing other negative issues were retweeted approximately 21 times each.

Approximately 12% of the highly retweeted content referenced non-governing provincial parties. These tweets were overwhelmingly positive (92%) in their references. The only non-positive reference to a

non-governing party was a neutrally framed announcement of an upcoming response by a non-governing party leader. The positively framed tweets referencing non-governing parties were retweeted 281 times (average ~23 retweets each). The majority of the content (91%) was generated by organizations or actors directly related to the political parties being framed positively. Tweets presenting non-governing parties positively also usually (75%) included negative framing of the governing party. While non-governing parties were positively represented in the most retweeted content, the original content for those tweets tended to be produced by political actors or organizations affiliated with the non-governing party referenced.

Twelve tweets (11%) referencing other actors or organizations without mentioning provincial political parties were identified in the highly retweeted content. Eight of these tweets were negatively framed, three were positively framed, and one was neutrally framed. The majority (75%) of the negatively framed tweets referenced Hydro One.

While there were 46 users who generated content that was highly retweeted, the total number of retweets of each of these users was highly variable. For comparison, Table 5-5 displays some relevant information about the five most retweeted users in the dataset. The single most retweeted user, an online-based political advocacy organization, received 738 retweets, which represents approximately 10% of the total dataset. This user was included in the *most engaged* user group, contributing 36 original tweets and retweeting 21 tweets, and 15 of their 36 original tweets received 10 or more retweets. This user had more than double the total number of retweets of the next most retweeted user and more than four times the retweets of the third most retweeted user. Every tweet by this user that was highly retweeted used negative economic framing referencing the governing Liberal Party. The second, third, and fourth most retweeted users each contributed between 19 and 22 tweets to the dataset; one of these users was classified as *most engaged* while the other two were classified as *highly engaged*. Each of these users was associated with traditionally empowered institutions in political discourse: news media and political parties. The fifth most retweeted user was also described as associated with political advocacy and included in the *most engaged* group but, in contrast to the most retweeted user, did not have a single tweet that was highly retweeted.

None of the political users identified in the *most engaged* user group and the highly retweeted content group were associated with the governing Liberal Party. Kathleen Wynne, the Ontario Premier during the sample period, was referenced in 1,831 tweets (26% of the dataset), including 407 @replies using her Twitter username. Similarly, Glenn Thibeault, the Ontario Energy Minister during the sample period, was @replied

116 times in the dataset. Neither of these politicians contributed to the Ontario Twitter energy politics dataset though each had an active Twitter account during this period. The official Liberal Party Twitter account only contributed three tweets to the dataset, all three being retweets from other users.

Table 5-5 - User description and amplification of most retweeted users

User description	***Number of retweets received***	***Percent of total tweets in dataset***	***Tweets contributed***		***Number of highly retweeted tweets***
			Original	***Retweets***	
Political advocacy	738	10.6%	36	35	15
News media	336	4.8%	18	1	10
Politician	169	2.4%	18	4	5
Politician	168	2.4%	21	0	4
Political advocacy	158	2.3%	52	7	0

5.5 Discussion

5.5.1 Describing Ontario Twitter energy politics

Ontario Twitter energy politics is highly skewed: a small number of individual users contribute disproportionately to the Twitter discourse. While the study collected tweets from 2,841 users contributing to Ontario Twitter energy politics, the *most engaged* 1% of users contributed 16% of the overall data collected. The *most engaged* and the *highly engaged* users (together, the top 10% of users) combined to contribute approximately 48% of the dataset. Previous research indicates that a small number of users often dominate Twitter discourse while the majority of users contribute a small number of the overall tweets (Bruns & Stieglitz, 2014a; Jansen et al., 2009) (similar patterns of user activity have also been noted in Facebook groups dedicated to emerging energy technologies (Rantala, Toikka, Pulkka, & Lyytimäki, 2020)). Ontario Twitter energy politics reflected this common characteristic of Twitter discourse. Given this common feature of Twitter discourse, future transitions research utilizing Twitter data should continue to expect a minority of users to dominate the conversations of focus. Rather than forums for collecting *the public* discourse, social media may be better understood as a forum for collecting *an engaged public* discourse.

Additionally, this research identified that the more engaged users tend to contribute to the conversation in distinct ways. The *most engaged* users contributed mostly original content, whereas the *least engaged* users contributed mostly retweeted content. Hashtags associated with sports and major media events have been identified as having large proportions of users contributing original tweets, suggesting that users are using Twitter to comment about the event in a public space (Bruns & Stieglitz, 2012). Alternatively, hashtags associated with "breaking news" events tend to be associated with greater proportion of retweets, suggesting users are trying to amplify information by sharing the information contained within the tweet with their follower network (Bruns & Stieglitz, 2012). Producing original content allows users to react to events and share their thoughts and opinions in a public space, whereas retweets allow users to amplify information, and these two forms of Twitter interaction can be understood as serving distinct forms of engagement with the Twitter discourse.

Therefore, in this case, the most engaged users are, to a greater extent, utilizing #onpoli as an *ad hoc* public space for political discourse, where they are contributing their own ideas and perhaps reacting to political events, similar to users reacting to sporting events or major media events. In contrast, the *least engaged* users are less focused on contributing their own thoughts and opinions on energy issues to the *ad hoc* public space and are more likely to amplify other users' content, similar to activity associated with "breaking news" events. To that extent, high engagement in Ontario Twitter energy politics is associated with a different form of interaction with the discourse in addition to greater active contribution to the discursive space. In future research, distinguishing various forms of user engagement, by examining original tweets or retweets, may provide additional insights into how users are participating with a specific conversation of interest.

Engagement with Ontario Twitter energy politics was highly variable over the course of the study, and specific news events appeared to drive users to contribute to the Twitter conversation. Twitter engagement associated with on-going political hashtags, like #onpoli, have been observed to fluctuate in response to media coverage of political events or issues (Bruns & Stieglitz, 2012), and in general, focusing events have been known to amplify Twitter user engagement for specific topics (Jungherr, 2014; Kirilenko & Stepchenkova, 2014; Thelwall, 2014). In reviewing the sampling of topics of interest for the high activity days, the top four most active days mostly focused on a single topic. For the remaining high activity days, save one, the activity was driven by multiple topics that each received moderate engagement but combined to create a high activity day. Ontario Twitter energy politics displayed engagement spikes in response to major Ontario energy news events,

and on the days with the most activity the Twitter conversations appeared most focused on reacting to a specific topic of interest.

5.5.2 Comparing the most engaged users and the users generating highly retweeted content

For some types of users, amplification in the Twitter discourse appears to mirror those who have traditionally been empowered in political discourse: established media and prominent political actors. User engagement in Ontario Twitter energy politics is not, on its own, a good indicator of impact on the discourse, as measured by amplification by other users through retweets.

Users with no stated affiliation that were part of the *most engaged* users group had little success generating highly retweeted content. Only one of the 14 *most engaged* users with no stated affiliation was included in the highly retweeted group. Generally, it appears that the *most engaged* users with no affiliation had little impact on Ontario Twitter energy politics, as measured through retweets, despite their large individual contributions to the discourse.

The two news media users that were included in the *most engaged* group did not generate highly retweeted content. Neither of these users represented well-established news organizations: a local radio station based in a relatively small community in Ontario and an online magazine established in 2016. In contrast, the 12 highly retweeted news media users included mostly well-established, Toronto-based (the largest city in Ontario) or national news organizations; although, the group did include one online news site. For news media users, association with well-established news organizations appears to be an important component in impacting Ontario Twitter energy politics.

Political users that were *most engaged* in Ontario Twitter energy politics and highly retweeted included two official party accounts and two accounts for party leaders. The political users that were part of the *most engaged* user group but who were not highly retweeted, included an electoral district party president, a political candidate, and an electoral district political association. For the *most engaged* political users, those with greater public recognition appear more likely to be amplified in the Twitter discourse. Additionally, many political users that were not included in the *most engaged* group were highly retweeted. Political users do appear to have significant capacity to impact Ontario Twitter energy politics but being highly engaged in the subject of energy issues was not, in itself, a means to high amplification.

While many of the users that generated highly retweeted content included actors that are typically empowered in political discourse, Twitter does offer a venue where savvy users can impact the discourse of an issue, at least on the platform. Ontario Twitter energy politics was disproportionately impacted by a single user, described as a political advocacy organization. This user was one of the *most engaged* users but also effective in generating highly retweeted content. In comparison, the fifth most retweeted user, also identified as a political advocacy organization, produced a large number of tweets that cumulatively received many retweets, but no single tweet was itself highly retweeted. As explored below, the content of both users included predominantly negative framing of the governing Liberal Party. Despite many similarities, one user was significantly more amplified and generated wider amplifications from individual tweets. The data analyzed reinforce the finding from previous research that savvy users can disproportionately impact discourse on Twitter (Rogstad, 2016). For these users, retweets were not simply a reflection of engagement or the framing of content, which suggests that other factors, such as strategy, organization, and networks, may explain the variability in user impact on Ontario Twitter energy politics.

5.5.3 Focused analysis of the most engaged users' tweets and the highly retweeted content

The coding of the tweets of the *most engaged* users and highly retweeted content highlighted the highly partisan frame that dominated Ontario Twitter energy politics. Issues that might broadly be defined as important to sustainability transitions (e.g., deployment of renewable energy technologies, climate change, long-term energy policies) were only addressed in a minority of the tweets reviewed. Instead, negative sentiment for the governing provincial Liberal Party was a prominent feature within Ontario Twitter energy politics. The majority of the critiques of the governing Liberal Party included economic concerns associated with the perceived high cost of electricity in the province. Polling data collected prior to the study period (November 15 to 19, 2016) had indicated the cost of electricity was the most important issue for Ontarians (Morrow, 2016). A similar concern was reflected in the data analyzed given the prominence of negative economic framing of energy issues in Ontario Twitter energy politics.

When reviewing the tweets of the *most engaged* users, the near complete lack of positive framing for the governing Liberal Party is striking. Every one of the *most engaged* users included some negative framing of the governing party in relation to energy issues, and the majority of the *most engaged* users appeared highly focused on criticizing the governing Liberal Party. Although non-governing parties were, when referenced,

more commonly presented with positive framing, most of these tweets were generated by political users associated with the positively framed party. While some of the *most engaged* users were associated with non-governing parties, prominent representatives from the governing Liberal Party were absent from Ontario Twitter energy politics entirely. Rather than being characterized by a partisan sentiment in favour of non-governing parties, it was negative sentiment for the governing Liberal Party that was most prominent.

Negative framing of the governing Liberal Party was also a large component of the tweets that were highly retweeted. While the highly retweeted content included some positive framing of the governing Liberal Party, these tweets were less common and were retweeted less on average than the negative tweets. Only positive frames for non-governing parties were identified in the highly retweeted content, but these were less numerous and less retweeted than negative framing of the governing party. Research indicates that climate change discourse on Twitter often occurs in a polarized 'echo chamber' (H. T. P. Williams, McMurray, Kurz, & Lambert, 2015), whereas examinations of Swiss nuclear policy discourse identified active interaction between Twitter users from competing positions (Arlt et al., 2019). Ontario Twitter energy politics seems to be better described as an 'echo chamber' with large proportions of the *most engaged* users' tweets and the highly retweeted content reflecting similar, largely negative, political framing.

5.6 Conclusion

Twitter offers a platform where users can easily share, and researchers can relatively easily collect, their opinions and thoughts related to topics influencing sustainability transitions. When considering the potential value of Twitter data for assessing political discourse and considering the socio-political dimensions of sustainability transitions, there is a need to understand the characteristics of Twitter data and Twitter users.

Twitter discourse, like other media discourse, tends to be dominated by a minority of individuals. In terms of gauging public perception, 2,841 users contributing nearly 7,000 tweets may seem to represent a large volume of data. However, the relative size of these datasets should be understood as a small proportion of the 10.2 million registered voters who were eligible to participate in the 2018 Ontario provincial election (Elections Ontario, 2019). Despite the relatively low barriers for the public to contribute to Twitter discourse, only a small proportion of the public will choose to do so. Additionally, Twitter data can be influenced through various means, such as bot activity, which complicates data analysis. While acknowledging these limitations, the

emergence of social media platforms has created new forums for public discourse with distinct characteristics that can provide researchers with additional perspectives of public debates regarding important issues.

Twitter activity tends to respond to outside events. The analysis of Ontario Twitter energy politics identified high activity responding to focusing events. Since Twitter users tend to react to outside events, one potential area of future research may be to evaluate *which* events garner Twitter users' reactions, and *which* events do not attract responses. Is Twitter engagement a response to well-connected users, such as politicians and journalists, driving user interaction on the subject, or are some events driven by wide engagement unassociated with well-connected Twitter users?

Additionally, this study analyzed the tweets of two groups of users: those users contributing the most to the discourse and those tweets that were highly amplified in the discourse. Whereas many of the *most engaged* users had no stated affiliation and seemed to use the platform as a space for sharing their thoughts and opinions, the majority of these users were not able to impact the larger discourse through high amplification of their tweets. The users that were most amplified in the discourse included a larger proportion of users that have traditionally been empowered in political discourse. However, an online-based political advocacy user, without a well-established position in political discourse, was the most amplified user in Ontario Twitter energy politics. Thus, Twitter does appear to have created the potential for users that have not traditionally been empowered to influence the discursive space; however, savvy and strategic use of Twitter communication, rather than simply engagement with an issue, appears to be important in generating consistent amplification from other users. Although Twitter has created a new discursive forum with a relatively low barrier of entry, the data examined here suggest that an elite minority of users, most traditionally empowered in political discourse but some novel, were highly amplified in Ontario Twitter energy politics; however, most unaffiliated users who were highly engaged in Ontario Twitter energy politics were not highly amplified in the discourse.

As described above, Twitter does not represent a direct reflection of the *public* discourse; however, examining discourse across diverse forums including social media platforms may provide broader insights into understanding how important topics are understood and prioritized by the general public. The analysis of the tweets in this case-study identified a discourse that was highly partisan, critical of the governing Liberal Party, and often highlighted economic issues associated with electricity costs. While the Ontario energy sector had been characterized by a number of progressive policies, closely associated with the governing Liberal Party, it was resentment for perceived high electricity costs that dominated the Twitter discourse. These findings may

reflect a Twitter discourse endemic to Ontario, or they may be artifacts of the data collection, but topics associated with sustainability transitions (e.g., various forms of electricity generation, renewable energy deployment, climate change, and the long-term energy policy) were not prominently observed in the Twitter discourse. While this lack of focus may be discouraging when considering future applications of Twitter-based research, determining the salience of these important topic areas to general public discourse (or lack thereof) should be seen as a key component to understanding the politics of sustainability transitions. In terms of considering the significance in relation to sustainability transitions research, this initial examination of Ontario Twitter energy politics suggests issues associated with sustainability transitions were not salient in the discourse; rather, users shared tweets that were highly partisan and focused on economic concerns.

Future transitions research exploring the activities and discourse on digital platforms should recognize the dynamic nature of these spaces. Digital platforms, like Twitter, are socio-technical systems where social behaviour is influenced by and influences the technological system (Felt, 2016; Geels, 2004; Halavais, 2014). In comparison to other socio-technical systems, such as large technological systems (e.g., energy systems, transportation systems), with significant physical infrastructure, the technological structure of digital platforms can be changed and updated much more readily (Markard, 2011). Additionally, as relatively new social forums, the rules, norms, and values associated with social interaction in these spaces continue to evolve. Users, including political actors and media organizations, continue to gauge the value of their approach to utilizing these spaces. Historical precedent suggests that policies governing researcher access and the costs associated with gathering Twitter data are changeable (Bruns, 2018; Felt, 2016). Major digital platforms, such as Twitter and Facebook, are privately owned; therefore, access to data for future research is dependent on corporate policies, and potentially changing regulatory environments.

Researchers using Twitter data also need to consider the ethical implications of sharing user data. While the data collected are publicly available, many users will not have considered or known that their data may be used for research purposes (Bruns, 2018; Markham & Buchanan, 2012). However, it is also true that many Twitter users are public figures who use the platform for messaging. Researchers should consider the reason and benefit for identifying users, especially in relation to users who do not otherwise have a prominent public profile (Bruns, 2018; Markham & Buchanan, 2012). For the purposes of this study there did not appear to be a strong case for identifying individual users; instead, profile descriptions were used to categorize users according to their stated institutional affiliations.

It is important not to overemphasize the representativeness of the data, but digital platforms, such as Twitter, do offer data rich sources to explore *forums* of public discourse. Twitter-based research is growing in a number of fields and new Twitter-based methods are being developed and improved. Researchers interested in exploring the socio-political dimensions of sustainability transitions should continue to monitor developments in Twitter-based research and consider potential applications. [6]

[6] *This chapter in its entirety can be found as a publication as follows: Labonte, D., & Rowlands, I. H. (2021). Tweets and transitions: Exploring Twitter-based political discourse regarding energy and electricity in Ontario, Canada.* Energy Research and Social Science, 72, *101870.*

Chapter 6 - Cross analysis of case studies

6.1 Introduction

Social and ecological systems face numerous sustainability challenges. The degree and dimensions of unsustainable practices are large and numerous: some are uncertain, and some are unknown (IPCC, 2018a; Raworth, 2012, 2017; Rockström et al., 2009; Steffen et al., 2015). Given the breadth of social and ecological activities that must be changed to meet a conception of sustainability, sustainability transitions – even if understood only in aspirational terms – will need to permeate most, if not all, social and ecological systems. A large contingent of sustainability transitions research is informed by a socio-technical systems perspective, which scrutinizes regimes in transitions (i.e., specific technical systems of interest and their associated institutions and actors) (Geels, 2004, 2019; Köhler et al., 2019; Markard et al., 2012). While changes in technological systems are relatively simple to measure, understanding the socio-political dimensions of sustainability transitions is a recognized challenge in the literature (Meadowcroft, 2009, 2011; Shove & Walker, 2007).

In this dissertation, I have utilized discursive approaches to examine the socio-political dimensions of sustainability transitions. As socio-technical systems transition, discursive struggles take place to reinforce or to reshape institutions associated with the regime. Sustainability transitions are not inevitable and do not necessarily proceed in a linear, predictable fashion (i.e., they are susceptible to unexpected changes and uneven progress) (Köhler et al., 2019; Loorbach et al., 2017), but institutional changes, which may not otherwise be noticeable, can be illuminated by investigating discursive struggle. The examination of discursive struggles can also identify when unsustainable institutional structures are being reinforced and serve to resist sustainability goals. Thus, examining institutions that are not changing in ways that support sustainability may also inform the understanding of sustainability transitions. Given that sustainability transitions will require major reorganization of socio-technical systems throughout society, and that this will necessarily require change in associated institutions, discursive struggles that may influence these processes will take place throughout society, as well. At a conceptual level, the breadth of discursive struggles that could be explored in relation to a sustainability transition is nearly limitless.

However, when considering this discursive terrain from the perspective of researchers trying to understand discursive struggle in sustainability transition, only a subsection of the discourse exists in forms

that can be captured physically and analyzed. Even with this limitation, there remains a broad discursive terrain that *could* be analyzed in relation to processes that permeate society. The challenge for researchers then becomes identifying where to examine on the discursive terrain and to identify forums of discursive struggle that could potentially provide meaningful insights.

In this dissertation, the discursive terrain related to energy system transitions has been explored in three studies: Chapter 3-5. These studies do not provide a full accounting of the terrain of discursive struggle related to sustainability transitions, or even sustainable energy transitions, for that matter; however, reviewing these studies collectively provides additional insights for understanding the discursive terrain related to sustainability transitions. Each study relied on discursive data collected from a different forum or forums – regime actor publications and interviews, newspaper media, and social media – which captured the discourses mobilized by diverse actors, each study applied different discursive approaches, and each study was driven by a distinct research aim.

In this chapter key findings from each study are briefly reviewed, and then the studies are cross analyzed based on several dimensions of comparison. In addition to considering the actors whose discourse is analyzed, the context of various discursive forums, and the discursive approaches used in each study, the cross analysis will also consider the temporal dimension of the studies presented. This cross analysis is then used to scrutinize some of the limitations associated with the conceptualization of the terrain of discursive struggle. The chapter closes by discussing how the terrain of discursive struggle can inform the understanding of the socio-political dimensions of sustainability transitions.

6.1.1 Chapter 3

The study in Chapter 3 – Regime actor innovation discourse: Public presentations and key informant perceptions of innovation in the Ontario electricity distribution sector – examined discourse from two forums (local distribution company (LDC) annual reports and key informant interviews) to identify innovation empowerment narratives (Raven, Kern, Verhees, et al., 2016; Smith & Raven, 2012) employed by actors across the LDC sector.

In terms of sustainability transitions, the LDCs can be understood as the most prominent regime actors, of all those examined across the three studies[7]: LDCs have a central role in the established Ontario electricity sector. Because LDCs are monopoly actors, their role in this regime is somewhat different from the role of many regime actors in other transitions studies. Often, incumbent regime actors are presented as in contest with challenging niche actors, but, in this case, monopoly regulation prevents direct competition. Nevertheless, despite the lack of direct market competition, the LDCs' regime position can be altered through regulatory changes or technological innovation. The examination of innovation empowerment narratives in this study illuminated how regime actors present the potential for innovation to reshape institutional structures governing their sector.

Each of the two discursive forums utilized for data collection in this study has a context, which influences the discourse that takes place. Given that the analysis in Chapter 3 was centred on identifying innovation empowerment narratives employed by LDCs and their representatives, the first forum –the annual reports – offered an opportunity for official presentations of the organizations' positions – at least as they chose to present them publicly – but these documents do not necessarily include narratives that directly address the question of interest. In contrast, the second forum – the semi-structured interviews – allowed for the key informant to be asked direct questions that would elicit responses likely to present an innovation empowerment narrative, of some kind. However, the individual representatives who participated in the interviews were free to expressed personal opinions and were thus not necessarily providing the LDCs' official position on these issues. When analyzing the interview data, it was possible to examine the responses to questions that prompted interviewees to state how innovative technologies should be regulated to determine which form of innovation empowerment narratives were being employed. When analyzing the annual reports, the study examined narratives associated with presentations of innovation or emerging technologies (when offered), but these presentations did not necessarily offer specific innovation empowerment narratives. There are numerous ways of presenting innovation and emerging technologies that do not address an underlying rationale about their associated regulation. Within this single study, it is possible to identify distinct characteristics of different discursive forums.

[7] This comparison is somewhat imperfect since multi-level perspective (MLP) descriptors, such as the regime, are defined by the system of individual studies; however, this comparison is explored in more detail below.

The study identified heterogenous innovation empowerment narratives, which revealed that these regime actors did not present a single consistent discourse regarding regulation of innovation in their sector. C*onforming* narratives that would limit the potential applications of emerging technologies, based on the existing regulation, were most prominently identified. Although some actors employed *transforming* narratives that encouraged novel applications of emerging technologies, these *transforming* narratives appeared to expand the LDCs' monopoly control in the sector, by including new services or expanding LDC business models. Though technically possible, the *transforming* narratives identified did not relinquish LDC control of in the sector. Furthermore, *boundary questioning* narratives, a novel conceptual category, were also identified. *Boundary questioning* narratives recognize that the application of the technology will depend on the institutional structures created, and that those structures are open to debate. The diversity of innovation empowerment narratives identified in the study suggests that while the theoretical concept of the regime may provide a heuristic for understanding transitions, the reality is more complex. Previous research has indicated that the regime, as a concept, is only semi-coherent because regime actors are less predictable than the MLP may suggest (Fuenfschilling & Truffer, 2014; Rosenbloom et al., 2016). The study found that regime actors – even within a highly-regulated, monopoly sector – assess their role and the incentives in relation to new technologies differently.

6.1.2 Chapter 4

Chapter 4 - Framing energy storage deployment: Media analysis of California and Hawaii newspapers – examined the coverage of energy storage technologies in the most circulated newspaper from the two states in the United States that led the deployment of those technologies. The coverage was analyzed through socio-political evaluation of energy deployment (SPEED) framework coding as well as by identifying themes of coverage related to the value proposition and the conflicts and concerns related to energy storage technologies over (nearly) a decade. The study analyzed how newspaper discourse changed over time in each state and compared the results across the two states.

Established news media organizations, such as the *Los Angeles Times* and the *Honolulu Star-Advertiser*, do not have a direct role in the energy sector regime; however, the relatively small number of established news media organizations, and individuals within those organizations, have a gatekeeper role that frames issues of importance in the public discourse (Shoemaker & Vos, 2009). From a sustainability transitions perspective, it is not immediately clear how these organizations are situated in relation to that part of the

energy sector regime that is deploying energy storage technology. Given that prominent newspapers are established organizations, with an elite position and gatekeeper role in framing public debates, it seems reasonable to suggest that the media discourse analyzed in this study can be conceptualized as more affiliated with the regime than the Twitter discourse presented in Chapter 5 and less affiliated with regime than the LDC actors examined in Chapter 3.

The discursive forum examined in this study is characterized by the media organizations analyzed. As discussed in the study, established media, such as newspapers, cover topics they perceive as *newsworthy* and these organizations have some degree of capacity to frame public debates. The newspapers examined in this study report on and potentially create an intermediary channel for regime actors (and also possibly niche actors) to convey thoughts and opinions to a broader audience. However, actors within these organizations make choices about what topics to cover and whose perspective to include in their coverage of those topics. These choices reflect the organizations' perceptions of public debates, as well as their own editorial philosophies, and commercial considerations, among other things. This context influences the coverage of any particular topic and will influence the discursive struggles that will be perceived in studies of such discursive forums.

The analysis of both newspapers' coverage identified comparable framing of energy storage technologies, based on a SPEED framework coding. The coverage was predominantly positive with technical, economic, and environmental benefits being the most commonly identified benefit frames identified in both newspapers. Economic risks were the most commonly identified risk frames identified in both newspapers.

Additionally, the theme analysis identified an evolution in coverage themes in both newspapers. While there were shifting themes in coverage in both newspapers analyzed, the themes and their evolutions were unique to each newspaper; this finding suggests that these changes in themes reflected local context in addition to technological improvements (the latter of which would have presumably been relatively consistent in both states). The analysis of themes in media presentations of value propositions and the conflicts and concerns associated with energy storage technology indicated a more advanced state of technology deployment in Hawaii: the application of energy storage technologies evolved and increasingly these technologies were presented as the *best* solution available, based on diverse criteria, for the electricity grids on various Hawaiian islands. The unique energy context associated with Hawaii's electricity sector created greater opportunities for energy storage technologies to be utilized.

However, when considering institutional change, perhaps the California coverage's evolution in themes represents a more advanced process of *transition*, at least as represented by the media discourse. In California, by the later years of the media analysis, energy storage technologies were being pursued as an alternative to natural gas energy applications. Energy storage technologies were being championed, not because they were the *best* solution on all grounds – in fact, they were presented as more costly – but because new criteria for assessment, namely, mitigation of climate change, were being introduced as important metrics for comparing energy choices. The media presentation in California highlights an institutional struggle to reframe decision-making in the space (Scrase & Ockwell, 2010). What was not captured in the media discourse, but almost certainly occurred, was a reshaping of electricity sector decision making in Hawaii, too. The new technological capacity offered novel solutions, which required new modes for planning and design of the electricity systems. These new modes of planning and design represent institutional change as well, but these specific changes were not reflected in the media through presentations of struggle or competition.

6.1.3 Chapter 5

Chapter 5 - Tweets and transitions: Exploring Twitter-based political discourse regarding energy and electricity issues in Ontario, Canada – explored discourse related to energy and electricity issues on the social media platform, Twitter. A few sustainable energy studies had previously utilized Twitter data (Arlt et al., 2019; Binder, 2012; N. Li et al., 2016; R. Li et al., 2019), but Twitter *discourse* has remained largely unexplored in this topic area. This exploratory study aimed to characterize Twitter discourse related to the politics of energy and electricity issues in Ontario.

As a discursive forum, Twitter is a relatively open forum and allows a broad range of actors to contribute to discourse on the platform. While some of the tweets included in the study were generated by established actors in Ontario political discourse, a significant portion of tweets was produced by unestablished political actors stating no official affiliation in their user description. While tweets are associated with a specific user, there is no guarantee for the majority of Twitter accounts that the user's name or additional information shared are authentic representations of the individual generating the content (though some more prominent actors do have verified accounts). In terms of thinking about which actors are represented in Twitter discourse from an energy transitions perspective, regime actors are able to contribute to the forum, as are key political actors and journalists, but the platform is also accessible to other users who are not traditionally empowered in the political discourse. Thus, Twitter offers a means for regime actors to

communicate directly to the public, but it also opens these actors to responses from broader segments of the population who are not traditionally empowered in the political discourse. Additionally, Twitter creates a space where niche actors can communicate to the broader public or present thoughts and opinions that challenge the regime. As with Chapter 4, it is not conceptually clear where a communications platform like Twitter would be situated in relation to the existing energy regime. Given that the discourse on Twitter is open to a more diffuse collection of actors and has fewer gatekeepers associated with sharing thoughts and opinions than traditional media, the discourse presented in this study can be understood as the least associated with the regime relative to the other studies in this dissertation.

The discourse that takes place on Twitter is highly influenced by the platform's design. Most obviously, users must share thoughts and opinions that meet the platform's concise character limit. But features of the platform – such as following structure, presentation of tweets in (roughly) reverse chronological order, and ability to retweet – also influence the type of discourse shared on the platform. The discursive forum created by Twitter is, as mentioned above, relatively open to diverse users but with limited traceability between the user accounts and the actors responsible for the content produced, and a high capacity for automated bots to influence Twitter-based discourse. Because high volumes of data are generated on Twitter, data collection must be significantly filtered for practical analysis, or alternatively, must rely heavily on automated approaches to analysis. Twitter, and other social networks, have created new discursive forums that researchers may choose to investigate to understand discursive struggle, but they are not without challenges when trying to understand their relation to the *public* discourse.

The study found that the Twitter discourse analyzed regarding the politics of energy issues did not reflect issues that are broadly associated with sustainable energy transitions. Instead, the discourse assessed was characterized by highly partisan and overwhelming negative framing of the (then) governing Liberal Party. Rather than the large dataset of Twitter discourse offering diverse perspectives engaging on important issues associated with long-term sustainability, the discourse analyzed was more aptly described as an echo-chamber with dominant framing repeated and amplified consistently.

6.2 Actors' discourse analyzed

In this dissertation, each study analyzed the discourse of different collections of actors in specific discourse forums. In Chapter 3, corporate annual reports and key informant interviews were analyzed; in

Chapter 4, media discourse was examined; and, in Chapter 5, Twitter discourse was explored. As described above, these studies can be understood conceptually as examining discursive forums from the most aligned with energy regime to the least aligned with the regime, respectively. However, the congruence across conceptual frameworks is imperfect.

One challenge is that the definition of a regime in sustainability transitions research is provisional to the specifics of a study (Avelino, 2017; Sorrell, 2018). The MLP is described as a heuristic framework, and the definitions of regime and niche depend on the system being studied (Geels, 2011). The studies in this dissertation focus on distinct socio-technical systems; therefore, there is no single conceptualization of the regime across the studies. Although each study explored issues associated with sustainable energy transitions, the definition of the regime in each study varied and comparisons across studies are thus not completely congruent.

The discursive forums studied vary based on the openness to multiple actors. The study in Chapter 3 focused on discursive data from highly targeted forums: only the discourse of LDC representatives and LDC annual reports was examined. Because the discursive forums were highly targeted, it was straightforward to associate the discourse analyzed in relation to the regime. Similarly, a study could be designed that examined a discursive forum highly targeted on niche actor discourse. In that case, it would be clear that the discourse examined would relate to niche actors rather than the regime. Thus, a discursive forum targeted on a specific actor group is relatively easily associated in relation to a defined regime.

In more open forums, a broader array of actors can contribute to the discourse. The study in Chapter 4 included newspaper articles discussing energy storage technologies, and within those articles there was a variety of actors quoted or whose thoughts and opinions may have influenced the coverage in some way. Comparing across the studies, the discourse represented in newspaper coverage is more open than the targeted study in Chapter 3, but less open than the Twitter discourse that was examined in Chapter 5. Whereas anyone with an internet connection, knowledge of the platform, physical ability, and the will to share a thought or opinion can contribute to the Twitter discourse considered in Chapter 5, it is ultimately the media organization's choice to share any individual's thoughts or opinions within the newspapers examined in Chapter 4. Twitter discourse can be understood as more open because the platform plays a more limited gatekeeper role in controlling the discursive forum than do newspapers.

For more open discursive forums, situating the discourse analysis in relation to MLP descriptors is less straightforward. Both newspaper articles and Twitter content may include discursive contributions from a variety of actors, some highly associated with the regime, others peripheral to the regime, or highly associated with a niche depending on the socio-technical system of interest. However, it is not simply that less open forums are more associated with the existing regimes. For example, it is possible to conceive of a media organization whose institutional structures preferentially empower the discourse of niche actors. As discursive forums become more open, there is less clarity regarding the actors represented in the forum and how these relate to the regime of interest.

It is possible with intention and analysis to ascertain the actors represented within any specific discursive forum. That was not an explicit aim of the studies in Chapter 4 and Chapter 5, so comparing these studies in relation to their regime orientation remains imperfect. Additionally, while a discursive forum may be described by its targetedness or openness, studies examining discourse from open forums can target discourse of specific actors. In other words, open discursive forums can be studied in a targeted way. For example, it would have been possible to examine only the discourse associated with utility actors in the newspaper coverage in Chapter 4. And, in Chapter 5 only a subset of Twitter users' discourse that was collected was ultimately analyzed. More open discursive forums have the potential, though not the guarantee, to include a greater array of actors' discursive contributions; as a result, more open discursive forums are less clearly situated in relation to MLP descriptors that are common in transitions literature.

In terms of using discursive approaches to understand sustainability transitions, it is important to consider the characteristics of the discursive forum being analyzed. For any issue of interest, it is possible to conceptualize a broad discursive terrain. Any discursive forum will only offer a subsection of the discursive terrain for an issue of interest. Therefore, it is important to recognize the characteristics of the discursive forum being analyzed and to consider who is or is not represented in any discursive forum. Targeted discursive forums, or studies that target the discursive contributions of specific actors, can be easily understood in relation to their association with a defined regime, but these studies only offer a limited perspective of the discursive terrain. While more open discursive forums potentially offer a broader perspective on the discursive terrain, more open forums are less easily situated in association with a defined regime. Thus, it is critical to evaluate the discursive forum being analyzed and to consider how this may be situated on a larger discursive terrain.

6.3 Discursive forum context

In addition to acknowledging actors represented in any specific forum, it is important to consider the context of a discursive forum. Across the studies in this dissertation, the discourse analyzed was sourced from interviews, annual reports, newspaper articles, and Twitter. Each of these forums has different contexts which influence the discursive contributions to that forum.

A major component of context to consider relates to who is communicating and who is the intended audience of that communication (V. A. Schmidt, 2008). For example, LDC annual reports offer a presentation of how those organizations choose to present themselves publicly. LDCs have no obligation to produce these reports; what is included in these documents are choices made by the organization, and it is reasonable to assume that the LDCs are presenting their activities in a manner they deem favourable. One can imagine that the same annual activities might be presented differently in a formal rate application with the regulator (where assertions could be challenged in a quasi-judicial setting). In contrast, the discursive forum of interviews with LDCs representatives has its own context. The representatives were aware that their comments would be used for research purposes; they likely interpreted that as a Ph.D. candidate asking questions about the regulation of energy storage technologies that I had a baseline of knowledge that might vary from other audiences. The participants may also have felt the need to seem knowledgeable on topics of inquiry since they had agreed to participate in an academic interview. While there are numerous discursive forums that may lend themselves to analysis each reflects a different context, and this will influence the discourse that is collected and reviewed.

The media analysis in Chapter 4 suggested that certain types of policy decisions – those impacting general readership to a greater degree rather than those directly impacting utilities, and thus only indirectly impacting general readership – may receive greater scrutiny before their implementation. This finding provides a useful example of how the context and the actors examined shapes the discursive struggle identified in a study. One rationale for this finding is that the newspaper's readership is likely to be more engaged in policy decisions that directly impact the general public. While it was not examined, one can imagine that an industrial journal targeted at an audience of utility actors may have included more debate regarding the energy storage technology mandate prior to the policy being implemented. The discourse captured in newspaper coverage was shaped by specific institutional factors, which do not necessarily reflect the full discursive terrain associated with the topic of interest.

The emergence of social media platforms, like Twitter which was examined in Chapter 5, have created new forums for discursive exchange, and the context and audience for users sharing thoughts and opinions in these forums continues to evolve. In considering the tweets examined in more detail, the context for engaging in Twitter discourse likely varies greatly across users. The non-affiliated users, the news media users, the political users, and the political advocacy users, all likely consider the audience and purpose for sending a tweet quite differently. Individual Twitter users have an imagined audience that may be approximated by their followers, and they likely have a conception of who that audience is (Marwick & Boyd, 2011); however, public tweets have a much broader potential audience – I highly doubt that any of the Twitter users examined in this dissertation assumed that the content they were producing would be analyzed in Ph.D. research. An assumed audience may be expected to understand elements of communication, such as references, tone, or sarcasm, that non-intended audiences will completely miss.

Another element of context that should be considered is the form of communication. The expectation for how ideas will be presented varies greatly between a semi-structured interview, where responses may be conversational; tweets, which are necessarily pithy and potentially include embedded media; and a written report or article, which is expected to present logically organized information in a grammatically correct fashion. The norms of various forms of communication will impact how ideas are presented, and thus the expectations for the interpretation of those communications must recognize those contexts. The format of the communication shapes the discursive contributions that will be observed in different contexts. In addition to recognizing that a specific discursive forum will only offer one perspective on a much larger terrain of discursive struggle, the context of that forum will impact the discourse observed and its relationship to the broader terrain associated with that issue.

6.4 Discursive approaches

The three forms of discursive approaches classified by Isoaho & Karhunmaa (2019) – discourse analysis, framing and frame analysis, and narrative analysis – have been applied across the studies in this dissertation. The diversity of discursive approaches relates to the varied purposes of the studies as well as the context of the discursive forums being analyzed.

The analysis in Chapter 3 can be most readily categorized as discourse analysis. While the description of the study involves the identification of niche empowerment narratives, the identification of these narratives

was not based on understanding the rationale for changes in the evolving electricity sector. Rather, the analysis examined responses from LDC representatives regarding how innovations should be regulated, and it examined how innovations were being presented in annual reports to identify assumptions regarding the nature of the selection environment: were innovation selection environments assumed to be static or were the selection environments assumed to be malleable based on innovation potential? Discourse analysis approaches aim to understand the ideas contained within communication, and in terms understanding institutional structures, to highlight the assumed rules, norms, and values that are perceived as legitimate. As such, discourse analysis is well-aligned with examinations of how, or where, or which institutional structures are being reinforced or challenged in sustainability transition processes.

The discourse analysis in Chapter 3 was targeted at understanding a highly focused question of institutional struggle. As mentioned above, the design of the study meant that the interview content was more likely to elicit responses that would contain niche empowerment narratives rather than the annual reports which could speak to innovation in the sector without necessarily presenting any indication of assumptions related to the selection environment. Applying discourse analysis to examine more specific points of institutional contestation requires data that are likely to present assumptions about the rules, norms, and values of interest. Although it might have been possible to analyze the Twitter data collected in Chapter 5 to identify innovation empowerment narratives applicable to the LDC sector, it is unlikely that these types of narratives would have been available in any meaningful quantity. True, it would then be possible to conclude that innovation empowerment narratives applicable to the LDC sector are not widely shared in this discursive forum, which would increase knowledge about sustainability transitions in some small way, but that does not seem like a useful application of effort.

Framing and frame analysis were applied in both Chapter 4 and Chapter 5. In Chapter 4 the frames considered were identified deductively, based on the SPEED framework, whereas, in Chapter 5 the frame analysis was based on inductive coding aimed at understanding what turned out to be partisan framing of the Twitter discourse. The SPEED framework in Chapter 4 is designed to measure which dimensions of energy technology benefits and risks are made salient, whereas the frames in Chapter 5 were intended to describe the most prominent themes in the Twitter discourse.

In both cases, coding frames in each forum offered a means of quantifying large amounts of data; however, it is less clear if this discursive approach clarifies discursive struggle and institutional contests. In the

case of the media analysis, the quantifying of risk and benefit frames does indicate that certain frames were more prevalent than others. The fact that technical and economic benefits frames were the most common in the coverage, followed by environmental benefits and that economic risks were by far the most common risk frames identified, does offer some broad socio-political insights regarding how an emerging energy technology is presented and evaluated. As was considered in Chapter 3, energy storage technologies could potentially be applied in ways that would challenge existing energy regulation, but the regulatory implications – benefit or risk frames – were not prevalent in the media coverage analyzed in Chapter 4. In terms of understanding the socio-political dimensions of the transitions, the frame analysis indicates that the economic dimensions of these new technologies dominate the media discourse rather than their regulatory dimensions. While somewhat unsurprising, this finding does highlight certain realities of the institutional structures that influence sustainable energy transitions. Namely, it shows that the economic dimension of emerging energy technologies is prominently evaluated in capitalistic societies. However, the frame analysis conducted using the SPEED framework does not illuminate the points of institutional struggle because quantifying the frames that are being made salient in the coverage does not provide specific details regarding competing ideas for institutional structures. Understanding institutional struggle requires greater detail than can be offered from quantification of risk and benefit frames in media coverage.

Similarly, the frame analysis in Chapter 5 indicates that the Twitter discourse analyzed was predominantly partisan. This framing highlights the formal electoral political contestation regarding energy policy in Ontario. Again, the frame analysis in this study cannot illuminate specific details regarding institutional struggles, but it does present a picture of the Twitter discourse regarding energy policy in Ontario. In that discursive forum, the most prominent institutional contests related to energy policy were contextualized through the existing partisan political process.

The frame analysis conducted in Chapter 4 and Chapter 5 quantified relatively broad categorizations of relatively large datasets. The institutional insights that can be gathered from a frame analysis directly reflect the frames being used to analyze the data. The categories applied in this dissertation are relatively broad: SPEED analysis aims to quantify risk and benefit in six dimensions, and the Twitter analysis considered positive and negative framing of three actor groups in relation to energy issues. As such, only the institutional struggles that are illuminated by those specific frames will be identifiable through this methodological approach. While frame analysis is a discursive approach, the degree to which this approach will highlight institutional struggle is highly dependent on the frames being selected for analysis.

Although the analysis based on SPEED frames might not be able to identify specific points of institutional contestation that arose during the study period, it does create a means of presenting a decade's worth of energy storage newspaper coverage in a format that can be compared across jurisdictions. Equally, it is possible to compare energy storage newspaper coverage to those of previous studies of energy storage and to other energy technologies. This discursive approach certainly offers useful insights, but in terms of considering the relationship to understanding institutional struggle, frame analysis is highly dependent on designing the methods that targets these findings.

In Chapter 4, a form of narrative analysis was also used to examine the newspaper coverage of energy storage technologies. Narrative analysis focuses on consequential elements within stories to provide rationales for events. The coverage themes were developed by identifying value propositions, applications of technologies, and conflicts or concerns associated with energy storage technologies. Each phase of coverage could be used to develop a narrative of the state of energy storage technologies. These phases indicate that different elements were presented as consequential in coverage of energy storage technologies at different times. Additionally, the evolution of themes through phases of coverage provides a longer-term narrative of energy storage technology in each jurisdiction.

In contrast to the framing analysis, the narrative analysis distinguished important contextual differences across the two jurisdictions studied, as represented in the media analyzed. While the framing of benefits and risks associated with energy storage technologies was comparable across the newspaper coverage in both jurisdictions, the specific value propositions, applications, and noted conflicts and concerns were unique. The consequential elements selected for analysis describing energy storage technology applications were different in California and Hawaii. Between the two states, the narratives of energy storage technologies were quite distinct, and this might reflect unique drivers of energy storage applications and associated conflicts and concerns that are reflective of the different energy contexts. However, these distinct narratives in coverage could also represent artifacts of the media organizations covering the topic in each context, as well. Because of these overlapping variables, comparisons of the theme evolutions across the two newspapers are more challenging.

In terms of understanding the institutional struggle associated with energy storage applications, the narrative analysis in Chapter 4 identifies changing applications and changing value propositions for the technologies, which suggest that there may have been associated changes in institutional structure shaping how

the technology is being deployed. In the case of newspaper coverage in California, drivers for energy storage applications shifted from a policy mandate for investor-owned utilities to purchase energy storage capacity to a socio-political imperative to reduce greenhouse gas emissions by utilizing energy storage technologies instead of natural gas. These changes reveal institutional evolution. These drivers identified reflect evolving institutional structures impacting the deployment of energy storage technologies. The mandate is a rule that impacts how the energy sector is governed in the state, and in the latter phase of the study period there appears to be socio-political negotiation regarding how energy technologies should be valued. The narratives identified in newspaper coverage do not necessarily present a comprehensive account of institutional struggle. Narratives provide a rationale for selected events by focusing on selected consequential elements; narratives simplify complex realities. However, as revealed in the California coverage, the examination of narratives can reveal underlying shifts in institutional structures.

Across the three studies in the dissertation, I have employed a variety of discursive approaches. The selection of discursive approaches to employ in each study was driven by the research questions at hand and the data being analyzed to answer those questions. While these discursive approaches have the capacity to illuminate the role of institutional structures in transitions, the specificity with which institutional struggles can be understood varies depending on the approach used and the data available. While each study in this dissertation deployed discursive approaches to understand energy transitions in different contexts, these approaches do not necessarily reveal institutional contests. Discursive approaches have the capacity to illuminate institutional contests, but they do not do so necessarily. The potential to illuminate specific institutional contests depends on the how those discursive approaches are applied.

6.5 Temporal parameters of studies

Transitions are understood as long-term processes, generally expected to be multi-decadal (Grubler et al., 2016; Köhler et al., 2019; Sovacool, 2016). Clearly defining beginnings and ends to transitions, or structured phases within a transition can be a challenge: transitions are uncertain and subject to non-linear shifts. However, given the (relatively) long transition processes, the temporal scale of a study places an additional constraint when considering the practical realities for researchers exploring discursive struggles related to transitions and understanding the socio-political dimensions of transitions. The purpose of applying discursive approaches in this context is to examine discursive struggle that can inform the understanding of institutional

changes associated with transitions. While transitions are generally long-term processes, it is not necessarily the case that the temporal dimension of a transitions study must match that time frame. However, the temporal dimension of a study will affect the potential research questions that can be pursued and the knowledge regarding transitions that is possible to reveal.

The temporal scale of the studies in this dissertation varied. In the examination of LDC narratives regarding energy storage technologies and innovation in Chapter 3 a snapshot approach was employed. Because the data collection was based on a single interview with each LDC representative and a single annual report released by each LDC, it was not possible to examine the evolution of discourse. In that case, the study focused on comparing across organizations governed by the same regulatory environment to understand narratives about emerging technology. The snapshot approach only offers a limited understanding of long-term transitions; however, examinations of conflicts or cohesion during a specific period or in relation to a specific topic may be insightful for understanding transition dynamics. In the case of Chapter 3, it was found that regime actors within the same sector employed competing narratives about the role of emerging technologies. These findings cannot predict which of these competing narratives will ultimately prevail, but they can reveal that competing narratives exist and that there is a potential for institutional struggle to develop in this space.

The Twitter analysis in Chapter 5 offered a slightly longer temporal examination of discourse. In this case, the study examined prominent frames in Twitter discourse over the course of 133 days. This temporal scale was selected to balance competing factors related to the study: the expectation that a policy document of importance would be released, the unknown characteristics of political discourse related to energy issues on Twitter, and the challenges associated with the big data characteristics of social media platforms. While the data collection period was several months, in terms of evaluating sustainability transitions, this period is akin to a snapshot approach. Because regime structures are generally expected to be relatively stable, it is unlikely that the discourse of broad groups of actors would be identified as changing in this length of time. The exception to this point would be if a relatively short sampling was conducted before and after an event that was perceived as a point of non-linear change in a transition. This type of approach might be possible when examining historical events – or perhaps by shear luck when examining 'current' events – however, there is no indication that the sampling in Chapter 5 included a major shift in discourse. Non-contiguous shorter sampling periods might also be combined to compare across a longer segment of a transition. Resampling of

Twitter discourse over several years might reveal evolving characteristics and dominant themes within the discourse.

The newspaper media analysis in Chapter 4 offers the longest temporal scale of the three studies in this dissertation. During the study period, nearly ten years, there were large deployments of energy storage technologies in both states. Large-scale deployment of technological infrastructure takes time; therefore, it should be expected that to observe institutional change associated with these deployments, longer timeframes of study will also be required. Studies with longer temporal parameters create the potential to identify institutional changes through time. Indeed, the analysis in Chapter 4 identified phases of evolving value propositions and conflicts and concerns associated with energy storage technologies in two states. When reviewing the institutional change on a longer temporal scale and relying on newspaper coverage to describe the associated events, only certain events will receive comment and be captured for analysis. Although it is possible to identify some changes in institutional contexts based on the coverage, clearly a few hundred articles cannot capture all the socio-political contest that took place regarding the deployment of energy storage over a decade in two states. Transitions are long-term processes and studies with longer temporal scales offer the opportunity to highlight key changes in discursive struggle, but transitions are also complex processes and studies with longer temporal scales may also require a greater degree of simplification of that complexity.

6.6 Limitations of the discursive terrain of sustainability transitions

One limitation of the discursive terrain related to sustainability transitions is its conceptual expansiveness. Sustainability transitions, if they are to meet their objectives, will necessarily transform diverse institutional structures throughout society. In terms of considering sustainable energy transitions, it can be expected that many official rules and regulations governing the design of energy systems will need to change, but it is also true that the norms and values of practitioners associated with these activities will need to be reshaped as well. Broader still, energy system designs are largely shaped by energy demand. The demand for energy is influenced by the institutional structures associated with energy users. Because energy systems facilitate modern society, the rules, norms, and values associated with almost any activity could conceivably be implicated in sustainable energy transitions. To that end, discourse offering insights regarding the rules, norms, and values associated with any of these activities could, arguably, provide insights about sustainable energy transitions.

Given the conceptual breadth of institutional structures that will necessarily be impacted by sustainability transitions, discursive struggle reinforcing or restructuring any of these institutional structures could provide insights into sustainability transitions. Therefore, almost any study of discursive struggle could be justifiably situated on the discursive terrain associated with sustainability transitions. On the one hand, all these changes, big and small, will impact sustainability transitions in some way. The conceptual vastness of the discursive terrain of sustainability transitions reflects the far-reaching implications envisaged by *sustainability transitions*. To transition to a societal system that is *sustainable* will be a massive undertaking that will have far reaching implications. On the other hand, the fact that it is conceptually possible to justify nearly any examination of discursive struggle as being situated on a discursive terrain does not suggest that any examination of discursive struggle situated on this discursive terrain is equally insightful.

The conceptualization of the discursive terrain does not offer a prescription for identifying meaningful discursive struggle. It is the researcher's role to design studies that will produce useful insights. This does not suggest that researchers should only focus on regime actors, or niche actors, or those perceived as most powerful with the regime of interest; there are potential rationales for exploring discursive struggles associated with more diffuse actors with less power. However, one should consider the potential insights that are available. There needs to be consideration for the context of the discursive forum being examined, who is represented in that forum, the likelihood that investigating that discursive forum will inform understanding of the discursive struggle of interest, and how that discourse relates to the institutional struggle of interest, or what the discursive struggle investigated in that forum could reveal about sustainability transitions. Because sustainability transitions are far-reaching, there is greater need for researchers to develop thoughtful rationales to justify their particular study design.

An associated limitation that must be considered regarding this dissertation is whether the collection of studies included provides an adequately illuminating initial foray of the discursive terrain related to sustainable energy. The overarching purpose of this dissertation was to explore how discursive approaches could deliver useful insights into the socio-political dimensions of sustainability transitions. The conceptualization of the discursive terrain associated with sustainability transitions emphasizes the wide-ranging potential for this approach. The studies pursued in this dissertation explore various slices of this terrain; the studies had different purposes, utilized different discursive approaches, and examined different actors within different discursive forums. Despite their varied nature, these studies can only offer small cross sections of potential study purposes and designs. As such, the conclusions drawn from a collective review of

the studies will themselves only provide a limited understanding of the discursive terrain associated with sustainability transitions. However, the variety in studies included in this dissertation provides an initial overview that emphasizes the conceptualization breadth of the discursive terrain associated with sustainability transitions.

When reviewing the studies in this dissertation, it seems valid to point out that that some studies mirror the limitations noted more widely in sustainability transitions research (Geels, 2019). In Chapter 3 and Chapter 4 the studies centre on the technological component of socio-technical systems – most notably energy storage technologies – and assume that the deployment of these technologies, or the contestation of their deployment, can and should be understood as important to understanding sustainable energy transitions. While it is true that these technologies do not inherently support sustainability in the energy sector, the recent growth in energy storage technology deployment, their novel technical characteristics in the electricity sector, and the regulatory ambiguity regarding their application make energy storage technologies useful for examining energy system changes. Chapter 5 is not primarily driven by a technological focus. When reviewing the Twitter data collected, partisan politics and economic critiques drove the conversation. However, it is true that my examination of the data to identify issues that may be associated with sustainable energy transitions was based on various energy technologies to a large degree.

Another potential limitation of this approach is that analysis of discursive struggles may more meaningfully *describe* complexity of socio-political dimensions of sustainability transitions within the specific context being analyzed, rather than providing insight regarding sustainability transitions writ large. Research providing a more thorough understanding of the socio-political dynamics that encourage or block institutional change in one context cannot directly predict the insights that *will* influence a separate context. When considering technological innovations' impacts on transitions in different jurisdictions, researchers have described spillover effects where technological innovation generated in one context, once developed, advances transitions in other contexts (Grubler, 2012). Similarly, institutional innovations that generate positive outcomes may offer spillover opportunities in analogous, if not directly equivalent, ways. Understanding the struggles that lead to institutional change furthering sustainability objectives in one context can highlight which rules, norms, or values were contested, by whom, and how. These findings may not be directly applicable in another context – the existing material technological system, actors and actor networks, and rules, norms, and values may not be analogous – but these insights can inform strategies for advancing sustainability.

A final potential limitation relates to the ontology of understanding institutional struggle through discursive approaches: discourse is always interpreted and recreated by individuals within particular institutional contexts. Even diligent analysis of robust discursive data cannot account for the various ways in which the ideas shared are interpreted and reproduced throughout social systems by diverse actors. Discursive data capture social interactions. The interpretation of those interactions by a researcher (including this one, of course) may not reflect the interpretations of the actors involved. Researchers can attempt to describe discursive struggles and try to understand their context and the contests portrayed within the data, but, by their very nature, the importance of discursive struggle relates to many different actors' interpretations and perspectives of what is or is not legitimate given their context. Through the examination of discourses being mobilized, prominent orientations and themes may emerge, but these will be filtered through the researcher's own orientation to the data. Therefore, discursive approaches – even highly structured approaches based on detailed and transparent protocols – can only provide an interpretation of the discursive struggle associated with a transition, but ultimately, there is not *a* description of discursive struggle associated with a transition. The transitions processes might be better understood as emergent from collective discursive struggles, rather than a product of the specific discursive struggle in a specific context. Transitions are highly complex processes involving technological systems, multiple actors, and institutional structures. To study these processes, it is necessary to make some simplifications that can help understand these processes. Interpretation of discursive struggle represents one such simplification.

6.7 Conclusions

The three studies in this dissertation provide differentiated explorations of the discursive terrain associated with sustainable energy transitions. The concept of the discursive terrain reinforces the need to scrutinize any specific discursive forum that is studied to understand socio-political dimensions of sustainability transitions. Socio-technical systems are comprised of technological systems, actors and actor networks, and the associated institutional structures. Discursive approaches offer the potential to identify discursive struggles as institutions undergo change in transitions processes. The institutional structures include all the rules, norms, and values that shape various actors' understanding and interaction with a technological system of interest. Any specific regime will include numerous actors who are influenced, to varying degrees, by a wide range of institutional structures. The terrain of discursive struggle offers a conceptualization of all institutional structures that may reshape a regime in a transition. Studies aiming to understand these

institutional structures will be limited in the discursive forums available. The terrain of discursive struggle emphasizes the limits within which it is possible to fully study the institutional changes that will accompany sustainability transitions.

While discursive approaches offer a means to examine institutional struggle, there is a need to recognize how the discursive forums being studied relate to the broader terrain of discursive struggle that exists. Who is represented in a forum? What is the context of the discourse being examined? These are fundamental considerations that should accompany any discursive study. Ultimately, the conceptualization of a broad terrain of discursive struggle emphasizes the need for researchers to present strong rationales for choosing to study a discursive forum or specific institutional struggle. While there are certainly many institutional structures that will need to evolve during a transition, some discursive struggles will be more consequential than others and some discursive struggles may be more readily examined in the data. It is the role of the researcher to identify when these two characteristics overlap; however, it is also important to recognize that even well-designed studies will only have access to a portion of the terrain of discursive struggle.

In relation to sustainability transitions, associating discursive forums with established descriptors within a sustainability transitions framework can be conceptually difficult depending on the specific characteristics of the discursive forum. Although discursive forums that are highly targeted on specific actors can be associated with established actor descriptions, more open forums that capture discourse from a broader collection of actors are not easily described on a regime-niche spectrum. When considering discursive forums and who is captured within any specific forum, there is no clear alignment with established sustainability transitions research, and this may limit future applications of this concept.

The studies in the dissertation offer three perspectives on how discursive approaches can be applied to illuminate the socio-political dimensions of sustainability transitions. Across the studies the specificity of the institutional struggles identified varies. This relates to the study purpose, the data analyzed, and the application of discursive approaches to analyze the data. Discursive approaches have the potential to illuminate institutional struggles, but they do not necessarily illuminate these struggles. Institutional struggle is a discursive process, which is why discursive approaches have the potential to illuminate these struggles; however, not all discourse communicated relates to institutional struggle. Discourse analysis, frame analysis, and narrative analysis all have the potential to be targeted to identify institutional struggles, but equally they can be meaningfully applied to analyze discursive elements that have no relation to institutional struggle. Thus,

the potential for discursive approaches to illuminate the socio-political dimensions of sustainability transitions depends on the discursive data available and how those approaches are applied.

This dissertation provides only a preliminary conceptualization of the discursive terrain associated with sustainability transitions, there are numerous research veins that could be explored further. In the concluding chapter, the specific contributions of knowledge from each study, and from the three taken together, will be reviewed. Furthermore, some future directions for research that build upon the studies included in this dissertation and the conceptual framework developed will also be presented.

Chapter 7 - Conclusion

7.1 Introduction

In this dissertation, I have set out to explore how and to what extent discursive approaches can be applied to understand the socio-political dimensions of sustainability transitions. As presented in Chapter 2, the theoretical framework for this dissertation framed the socio-political dimensions of sustainability transitions as discursive struggles to reshape institutional structures. In the sustainability transitions literature, technological systems, actors and actor networks, and institutional structures are described as three co-evolving elements that compose socio-technical systems. The institutional structures – the rules, norms, and values – shape actor behaviour in myriad ways by defining what is perceived legitimate and appropriate. The socio-political dimensions of sustainability transitions can be understood as the collective decision-making that reinforces, maintains, or challenges the institutional structures that inform social interaction and collective behaviour. The many institutions that structure social interactions and collective behaviour are discursive products. That is, institutions are created, maintained, and challenged by actors that (consciously and unconsciously) receive, interpret, and reproduce various discourses. A discourse refers to the means by which actors communicate and share ideas that present how they understand the world and what ideas or actions should be considered legitimate. In this interpretation, discourses are the fundamental elements that allow for social organization and that construct (or challenge) institutional structures. For sustainability transitions to take place, previously established unsustainable institutional structures must be contested and reshaped to support emergent, sustainable socio-technical systems. Thus, discursive approaches offer a means to examine how institutions are being contested by various actors.

However, sustainability transitions are complex processes. Any specific sustainability transition will involve innumerable potential contests to reshape various rules, norms, and values that structure social decision-making related to that system. These contests to reshape institutional structures occur through discursive exchange. New ideas for legitimate organization or alternative perspectives or opportunities must be presented to establish new rules, norms, or values. These new ideas may be accepted, rejected, negotiated, or reinterpreted in any number of ways collectively. Because the institutional structures are primarily constructed by discourses, the contests that reshape those structures take place through discursive exchange; a process

referred to as discursive struggle. Thus, discursive approaches offer a means to understand the socio-political dimensions of sustainability transitions because they can capture discursive contests to shape and reshape institutional structures.

While discourses construct social institutions and discursive struggles reshape institutional structures, not all discursive struggle is accessible to a researcher. Therefore, researchers aiming to understand institutional change associated with a sustainability transition must focus their efforts on specific discursive struggles that are accessible and that they believe will illuminate meaningful components of the institutional change. Additionally, there are varied discursive approaches that may illuminate distinct features of the institutional structures associated with a sustainability transition. Therefore, in addition to considering the diverse landscape of discursive struggle associated with a sustainability transition, one must also consider how those struggles might be probed. In this dissertation, I have presented three quite different studies that investigated distinct topics and that apply varied approaches. Although they vary in discursive forums, temporal scale, and study design, all the studies apply discursive approaches to examine the socio-political dimensions of sustainability transitions in the energy sector.

The three studies in this dissertation offer specific contributions to knowledge based on their topic of focus and study design. Across the studies, there have been empirical, methodological, and theoretical contributions to knowledge. Collectively, the studies also offer insights regarding the application of discursive approaches to understand the socio-political dimensions of sustainability transitions. In this chapter, I briefly review some of these contributions; I also discuss some broader implications of this dissertation and recommend potential avenues for future research.

7.2 Chapter 3

In the first study, discourse analysis was applied to identify niche empowerment narratives used by monopoly regime actors, namely local distribution companies (LDCs) in Ontario. By analyzing the niche empowerment narratives, the study examined the coherence of regime actors' understanding of the innovation selection environment. In analyzing innovation empowerment narratives, the aim was not to identify clearly articulated arguments for how the selection environment (in this case the regulated offering of the LDC) ought to incorporate innovation; rather, the analysis targeted the assumed nature of the selection environment: either fixed or open to change. In this case, discourse analysis identified that various regime actors presented

heterogenous narratives regarding whether the institutional structures influencing the application of innovative technologies could or should change. While some actors shared narratives that assumed innovative technologies would need to compete in the existing selection environment, others presented narratives that assumed the selection environment should be changed to accommodate innovative technological deployments.

These findings suggest that there is potential for socio-political contest to emerge in this sector. Given that some actors assume the institutional structures dictating the selection environment are fixed and others see them as malleable, there is potential for a contest to develop. Although the results showed a heterogenous collection of narratives presented by the LDC actors, in the absence of the research findings, it would have been plausible to assume that regime actors in a monopoly sector would present a homogenous group of narratives that did not question the selection environment. Had that been the case, there would be little reason to suspect that socio-political contest to reshape the selection environment would emerge from the actors examined. This study presents the potential for discourse analysis to identify competing assumptions about institutional structures. By illuminating possible contests regarding institutional structures, discourse analysis applied in this manner can reveal otherwise obscure socio-political dimensions of sustainability transitions.

In terms of empirical contributions, Chapter 3 offers insights regarding the present and potential future deployment of energy storage technologies in the LDC sector in Ontario, as well as about how LDC representatives understand innovation in their sector, and how LDCs present themselves publicly. The research identified that larger LDCs were more commonly pursuing and deploying energy storage technologies, as pilot projects or demonstrations. While LDC size appeared to influence which organizations deployed energy storage technologies, LDC size did not appear to influence the type of innovation empowerment narratives used to describe how energy storage technologies should be deployed.

As described in Chapter 3, innovation empowerment narratives communicate whether an existing selection environment for an innovation can and should change to accommodate that innovation (Raven, Kern, Verhees, et al., 2016; Smith & Raven, 2012). Three forms of innovation empowerment narratives were identified during the analysis: conforming, transforming, and boundary questioning. Across the interviews and in public presentations, a range of innovation empowerment narratives were identified, and their use had no apparent correlation to the LDC size or experience with energy storage technology pilots.

From a theoretical perspective, this finding reinforces the conceptualization of semi-coherent regimes in sustainability transitions (Bosman et al., 2014; Fuenfschilling & Truffer, 2014; Rosenbloom et al., 2016).

Rather than LDCs and their representatives understanding and reacting to innovative technologies with a unified vision and narrative, these regime actors presented and expressed contesting narratives, suggesting these actors have heterogenous perspectives in their sector. LDCs, it should be noted, are monopoly sector incumbents where entry of niche actors is prohibited through established rules. Given this context, sustainability transition theory would suggest that transitions in this sector would only occur through innovation or contestation of the institutional structures in place, not through the introduction of new actors. Thus, incumbents in monopoly sector regimes are less susceptible to challenges to their position than most other sectors. One might suspect that the relative stability of the sector would increase the incentive for these actors to perceive innovation and regulator challenges coherently as a regime. However, competing innovation empowerment narratives were identified across the LDCs and the LDC representatives. These results indicated that regime actors, even in tightly controlled sectors, will understand their sector and innovations in diverse ways, which will also lead to regime actors pursuing varied strategies. In practice, regimes are complex and regime actors are unlikely to operate as a cohesive group. While sustainability transitions research commonly categorizes some actors as part of an incumbent regime and other actors as niche challengers to conceptualize their roles in a transition and their likely motivations, the reality of actor behaviour and motivation is more complex than the simplified heuristics deployed to describe these actors.

Additionally, the analysis of innovation empowerment narratives regarding energy storage technology presented a theoretical contribution regarding how innovation empowerment narratives are understood. A new conceptual category of narrative was developed in this study: boundary questioning narratives. Through the conceptualization of boundary questioning narratives, the definitions of the existing innovation empowerment narratives, conforming and transforming narratives, were further refined. Boundary questioning narratives imply that a selection environment *can* be transformed, but they do not entail that the selection environment *should* be transformed. Boundary questioning narratives illuminate that innovation empowerment narratives have two components: a feasibility component (i.e., can the selection environment change?) and a normative component (i.e., should the selection environment change?). With this framing, transforming narratives can be understood to imply the selection environment *can* and *should* be changed. In contrast, conforming narratives can be constructed in two ways. They may include those narratives that imply that the selection environment *cannot* change, or they could imply that the selection environment *can* change, but it *should not* change. While not explored further in Chapter 3, I recommend that future research should

aim to refine the distinction between these two forms of conforming narratives and to consider their implications for how and why innovation may be limited in some spaces.

Regarding further recommendations for future research, innovation and the application of regulation to modernize electricity systems is an important area of contemporary policy debate (Canadian Electricity Association, 2019; Carlson, 2017). Regulatory choices in this space impact the deployment of renewable energy, cost of and access to electricity, and system resilience, among other things. Broadly speaking, many visions of sustainability transitions, including the Government of Canada's, rely on electricity systems being reoriented away from greenhouse gas emitting sources and then serving the electrification of sectors that currently rely on fossil fuel (Armaroli & Balzani, 2011; Davis et al., 2018; Griffith, Calisch, & Fraser, 2020; NRCan, 2018; J. H. Williams, DeBenedictis, et al., 2012). While electricity systems have been an important subject of sustainability transitions research (Markard, 2011; Verbong & Geels, 2010), there has not been, to my knowledge, significant grappling with the monopoly sector characteristics of electricity systems. As explored in Chapter 3, electricity systems cannot be understood through the typical incumbent-challenger lens that is commonly deployed in sustainability transitions research. I believe further exploration of the institutional conditions for monopoly sector and how these impact transitions dynamics is an important area of future research.

The specifics of electricity regulation and the structures of these sectors vary across jurisdictions. Electricity utilities play a critical and potentially counterproductive role in progressing sustainable energy policies (Stokes, 2020). In Chapter 3, LDC annual reports were examined to identify innovation empowerment narratives. Utility annual reports seem to be an under-utilized data source for exploring utility strategies in sustainability transitions. Further examination of how utilities position themselves publicly could be a productive area of future research. From a political perspective, there may be value in contrasting public positioning by utilities and relatively opaque positioning in policy processes or in regulatory submissions. While public positioning documents offer a means for these firms to present a narrative, their policy and regulatory submissions indicate their efforts to influence institutional structures and their investments and rationales for those investment. By comparing the public to the relatively opaque forums, it would be possible to see how well the public narratives represent a firm's actions in other venues. Additionally, given the varied electricity sector characteristics and policies across jurisdictions, there may be potential to compare utility responses to various policy choices, such as renewable portfolio standards or net-metering, or electricity sector innovations, such as the deployment of distributed solar or electric vehicles. Comparing various jurisdictional characteristics and utility responses may highlight conditions that encourage utility buy-in or contestation.

Given the crucial role of electricity systems in sustainability transitions, there is great potential value in engaging with various actions and motivations of the incumbent actors in these sectors.

7.3 Chapter 4

In Chapter 4, two discursive approaches were utilized to examine the newspaper coverage of energy storage technologies (ESTs) across two jurisdictions, over a decade. The coverage was analyzed to quantify categories of risk and benefit frames associated with ESTs and to identify the evolution of narratives regarding ESTs during the study period. By quantifying the framing of emerging technology, such as EST, it is possible to assess the risk and benefit frames that are being made salient in media coverage. Because the frames involved are rather unspecific, the study does not inform specific socio-political contests related to that EST deployment in either jurisdiction. Rather, the frame analysis offers a high-level measure of which dimensions of this emerging technology were perceived as newsworthy. In terms of understanding the socio-political dimensions of sustainability transition, this discursive approach offers a measure of how ESTs were being evaluated in the media discourse at a high-level, which reflects the categories of frames utilized in the analysis.

In contrast, the narrative analysis, which focused on identifying the value proposition for ESTs, applications of these technologies, and conflicts and concerns, was able to identify evolving themes in the EST coverage. The narrative analysis was able to identify themes specific to each jurisdiction and unique changes in those themes based on the coverage. Because the analysis was based on nearly a decade of newspaper coverage, the analysis does not illuminate all the institutional contests relevant to the deployment of EST, but it does offer a perspective on the socio-political dimensions of this sustainability transition, as presented in these newspapers. The narrative analysis identifies the changing socio-political dimensions that were prominently presented in the media coverage of ESTs.

More so than the other chapters in this dissertation, the study in Chapter 4 was designed to complement previous research. The study examined coverage of energy storage technologies (ESTs) by the most widely distributed newspaper in California, the *Los Angeles Times* (LAT), and in Hawaii, the *Honolulu Star Advertiser* (HSA). California and Hawaii are the two leading jurisdictions for EST deployment in United States and over the study period both states saw a significant increase in deployment of ESTs. Previous research had examined newspaper coverage of ESTs in Alberta and Ontario (Ganowski et al., 2018) and in Canada and the United Kingdom (Ganowski & Rowlands, 2020). Both previous studies compared overall levels of coverage

in specific jurisdictions and employed the SPEED framework to analyze frames utilized in the coverage. The study in Chapter 4 used a similar approach, and, in addition to providing further empirical contributions to knowledge, this study was intended to expand on earlier findings.

The study analyzed EST coverage in two newspapers over roughly a decade and made empirical findings regarding that coverage. The research identified that EST received more coverage in the HSA than the LAT. There were more than double the number of EST articles in the HSA than the LAT, despite the fact that the LAT is a more well-resourced newspaper that prints more articles in general. The SPEED frame coding identified comparable patterns of benefit and risk frames used in both newspapers, and the pattern of benefit and risk frames echoed previous research regarding EST coverage in newspapers and was distinct from coverage of various other energy technologies. While the consistency in framing across studies does emphasize a pattern in coverage, some caution should be acknowledged since intercoder reliability testing highlighted the subjectivity of frame coding. However, at least in early phases of deployment, it does appear that ESTs tend to receive relatively consistent framing that is predominantly positive.

In addition to adding empirical findings regarding EST coverage in two more jurisdictions, Chapter 4 also included methodological contributions to SPEED framework analysis. As explored in the coding protocol for Chapter 4, unitization of thematic codes can be challenging. In my review of previous research that utilized the SPEED framework, there were few details describing how units of analysis were defined. While thematic coding remains a subjective process, the definition of thematic concepts and distinguishing between elaborated, revisited, and reinforced concepts offers a coding structure to inform future research using this method.

The narrative analysis of EST coverage also identified fluctuating themes of coverage. While the evolution in themes of coverage provided a variety of empirical contributions regarding the coverage of EST in these two jurisdictions, I will revisit only a select few findings here. First, there was relatively rapid evolution in narratives regarding solar PV plus battery (PV+B) applications in Hawaii, particularly in relation to the contests and conflicts associated with the technology. Though the study only examined the EST coverage for just under 10 years, the narrative regarding PV+B shifted from a future challenger to electric utilities, to a tool of electric utilities to constrain solar PV growth, and finally to a generally uncontroversial and beneficial technology. The rapid shifting of media narratives related to PV+B applications in Hawaii likely reflects some specifics of the energy context, but these findings do indicate that the socio-political conflicts and contests

associated with deployment of energy technologies are, when viewed over a longer-term, potentially quite malleable. Second, when reviewing the later phase of EST coverage in the LAT, there appears to have been an important shift, from a sustainability transitions perspective, regarding how energy storage was being valued and compared with other energy sources. In the LAT EST coverage, the state's clean energy mandate was presented as reshaping how energy sector decisions should be made. Rather than selecting the more economical but greenhouse gas (GHG) emitting natural gas generation, a public debate was presented in the coverage to suggest that environmental impacts and associated GHG emissions of energy sources should determine energy sector priorities. These shifts in the parameters of public debate over energy system decisions present a potentially important shift in institutional structures. Rather than prioritizing economics of energy decisions, the public, as presented in the coverage, had mobilized to reshape the social decision-making process in this space.

At this stage, after three complementary studies regarding EST newspaper coverage, there appears to be some consistent findings: EST receives generally positive coverage; technical, economic, and environmental benefit frames are most common; and the most prominent concerns relate to economic risk and high costs of the technology. As deployment of EST progresses, it would be interesting to see if this generally positive media framing persists. On the one hand, the technology will become more commonplace and less newsworthy, but, on the other hand, there may also be challenges or issues. For example, in 2018, there was a string of utility-scale battery fires in South Korea and there have also been battery fire incidents in North America (Spector, 2021). It remains to be seen how these fire events will shape the media discourse, but in 2012, there were several battery fires associated with wind farms in Hawaii. The analysis of HSA coverage, however, noted that those incidents did not linger in the media coverage. A detailed review of the EST coverage from South Korea might provide a useful expansion of existing research in this area. Given the concentration of fire events, South Korean EST coverage would test the positive framing that has been found to date, and it would also be worth exploring if these fire incidents remain an important component of EST coverage or if, like in Hawaii, these incidents quickly fade from prominence in the media discourse.

The research in Chapter 4 was based on a single newspaper in each jurisdiction. A more thorough analysis of media discourse, particularly in California where a more extensive media ecosystem exists, could further illuminate some themes identified in this research. One topic of coverage to explore further is the media coverage of the energy storage mandate that was imposed on investor-owned utilities in California. The analysis in this study did not identify media coverage of this significant policy in advance of its

implementation. It would be helpful to understand whether this was a common feature of the California media discourse or unique to the LAT. Furthermore, similar energy storage mandates have now been implemented in other jurisdictions (Twitchell, 2019), and it would be illuminating to see if these policies are scrutinized in the media as they are implemented elsewhere. Given the need to transition energy systems rapidly, identifying policy approaches that are less prone to public criticism (for better or for worse) may offer an attractive strategy for policymakers trying to drive significant sectoral change.

7.4 Chapter 5

Sustainability transitions have broad implications across society. When discursive approaches are applied in an effort to understand the socio-political dimensions of sustainability transitions, the selection of a discursive forum has the potential to influence the perception of discursive struggles: varying discursive forums are composed of different actors who may have diverse relationships to the institutional changes of interest. The application of discursive approaches requires discursive data, and historically only a relatively small subset of discursive forums offered discursive data that could be captured physically and then studied. Technological advances have made discursive data available for potential study because an increasingly large portion of communication and interaction occurs in forums that are documented. Social media platforms have created novel forums of social communication and interaction. This study aimed to explore the discursive exchange related to the politics of energy and electricity issues on Twitter. In terms of understanding the socio-political dimensions of sustainability transitions, this study offers insights regarding how discursive approaches might be utilized to examine new and emerging discursive forums that have not previously been explored in the sustainability transitions literature.

The research presented in Chapter 5 was designed to explore public discourse regarding the politics of energy and electricity issues on the Twitter platform. At the time of writing, there has not been any comparable research investigating Twitter discourse related to energy issues. As such, Chapter 5 aimed to provide a preliminary description of energy discourse on Twitter and to consider potential applications moving forward.

From an empirical standpoint, the research highlights the dominance of negative sentiment, often on economic terms, towards the (then governing) Liberal government regarding energy issues. The majority of both groups of tweets analyzed in detail (i.e., the most active users' tweets and the tweets that were highly retweeted) were framed in partisan terms with largely negative framing of the Liberal government. From a

political strategy standpoint, the analysis also showed that few Liberal government representatives engaged in the Twitter discourse on these issues. High ranking officials within the government from the Liberal Party were often referenced in tweets, but neither the accounts of these individuals nor official Party were identified in the tweets reviewed. Overall, it appeared that the Liberal government had chosen not to participate in the political debate on Twitter regarding energy issues (at least during the period of the study), and the Twitter discourse that emerged resembled an echo chamber that amplified negative framing of the Liberal government.

Beyond the partisan political dimensions of the findings, the study explored the unique characteristics of Twitter discourse. The data collected included a significant portion of presumed bot activity, despite the research targeting a relatively restricted subject. The research also distinguished between those users who were highly engaged and those actors that were highly amplified through retweets. The findings highlighted that many of the users most engaged in a topic of conversation were not highly amplified in the Twitter discourse. This was particularly true for users with no stated affiliation. In contrast, many of the users whose tweets were highly amplified were actors, such as politicians and major media representatives, who have traditionally been empowered in political discourse. However, the design of the Twitter platform creates the potential for users to become highly amplified through retweets, and a user describing itself as a political advocacy organization was by far the most retweeted in the dataset. The data analyzed indicated that savvy users, even those who have not been traditionally empowered in the political discourse, have the potential to influence the Twitter discourse. However, despite creating a space where actors without traditional political power can contribute to a public discourse, Twitter does not appear to have reshaped the power dynamics to empower the general users who are highly engaged in a topic area. While some elite, savvy users might influence the Twitter discourse, for the most part, those traditionally empowered in the political discourse maintain that influence on the Twitter platform.

Another empirical finding was the relative lack of Twitter discourse regarding topics broadly associated with sustainability transitions. The data collection for this study was only 4 months and was based on tweets containing specific keywords. Therefore, the data analyzed contains only a subset of tweets that may have related to topics associated with sustainability transitions, but reflecting on the massive scale, underlying urgency, and huge stakes that drive the need for sustainability transitions, it is ominous that these issues are not prioritized is all public discourse regarding energy and electricity issues.

Because there were no comparable studies identified in the literature, Chapter 5 also provided methodological contributions. The study was able to quantify elements of the Twitter discourse to highlight salient frames related to a specific topic area. In this regard, the study also reflects the limitations of small data approaches (i.e., manual interpretation of data) to explore big data sources of discursive data. Even though the study included only tweets regarding a single topic area, in a single provincial jurisdiction, for a relatively short period of time, the data analysis relying on manual interpretation had to be limited to a small portion of the total data collection. There are numerous potential means of analyzing Twitter data, but based on current Twitter activity, discursive approaches that require manual interpretation are only viable for research focused on subsets of the Twitter conversation.

Twitter is a social media platform with a unique role in public discourse. It is used by a minority of the public in North America (Wojcik & Hughes, 2019), but there are indications that the platform is particularly influential with members of the media (McGregor, 2019; McGregor & Molyneux, 2020; Usher & Ng, 2020), who themselves have an indirect but potentially significant role in shaping public and political debate (F. Fischer, 2003; McCombs, 2004; Soroka, 2002). Influential actors can use Twitter to drive media attention. In recent months, the former President of United States' Twitter account was banned from the platform because it had been used to incite violence (Conger & Isaac, 2021). Twitter is both a relatively niche discursive forum and, at times, oddly consequential. Given these uneven characteristics and the large volume of discursive data produced on the platform, a key challenge for future research is to identify the discursive data that merits the attention of manual interpretation. This dissertation has argued that discursive data can offer useful insights into institutional change, which remains a gap in the sustainability transitions literature, and social media platforms, like Twitter, have created bountiful sources of discursive data. With social media-based research emerging across a broad range of fields, sustainability transitions researchers should draw on methodologies from diverse subject areas as they are employed on Twitter and other social media datasets.

7.5 The terrain of discursive struggle

The terrain of discursive struggle represents another theoretical contribution to inform sustainability transitions research. There have been a variety of discursive approaches that have been deployed in the sustainability transitions literature (Isoaho & Karhunmaa, 2019). The application of discursive approaches to question actor coalitions and institutional structures has both been identified as an important component of

current research in the field and of future research directions (Geels, 2019; Köhler et al., 2019). In this dissertation, I have presented the terrain of discursive struggle as a conceptual framework for understanding the broad range of discursive struggles that may influence a sustainability transition. Discursive approaches can illuminate the discursive struggle taking place as institutions are contested and reshaped during sustainability transitions. However, not all discursive struggles will be equally available for research and analysis. This is because most discursive interactions are not physically captured, and therefore cannot be analyzed.

In conceptualizing the landscape of discursive struggle, I have tried to both acknowledge the vast range of institutional struggles that might be involved in any sustainability transitions and to emphasize the limits of discursive research to consider the whole terrain. This vast range of potential institutional struggles is a conceptualization of the socio-political dimensions of sustainability transitions. I believe this conceptual framework guides researchers to recognize the limits of any individual study. Sustainability transitions are broad and complex; research can help to inform and understand dynamics of sustainability transitions, but it is useful and realistic to maintain a humble perspective on our collective capability to simplify and understand these processes. I believe the terrain of discursive struggle centres this insight.

Recognizing that a broad array of institutional struggles will be necessary to promote sustainability transitions, further exploration of the types of institutional changes that can facilitate the fastest and most positive sustainable outcomes could provide valuable insights. In the transitions literature, the established institutional structures are often referred to as the rules, norms, and values of a regime. There may be strategic insights offered by distinguishing between rules, norms, and values as institutional structures. As discussed in Chapter 3, while rules, norms, and values all contribute institutional structures that shape social behaviour, these three categories overlap, interact and are articulated in forms that are unevenly available for analysis. Formal rules – laws, contracts, regulation – will be more clearly defined than norms or values, which may make this category of institutional structure more accessible to study; however, norms and values (including those related to the application of more formal rules) should not be overlooked due to their relative vagueness. Further exploration and consideration for the types of institutional structures and the discursive struggle that will be accessible to discursive approaches is worth pursuing.

Expanding on this concept further, it is worth considering why some institutional structures are more difficult to disrupt than others. Additionally, in Chapter 6, I highlighted that the terrain of discursive struggle does not prescribe a means of identifying *meaningful* points of discursive and institutional struggle. There may

be value in both these regards to further theorize how power is distributed across any conceptual terrain of discursive struggle. A number of scholars have emphasized the need to conceptualize the role of power in sustainability transitions (Avelino, 2017; Avelino & Wittmayer, 2016; Brisbois, 2020; Geels, 2014; Köhler et al., 2019) and these efforts would likely benefit the conceptualization of the terrain of discursive struggle as well. Further examination of power seems like a key component to understanding the socio-political dimensions of sustainability transitions. An incorporation of attention to the distribution and exercise of power could inform which institutional struggles and which discursive struggles across the terrain of discursive struggle may offer meaningful insights regarding sustainability transitions.

7.6 Sustainability transitions in practice

The IPCC Special Report on 1.5°C of warming, which was released in 2018, presented a wide range of risks associated with increased climate change, along with a collection of socio-technical transition pathways that could limit warming to 1.5°C. The pathways presented in the report, though necessary to mitigate severe climatic risk, all required a rapid and significant reduction in GHG emissions. The UNEP 2019 Emission Gap Report estimated that emissions must be reduced by 7.6% annually between 2020 and 2030 to meet the 1.5°C warming target (UNEP, 2019). However, over the preceding decade (i.e., 2010-2019) emissions *increased* 1.3% annually on average (UNEP, 2020). Although clearly necessary to mitigate the risks associated with climate change, the GHG emissions reductions required to meet the 1.5°C pathways are unprecedented.

However, recent experience driven by the COVID-19 pandemic has forced a historically unique global shift in social systems. Across the globe, at varying times throughout 2020, large portions of national and subnational populations have had to endure lockdowns and social distancing measures that radically reshaped everyday behaviour and economic activity. As a result, energy use profiles and GHG emissions were profoundly reshaped in 2020 when compared to previous years (UNEP, 2020). The COVID-19 pandemic should clearly be understood first and foremost as a health crisis. As of this writing, an estimated 2.7 million people have lost their lives, 125 million have been infected, and innumerable people had their lives disrupted in ways big and small that may have lasting impacts. Vaccines, which offer the hope of greater normalcy, are beginning to be distributed; however, the future trajectory of the virus and its full effects remain to be seen.

The experience of the COVID-19 pandemic demonstrates that significant portions of human activity can be reshaped in a short period of time and that drastic reductions in GHG emissions are possible, under the

appropriate conditions. In this case, these reductions were driven by an acute and uncertain pandemic threat. The reorientation of social systems to respond to that threat imposed significant, yet highly uneven, costs across society. Although a full accounting of the emissions impact was not available at the time of writing, early estimates have suggested that 2020's mass economic disruption, social restriction, and uncertainty would likely result in approximately 4.2-7.5% reduction in GHG emissions (Le Quéré et al., 2020). Coincidentally, the high-end estimate of emission reductions in 2020 is comparable to the year-over-year reductions needed between now and 2030 to remain on the 1.5°C warming pathway.

Tragically, it required a global pandemic to reduce GHG emissions at a scale commensurate to the climate crisis, an outcome that has eluded decades of international efforts to acknowledge and address climate change. Following a pathway to limiting warming at 1.5°C would demand a further, equal emissions reduction in 2021 beyond what has been wrought by the COVID-19 pandemic. Clearly, the spontaneous social and political reactions to an uncertain health crisis do not reflect an ideal approach to responding to climate change. Given the nature of climate change and the scale of response that will be necessary to respond, the social and political measures necessarily need to be sustained (and sustainable) in ways that COVID-19 responses were not. Across many nations, including Canada, there are currently stimulus efforts aimed at driving an economic recovery in response to the COVID-19 pandemic (Department of Finance Canada, 2020; Evans & Gabbatiss, 2021). It is welcome to see that both in Canada and internationally, an unprecedented amount of stimulus funding is being leveraged to target the development of perceived sustainable energy solutions. In place of equivalent investments in other sectors, funding for sustainable energy initiatives is likely to be a net benefit for long-term climate change mitigation. And while the near-term social benefit that economic stimulus will drive should not be dismissed, it is difficult to imagine that economic stimulus to return to a pre-pandemic economy is compatible with pathways that limits warming to 1.5°C.

The research in this dissertation emphasizes the role of discourses to build, maintain, and challenge institutions. To mitigate the risks associated with climate change, large-scale sustainability transitions must occur across social systems as rapidly as possible. Sustainability transitions will require institutional transformation. While the experience of the COVID-19 pandemic demonstrates that major reorientations of social systems are possible, there is a need to build climate action at a scale comparable to the disruption of 2020, and then to redouble those efforts year-over-year. Additionally, climate action must elevate the pursuit of justice to fulfill the aims of sustainability transitions. As one considers the institutional structures that impede climate action and sustainability outcomes, it is necessary to recognize that these structures are socially

constructed and that they reflect collective decision-making. The collective decision-making that has built these structures is not always done explicitly or in the public consciousness, and it has been skewed by historical power dynamics and the influence of entrenched institutional structures. The challenge ahead, which is immense, is to mobilize and maintain coalitions that can overcome the problematic aspects of current institutional structures – the rules, norms, and values that inhibit sustainability outcomes.

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Appendix A - Energy storage interview protocol (Chapter 3)

Section 1: Participant and LDC context questions
Purpose: Draw out potential points of comparison between interviews. It is hypothesized that participant philosophy about the role of LDCs may impact the acceptance and attitudes toward energy storage technology. There may also be a link between size of LDC and ability to invest in innovative technology. The first few questions should be relatively simple and non-controversial.

1. Could you briefly describe your role with [**name of LDC**]?
2. How long have you been working in the electricity sector?
3. Given the large number and diversity of LDCs in the province, in 2 to 3 sentences, how would you describe your LDC compared to others in the province?

   Prompt: This could relate to customer base, infrastructure, philosophy. It is open to your interpretation of what is descriptive.

4. When comparing to other LDCs throughout the province is your LDC best described as conservative or innovative?
   a. In what ways?
   b. Why?

Section 2: Energy storage technology at the current stage
Purpose: To understand the current state of energy storage technologies at the participants LDC

5. At this stage, has [**name of LDC**] made use of energy storage technology?

6. Are there any projects, that you are aware of, where energy storage technologies have been, or are being, considered by [**name of LDC**]?

   a. In what capacity? Why were they not chosen?

7. When evaluating the potential for emerging technologies, like energy storage, what are the major considerations for [**name of LDC**]?

   a. Would you expect the considerations to vary between LDCs, and if so why?

8. Are there different standards when considering application of emerging technology vs. traditional approaches?

Section 3: Future potential for energy storage technologies at the distribution-level
Purpose: This section is trying to collect the participant's perspective for energy storage in the future 5 to 10 years. The timeline is chosen to reduce the uncertainty, but to allow participants to assume some technological progress, if they believe this is likely.

9. Looking forward 5 to 10 years, do you expect energy storage to increase in application at the distribution-level?

    a. What type of storage technology do you expect to be most significant at the distribution-level, and in what applications?

    b. Why do you think energy storage will not be important at the distribution-level?

10. Do you expect that the application of energy storage technologies will vary based on LDCs, either in the technology selected or the degree of deployment?

    a. If so, what would you expect to be the important factors for differentiating its application between LDCs?

11. Do you think energy storage technologies may allow LDCs to offer new services for customers?

    a. Could this extend to behind-the-meter services, or is that best left to non-LDC (non-regulated) providers?

12. When considering the application of energy storage technology at the distribution-level in 5 to 10 years, what are the biggest points of uncertainty for you?

Prompt: this might be political, regulatory, customer demand, technology, costs

Section 4: Policy questions
Purpose: This section is trying to identify potential policy barriers, as well as policy changes that might encourage the integration of energy storage technologies.

13. Given the current state of regulation and technology, what do you feel are the barriers for energy storage technologies at the distribution-level?

    a. What can be done to address these barriers for this technology?

14. Are there regulatory or policy changes that would encourage positive potential for energy storage technology?

15. When considering energy storage technologies at a distribution-level, in your opinion should this be the domain of LDCs or is there a role for 3rd party aggregators or storage service providers?

Section 5: Final thoughts

16. When considering the current application and future potential for energy storage technologies at the distribution-level, are there any important factors we have not had a chance to discuss?

Appendix B - Data analysis process (Chapter 4)

B.1 Data analysis process

Step 1. Upload all articles into Nvivo

Step 2. Initial article review – classify articles according to newspaper, year of publication, word count category (Pew Research - Project for excellence in journalism, 2005), **EST focus** (see below), and identify ESTs mentioned in the article

Step 3. Review subsection and focused articles from each newspaper in chronological order, code **SPEED frames** (see below), article **valence** evaluation (see below), note major topics of coverage

Step 4. Review major topics of coverage for each news paper, review EST-S and EST-F articles in chronological order for **coverage theme development** (see description in methods section)

B.2 Classifying article according to EST focus

ES mentions (EST-M) – These articles mention keywords from the data collection procedure but do not substantively focus on ESTs. Articles categorized as EST mentions include three or fewer sentences that discuss ESTs or EST policies.

ES subsection (EST-S) – These articles discuss ESTs or EST related policy for a portion of the article but are not primarily about ESTs. As a guideline, for articles categorized as EST subsections, the coder estimates ESTs or EST policies to contribute more than three sentences and less than a third of the article content. The coder should interpret ESTs or EST policies not to be the main topic of the article.

ES focused (EST-F) – These articles discuss ESTs or EST related policy as a major component of the article. As a guideline, articles categorized as EST focused the coder estimates ESTs or EST policies to contribute more than a third of the article. While ESTs or EST policies do not need to represent the main topic of the article, they are interpreted as a major component of the article.

B.3 SPEED frame coding

A SPEED frame identifies when ESTs are presented as a potential benefit or risk *to* one of six dimensions: cultural, economic, environmental, legal and regulatory, political, and technical (Stephens et al., 2014, 2008). Each of these frames may be invoked in multiple ways, which are identified as *concepts* in this

study. SPEED frame concepts can be understood as subthemes within each SPEED frame. In the codebook table (Appendix C), a number of concepts are listed for each SPEED frame.

The coding for this analysis aims to quantify the number of SPEED frame concepts presented in each article, as well as to account for concepts that are revisited and reinforced (more detail below).

The purpose of the analysis is to identify how and to what degree the benefits and risks of ESTs are framed within articles from each newspaper. The coding identifies when ESTs are presented as offering a benefit or risk *to* society through one or more SPEED frames, not that one of these frames offers a benefit or risk to ESTs. Therefore, an EST presented as a tool to supporting a 100% renewable energy (RE) goal would be a concept categorized as a regulatory benefit frame (and an environmental frame, see below) because the EST is being presented as supporting a policy goal. Alternatively, a policy offering a tax credit to invest in ESTs is not a regulatory (or economic) frame in itself because the policy is supporting the EST. However, if a reason is offered for why that tax credit is being offered that would likely present a regulatory benefit frame. The announcement of a tax credit may be expected to generate a new market (economic benefit), but this would only be coded as an economic benefit frame if this point is explicitly made. Reference to a tax credit for ESTs without noting its potential or ability to increase the market should not be considered an economic benefit.

To the degree that it is possible, the coding is used for explicit frames. In the example above, the fact that a tax credit has been established for ESTs implicitly suggests that those establishing the tax credit view ESTs as offering some sort of benefit; however, without there being an explicit reason presented – why that tax credit was established or what it might do – then a coded frame should not be applied.

Political frames are evaluated with an exception to the explicit reference rule above. A politician is not required to say they believe supporting an EST tax credit is politically beneficial. When political actors or political actions (bills or legislation) are referenced, a political frame should be considered, but it is not necessarily the case that a political frame will be interpreted. A politician or the legislature supporting a tax credit (or some other policy) specifically referencing ESTs should be considered a political benefit since the politician presumably considers the EST policy they are favouring as politically beneficial, in some way. Conversely, a bill supporting ESTs being blocked should be coded as a politically risk because politicians are choosing not to support ESTs in this manner. A reference to the fact that a bill or tax credit for EST exists should not be coded as a political frame unless an actor or the legislature supporting the bill or tax credit is mentioned.

Again, considering a tax credit, if a politician is referenced as supporting an EST tax credit because it will help integrate RE, that example would be coded both as a political benefit (the politicians support for the tax credit) and a technical benefit (ability to integrate RE).

Many statements could be interpreted as a benefit to some actors and a risk to others. The coder should focus on the actors and framing most explicit presented in a statement. For example:

> *"Experts said the batteries, combined with renewable energy sources, could eventually threaten utilities' long-held monopoly over the country's power industry."*
>
> (*Los Angeles Times*, June 18, 2014)

While the above could be interpreted as a potential economic benefit for customers (i.e., experts suggesting the market will open to competition could be considered an economic benefit to consumers); this is not made explicit in the text. By contrast, the sentence references the risk to the business model of utilities, therefore, this example is more appropriately coded as an economic risk.

B.4 Units of analysis

The coding in this study focus on frames as *thematic* units rather than *physical* units (Riffe et al., 2008). Rather than trying to measure the number of words, sentences, or paragraphs within an article utilizing a specific frame, the coding is based on the concepts being articulated, revisited, and reinforced.

As described above, each SPEED frame can be invoked through multiple concepts, and this is the unit being coded and quantified for analysis. An additional SPEED frame coding should be captured every time the coder interprets a new concept being presented. For example, "ESTs can help integrate renewable energy into the electricity grid" is a technical benefit concept. "ESTs can provide customers with backup power if the grid goes down" is also a technical benefit, but a distinct concept. Therefore, an article presenting both concepts would be coded with a two technical benefit frames.

A single concept might be coded as a sentence or over multiple sentences. For example, below are two descriptions of the energy storage being used to shift energy away from peak demand times:

> *"The systems help save energy by drawing from the batteries at times of peak energy use."*
>
> (*Honolulu Star-Advertiser*, October 13, 2015)

> *"Calif.-based Stem Inc. makes energy storage systems that help cut the peak energy demand of*

commercial customers with a technology called "peak shaving." Stem's systems, a battery and a monitor, are connected to businesses' meters. Powerscope, the company's software, analyzes a business's energy use and predicts periods of high energy demand. This software sends signals to the power monitor connected to the battery, automatically controlling when electricity is stored and when it is released. "When we're discharging the batteries, we are not disconnecting a whole building from the grid," said Tad Glauthier, vice president of Hawaii operations at Stem. "It's not enough storage to take the whole facility off, but (it) is reducing the amount it is pulling, which has the effect on the grid like if a whole bunch of lights are turned off."?"

(*Honolulu Star-Advertiser*, September 29, 2014)

Many concepts are potentially overlapping, and the coder must interpret whether distinct concepts are being presented or if overlapping concepts are being presented. This is commonly the case when discussing technical benefits: ESTs might be described as helping to integrate variable renewable energy generation, but this can mean storing energy for when it is most valuable to the grid, or managing voltage fluctuations, or making the renewable generation dispatchable. All of these different aspects might be presented as separate concepts with their own explanation, or they might all be presented as how ESTs help integrate renewable generation. Ultimately, this is up to coder interpretation.

For the purpose of quantifying SPEED frames within articles, the coding aims to distinguish between concepts that are elaborated, revisited, or reinforced. It is up to the coder to interpret the data and distinguish between these uses. If a concept is elaborated that should only be coded once. If a concept is revisited or reinforced an additional code should be used for each time the concept is revisited or reinforced.

B.4.1 CONCEPT ELABORATION

If a concept is presented in one sentence and then elaborated in the next, as described above, that should be coded as a single frame. Similarly, a concept may be presented in a sentence then elaborated later in the article, and this should also be coded as a single concept. This is particularly important because news articles are commonly structured as inverted pyramids with a lead paragraph presenting important ideas that are later expanded (Po¨ttker, 2003; van Dijk, 1983). An elaborated concept, even one separated by multiple sentences or paragraphs, is introduced and then followed by further detail of the original concept presented (i.e., elaboration).

Below is an example of a single concept being elaborated:

"A solar energy project that supplies Lanai with 10 percent of its electricity needs recently began operating at full capacity after the installation of a battery system that allows more renewable power to be integrated into the small island electrical grid.

The La Ola photovoltaic solar project, owned by Castle & Cooke , has a maximum output of 1.5 megawatts of direct current, or 1.2 megawatts after converting the power to alternating current for household use.

Since launch of the La Ola project in December 2008, its output had been restricted because officials were concerned that the power fluctuations associated with solar energy might damage the electrical grid. To address the issue, Castle & Cooke installed a battery backup system developed by Texas-based Xtreme Power to smooth out the volatility of the solar energy."

(*Honolulu Star-Advertiser*, April 19, 2012)

Technical benefit - concept: ES supports integration of RE

Project specific details that elaborate the concept: ES supports integration of RE

In the above example, the value of the ES is being elaborated on after more detail regarding the project is presented. If the detail of the project were removed, the two highlighted components would present a single concept:

"A solar energy project that supplies Lanai with 10 percent of its electricity needs recently began operating at full capacity after the installation of a battery system that allows more renewable power to be integrated into the small island electrical grid."…"Castle & Cooke installed a battery backup system developed by Texas-based Xtreme Power to smooth out the volatility of the solar energy."

(*Honolulu Star-Advertiser*, April 19, 2012)

Technical benefit - multi-sentence concept: ES supports integration of RE

Note that if multiple concepts are introduced, especially in the lead paragraph of an article, each may be elaborated on in turn.

B.4.2 Concept Revisited

In addition to quantifying SPEED frame concepts present in articles, the coding also aims to capture which concepts are emphasized through repetition. A single article can be coded for the same SPEED frame concept multiple times if a concept is revisited or reinforced (see below).

A revisited concept is one that is repeated within a single article. Whereas an elaborated concept is introduced then expanded upon, a revisited concept is discussed, other topics are presented and discussed, and then the same SPEED frame concept is repeated. Ultimately, the coder must use their interpretation to distinguish between a concept being elaborated and a concept being revisited.

When coding a revisited concept, the coder is interpreting that the first coding of the concept was not an introduction to the second coding of the concept. A single concept cannot be revisited consecutively; there should be other ideas presented (potentially not coded by any SPEED frames) between a concept being coded and then coded a second time, as revisited. Additionally, the ideas presented between the original concept that was coded and the revisited concept should not be interpreted as contextualizing the revisited concept.

B.4.3 Concept reinforced

Multiple coding of the same SPEED frame concept can also be applied if an article reinforces the same concept. Concepts are reinforced when multiple projects are mentioned highlighting the same concept or if multiple individuals or organizations are quoted highlighting the same concept.

If an article details multiple projects using EST and highlights the same SPEED frame concept, each additional project should be considered as reinforcing the concept and coded separately. Similarly, if multiple actors are quoted presenting the same SPEED frame concept, each additional actor or organization quoted should be coded separately. In addition to direct quotes, an article may reference reports, analysis, or positions of organizations in relation to ESTs; these types of references should be considered equivalent to quotes.

Descriptions of projects and/or quotes from actors or organizations are often included to elaborate a point in articles. Therefore, reinforced concepts only apply if multiple projects are described or if multiple actors or organization are quoted or referenced.

If a SPEED frame concept is revisited in an article, a second quote and/or project detail may be used to elaborate the revisited concept; the additional quote and/or project detail would not also be coded as a reinforced concept.

B.5 Valence evaluation

All EST-S and EST-F articles were categorized with a valence of positive, negative, or neutral. The valence evaluation of articles describes the articles overall tone regarding ESTs. The valence evaluation is

specifically related to the article tone towards ESTs, not the overall tone of the article, which may be about another subject primarily. The valence categorization is ultimately a measure of the coder's interpretation of the article and how ESTs are presented.

While the SPEED frame analysis can contribute to the valence evaluation, the valence is not a direct reflection of the benefit and risk frames identified. If an article employs many benefit frames and no risk frames, it is very likely that the article will be categorized as positive because, in that case, ESTs will have been presented overwhelmingly favourably. Conversely, an article presenting many risk frames and no benefit frames would very likely be categorized as negative. When there is a more mixed presentation of benefit and risk frames the valence evaluation offers an overall assessment of the article's presentation. Articles can also be categorized as neutral valence. Neutral articles do not necessarily have equal numbers of benefit and risk frames, rather a neutral valence suggests the article had a tone that was neither positive nor negative. The valence evaluation might consider the language used to convey EST frames, prominence of quotes from actors either favouring or against ESTs, lead and concluding paragraphs of articles.

Appendix C - SPEED frame codebook (Chapter 4)

Frame	*Benefit concepts*	*Concepts*	*Notes*
Cultural	Safe; contributes to energy independence; enhances customers control of energy; improves consumer choice; enhances customer/state resilience; can help fulfill other societal non-energy/environment goals (e.g., pumped hydro dam will support agriculture); jurisdiction as a leader; supports equitable society; provides health benefits; well designed (e.g., compact, aesthetically pleasing)	Unsafe; unhealthy or has toxic components; fire prone; contribute to jurisdiction is falling behind; contributes to social inequality; requires lifestyle change; lack of customer choice	The concept of toxic components should be interpreted as related to health
Economic	Saves money; good business opportunity; generates jobs or supports employment; there are a lot of installations happening (good business); the market for these is growing; good investment; organization investing in ESTs	High costs; emphasis on large capital requirement; risk to current business model for utilities (if emphasizing utility perspective); long payback period; hurting jobs; bad investment; no demand; little market interest	Discussion of future cost reduction is <u>not</u> economic benefit, unless highlighting expectation for a growing market; the announcement of awards or grants should not be considered economic frames without further detail – awards may be for research of advanced storage, which is a technological frame
Environmental benefit	Supports clean energy goals; reduces fossil fuel usage; reduces greenhouse gas emissions; fights climate change; "clean" or "green" technology	Disposal or production bad for environment; toxic for environment; pumped hydro storage impacting water availability; increased greenhouse gas emissions; threat to ecosystem or specific species	EST being used to complement RE is not considered an environmental frame without further elaboration
Political benefit	Stakeholder group supports; politicians supportive of EST or advancing legislation to support	Stakeholder group identifies EST as a risk to them; EST project being hotly debated or an issue of debate/concern; politicians oppose EST or block EST legislation	Utilities emphasizing EST as a threat could be considered political depending on presentation
Legal or regulatory benefit	EST supports regulation or legal requirements; EST supports policy goal	EST complicates regulatory process; EST is a risk to legal mandate or regulation; cause regulatory challenges; unclear regulatory standards	
Technical benefit	Balances RE; improves reliability; improves stability; provides backup; allows users to go "off-grid"; large capacity; known technology; flexible resource; quick response; use full capacity of RE output; advanced technology; longer life; faster charging	Complicated to integrate; not meeting expectations; having to close project because of EST issue; poor performance; lack of capacity; not suited to needs; short life	Some of these benefits overlap. It is up to the coder to determine if a new concept is being presented or if a concept is being elaborated Statements noting a project does not require a battery because of location is not a *risk*

Appendix D - Intercoder reliability testing (Chapter 4)

ICR testing may be performed for multiple purposes. When large datasets require coding, ICR testing may improve the consistency amongst coding teams (Macphail, Khoza, Abler, & Ranganathan, 2016). When combining coding across a team, it is critical that each member of the team is interpreting the data consistently to ensure that the combined coding reflects a coherent measure of all data. ICR can also be used to demonstrate the qualitative coding is done in a consistent, replicable fashion, which, it is argued, establishes greater scientific validity and provides stronger evidence to support research conclusions (Kurasaki, 2000). Additionally, to establish replicable patterns of coding, researchers are likely to refine their approach to data analysis and coding definitions (Macphail et al., 2016). In addition to improving reproducibility, establishing clear processes and coding definitions may improve the *stability* (i.e., the consistent application of codes by a single coder) of coding (Campbell, Quincy, Osserman, & Pedersen, 2018).

Measures of ICR use statistical approaches to compare the agreement among two or more coders (Feng, 2014). There are numerous approaches for calculating ICR that are distinguished based on their assumptions about coding and the number of potential coders that can be compared (Feng, 2014). Measuring percentage agreement (i.e., number of cases where coders agree divided by the total number of cases) between two coders is relatively straightforward but has become disfavoured because it does not account for chance agreement (Connor & Joffe, 2020; Feng, 2014; Zhao, 2013). A number of methods have been developed to account for chance agreement in coding, such as Scott's π, Cohen's κ, and Krippendorff's α (Feng, 2015; Hayes & Krippendorff, 2007; Zhao, 2013). While these methods are not without their own limitations, namely, the assumption of complete randomness in coding (Zhao, 2013), these measures provide a more sophisticated comparison among multiple coders that recognizes the potential for chance agreement. In addition to percentage agreement, Krippendorff's α was applied to measure ICR in this study using RECAL (http://dfreelon.org/utils/recalfront/).

As described in the Methods section, the principal investigator (PI) completed step 1 and step 2 of the data analysis process, then conducted a preliminary SPEED coding for all EST-F and EST-S articles from both newspapers. The deductive coding process was based on the SPEED framework and previous research that applied the SPEED framework to media analysis of EST coverage (Ganowski et al., 2018; Ganowski & Rowlands, 2020; Stephens et al., 2014, 2008). As necessary, adjustments were made for frame concepts that

were not described in previous research. A detailed data analysis process (Appendix B) was developed to support ICR. The preliminary coding was complicated by the ill-defined unitization of risk and benefit frames. To improve the ICR process, the unit of SPEED risk and benefit concept was developed, including distinguishing between elaborated, revisited, and re-enforced concepts.

Once the data analysis process was complete, a meeting with the secondary coder was organized to review the data analysis process, describe noteworthy elements of the codebook, and to code two shared articles. The secondary coder was also given two articles to code independently. Once completed, a second meeting was organized to discuss the results. Based on the independent coding, relatively consistent agreement was achieved between the two coders, although some discrepancies were discussed and clarified. At that stage, a random sample of 50 articles from the complete dataset (EST-M, EST-S, and EST-F articles) was shared with the secondary coder. They were asked to identify each article's EST focus, and then to conduct a SPEED frame analysis and valence evaluation for EST-S and EST-F articles.

After the second meeting with the secondary coder was complete, the PI reviewed all articles a second time and refined categorization and coding. The PI's and secondary coder's results for the 50-article sample were compiled. Each article was identified with binary measure for EST focus and valence; SPEED frame analysis compared the number of benefit and risk frames for each category for each article. The comparison of SPEED frame coding did not account for specific concepts coded or the specific text coded in each article. Table 4 shows the results for the ICR.

Table C-0-1 - ICR measurement for coding element

Coding element	***Percent Agreement***	***Krippendorff's Alpha***	***N Agreements***	***N Disagreements***	***N Cases***	***N Decisions***
EST FOCUS						
EST-M	82	0.636	41	9	50	100
EST-S	76	0.258	38	12	50	100
EST-F	86	0.609	43	7	50	100
VALENCE EVALUATION						
POSITIVE	86	0.687	43	7	50	100
NEGATIVE	90	-0.042	45	5	50	100
NEUTRAL	90	-0.042	45	5	50	100
SPEED FRAME ANALYSIS						
CULTURAL BENEFIT	88	0.563	44	6	50	100
CULTURAL RISK	96	0.587	48	2	50	100

ECONOMIC BENEFIT	88	0.657	44	6	50	100
ECONOMIC RISK	88	0.524	44	6	50	100
ENVIRONMENTAL BENEFIT	86	0.649	43	7	50	100
ENVIRONMENTAL RISK	98	0.497	49	1	50	100
LEGAL BENEFIT	88	0.193	44	6	50	100
LEGAL RISK	100	1.000	50	0	50	100
POLITICAL BENEFIT	96	-0.010	48	2	50	100
POLITICAL RISK	98	0.660	49	1	50	100
TECHNICAL BENEFIT	60	0.329	30	20	50	100
TECHNICAL RISK	94	0.380	47	3	50	100

For most coding elements according to percentage agreement, ICR is relatively high (+85%). In contrast, Krippendorff's α does not identify high agreement. While Krippendorff's α is recognized as a more conservative measure of reliability, and there is no defined minimum threshold for defining reliability, agreement >0.70 is generally recommended, even for exploratory research (Lombard, Snyder-Duch, & Campanella Bracken, 2004). The relatively high degree of the percentage agreement can partially be explained due to the discrepancy between the coding of EST-M and EST-S and EST-F articles. Because EST-M articles were not coded for SPEED frames analysis or valence evaluation, agreement of EST-M focus categorization ensured exact coding for SPEED frames and valence. The two coders agreed that 24/50 articles were EST-M. Therefore, a minimum of 48% agreement for SPEED frames and valence were ensured due to this level of agreement on EST-M categorization[8]. Given these limitations to the ICR comparison using percentage agreement, the ICR should be rejected as insufficient, and this conclusion must be acknowledged when considering the generalizability of the results.

While ICR measurements are often encouraged for qualitative research to promote scientific validity (Kurasaki, 2000), these approaches are not without critiques. First, coding of qualitative data inherently relies on interpretation of the coder (Campbell et al., 2018; Connor & Joffe, 2020; Joffe & Yardley, 2004). While the

[8] Although technical benefit frames have the lowest percentage agreement, I attribute the low agreement, somewhat counterintuitively, to the fact that these frames were most identified. Because both coders commonly identified one or more technical benefit frames, it was more likely that the exact coding would not match. I believe this can be understood, at least partially, as a lack of cohesive understanding of concept elaborated, revisited, and re-enforced. The discrepancy is also likely attributable to some technical benefit frames having conceptual overlap.

data analysis process document for this study was developed to provide thorough instructions for document coding, distinctions between coding elements were often, by necessity, described as based on coder interpretation. The SPEED concepts quantified are not objective components of the newspaper articles, they depend on the coder's engagement with the text and interpretation of meaning.

Secondly, high levels of ICR indicate that coders can, with sufficient effort, be trained to follow a consistent framework when coding, which does not necessarily suggest the coding is reliable beyond those trained individuals (Connor & Joffe, 2020; Joffe & Yardley, 2004). When multiple team members are coding large collections of data that will be analyzed collectively, there is clearly value in ensuring the team has a consistent interpretation of the coding framework (Campbell et al., 2018); however, that was not the purpose in this study. The coding in this study reflects the interpretation of frames within newspaper articles. While high ICR measurements would indicate consistent application of frames by each coder within the team, it would not necessarily suggest consistent interpretation of those frames beyond the trained team of coders. Given the development of concepts as the unit of coding, which was not previously established, high ICR measurement may have falsely exaggerated the validity of generalizing the results identified in this study to previous research.

Acknowledging these critiques of ICR measures is not intended to overlook the unsatisfactory ICR measures observed. The lack of high ICR presents a limitation when considering the generalizability of the study results. The SPEED frame analysis was pursued to analyze a decade's-worth of media coverage in two states and to potentially enhance the interpretive value of the study by complementing previous media analyses of ESTs. Given that the results of the ICR suggest the coding of article frames and valence was subjective, the degree to which results from this study can be compared to other results may be questioned.

While the ICR measurement may have highlighted the subjective nature of the analysis, from the perspective of the PI, the intercoder work remained valuable and was especially valuable for unitization of concepts. This is a recognized issue when codes refer to units of analysis that are thematic and interpretive, rather than physical (Campbell et al., 2018). While shifting to less interpretive coding, such as coding sentences or coding for specific words, may have increased the ICR measurement, there would be little epistemic value of this reliability measure in terms of assessing media discourse, which is fundamentally about competing ideas not quantitative measures of language. The coding of frames within the article is intended to provide an interpretation of media discourse through which readers would understand ESTs. While media framing has been shown impact public perception (albeit not deterministically) of specific issues and increase salience of

specific topic frames, there is little reason to believe an exact measure of words used or sentences employed in frames provides insight into these mechanisms or would provide a useful measure of media discourse. Therefore, the thematic unit of the SPEED frame concept was applied in this research. The ICR exercise led to more specific definitions of concepts and distinctions for elaborated, revisited, and reinforced measures of concepts.

My experience as the PI suggests that the requirement to define the concept units more specifically improved the stability of my own coding, particularly in relation to distinguishing between the number of SPEED frame concepts that were revisited and re-inforced within an article. For this study, only a single researcher was involved in coding the full dataset. The primary purpose for conducting ICR was to determine the replicability of news article coding. The measurement of ICR determined that reliability between coders did not meet established guidelines. However, the exercise also contributed to the development of more detailed and specific coding approaches and definitions (see Appendix B and C), which ultimately contributed to greater stability in overall coding by the PI.

Appendix E - Tweet frame coding (Chapter 5)

Coding included two components for each tweet: 1) identifying relevant actors being referenced in each tweet; 2) identifying positive or negative framing of energy issues in relation to the referenced actor. Tweets can reference more than one actor or group of actors, and they can also frame energy issues in distinct ways in relation to the referenced actors. Tweets might also reference a single actor, but employ multiple, or even contrasting, framings of energy issues in relation to that actor. Therefore, each tweet can include both multiple actors, and potentially multiple framing codes associated with each actor.

Actor codes	***Description***	***Examples (note: links have been removed)*** ***[underlined italics indicated actor reference example]***
Governing Liberal Party – Explicit	Governing Liberal Party explicit references mention either the Liberal Party, individual politicians from the Liberal Party, or referring to the Ontario government.	*@Kathleen_Wynne* wow 6 whole supporters, yup seems about right. You arent liked in ONT. People will not forget the HYDRO rate increases Katy. #onpoli Hydro prices to keep rising, just a bit more slowly, *Ontario government* says #onpoli
Governing Liberal Party - Implicit	Governing Liberal Party implicit references point to a current energy issue or policy. The #onpoli indicates that the tweet is political, therefore both positive and negative tweets about current energy issues or policy have an implicit association with the current government. When tweets referenced public institutions, such as Hydro One, these were deemed implicitly associated with the governing party if they referenced specific policy choices, such as privatization. No implicit association was made if the tweet focused on management or business activities of the organization, such as Hydro One applying to increase their customer rates.	Ontarian's In The Dark About Long-Term Costs Of *Fair Hydro Plan* #onpoli NDP Energy Critic @Peter_Tabuns ~ *Privatized Hydro One* is Out of Control #onpoli #KeepHydroPublic
Non-governing party	Non-governing party associated tweets made explicit reference to either a non-governing provincial party, politician from a non-governing provincial party, or referenced the political opposition.	*Ontario PCs* Call for an End to Secret Hydro Deal-making #onpoli Here's a better idea from *@OntarioNDP*: "Return Hydro One to public ownership & control, ensuring it serves the public interest" #onpoli
Other	Other actors or organizations associated tweets included public institutions (e.g., Hydro One, Toronto Hydro, or the Independent Electricity System Operator), non-provincial political actors (e.g., federal parties or politicians, non-Ontario provincial parties or politicians), energy technologies (e.g., nuclear generation, solar generation, renewables), and major energy projects	Blaming *Energy East's* demise on *Ottawa* 'dishonest' #cdnpoli #bcpoli #abpoli #onpoli

	(e.g., Energy East pipeline, the oil-sands). Tweets were categorized as referencing other actors or organizations if they did not also reference (explicitly or implicitly) the governing party or the non-governing party.	*Hydro One's* unreliable connections to Michigan are costing Ontario ratepayers millions in foregone revenue #onpoli

The framing codes were specifically related to energy issues and were associated with a specific actor coded in the tweet. Codes were determined based on the tweet text and embedded media. Links to written content were assessed based on the title and subtitle of the content, rather than a detailed reading. Identifying positive, negative, neutral, or having an unclear framing is based on the interpretation by the coder. The language used in many tweets was fairly unambiguous and included either positive or negative language. Examples of positive and negative language are included in the descriptions below. In some cases, users employ sarcasm in their tweets, but even in these cases interpreting positive and negative framings was quite straight-forward.

Energy issue framing codes	***Description***	***Examples (note: links have been removed)*** ***[underlined italics indicated framing example]***
Positive	Positive framing suggests that an actor was described positively in relation to an energy issue. Positive framing for one actor was often combined with negative framing for another actor. A common tweet construction with positive framing included a non-governing party political actor responding to a negatively framed governing party policy or action. Examples of language that indicated positive framing include "cut hydro rate", "lower bills", "saying no to", "demand accountability", "smart".	An @OntarioPCParty government *will lower hydro bills* by an additional 12%. That's change that works for families. #peoplesguarantee #onpoli If the cost of energy-saving upgrades is out of reach, Ontario's new Affordability Fund *is here for you* #onpoli
Negative	Negative framing suggests that an actor was described negatively in relation to an energy issue. Examples of language that indicated negative framing include "disaster", "failed", "haunts", "higher bills", "inflated", "let down", "scandal", "unfair", "waste".	Look at the *mistakes* these people r making Electricity-Whre do u even start? *Complete morons* @JustinTrudeau @Kathleen_Wynne #onpoli #cdnpoli @pdrobertson Look how their *reckless approach* to energy has *hurt people & hurt Ontario's future* - there is a pattern here. #onpoli
Negative economic	Negative economic framing was a prominent subset of negative framing. This coding was associated with tweets that mentioned increased energy costs, increased debt based on energy choices, loss of jobs due to energy issues, or wasteful spending in relation to energy.	*$5.5 million to sell* us on hydro privatization. Couldn't that money have been better spent? #keephydropublic #onpoli

		Ontario Liberal Know-how at Work: Less electricity use but *higher bills* for Ontarians #onpoli
Neutral	Neutral tweets discussed energy issues but did not include positive or negative framing. Many of the tweets coded with neutral framings made an announcement or stated a fact without additional comment.	RT @robertbenzie: .@GlennThibeault will release Ontario's "long-term energy plan" on Oct. 26. #onpoli OEB meeting about the Centre Wellington Hydro rate application on Sept. 21 #HaveYourSay #onpoli
Unrelated/ unclear	A small number of tweets were not assigned a framing code. These included tweets that were unrelated to energy issues, or tweets that were determined to be unclear. The unrelated tweets used a keyword associated with the data collection process but did not discuss energy issues. The tweets that were determined to be unclear generally included links to outside media that were no longer active. Without the full context of the embedded media conclusive coding was not possible.	Terrific rally in Hamilton Mountain tonight for Esther Pauls. I really love Esther's energy and enthusiasm. She would make a great MPP! #onpoli RT @coopge: Ontarios Green Energy Act. In all it's glory. #onpoli https://t.co/DlpZ8azPlC **[dead link]**

Appendix F - Topics of interest during high activity days (Chapter 5)

Date	*Number of tweets*	*Topics of interest*	*Percent of daily tweets*
October 17, 2017	456	*Auditor General of Ontario special report on the Fair Hydro Plan released*	87%
October 26, 2017	292	*Ontario Long-term Energy Plan released*	84%
October 18, 2017	255	*Auditor General of Ontario special report on the Fair Hydro Plan released the previous day*	71%
October 27, 2017	206	*Ontario Long-term Energy Plan released the previous day*	83%
November 25, 2017	188	*Promotion of the Progressive Conservative Party's "People's Guarantee"*	53%
		Hydro One proposal for prepaid electricity meters	11%
		Tweet about political rally [unrelated to energy issues]	11%
November 22, 2017	174	*Empower Ontario's Engineers to Obtain Opportunity: An Analysis of Ontario's Clean Electricity Exports – report by the Ontario Society of Professional Engineers*	60%
		Retweet of political advocacy organization criticizing governing Liberal Party's Fair Hydro Plan	11%
November 24, 2017	144	*Hydro One proposal for prepaid electricity meters*	86%
October 19, 2017	139	*Auditor General of Ontario special report on the Fair Hydro Plan released two days prior*	82%
		Newspaper article describing lost manufacturing jobs linked to electricity costs	11%
November 23, 2017	135	*Hydro One proposal for prepaid electricity meters*	56%
		General criticism of governing Liberal Party's energy policies	33%
December 5, 2017	132	*OEB Report: Report on an Investigation into Goreway Station Partnership*	38%
		Retweet of political advocacy organization criticizing "unfair hydro bills"	19%
		Promotion of the Progressive Conservative Party's "People's Guarantee"	15%
September 26, 2017	130	*Criticism of governing Liberal Party spending $5.5M on advertisements promoting the Fair Hydro Plan*	65%
		Reaction to governing Liberal Party awarding new feed-in-tariff contracts for renewable generation	23%