Socio-political acceptance of smart grid as a tool to mitigate climate change: the case of British Columbia

by

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Abstract

Jurisdictions around the world are investing in "smart grid", which comprises a myriad of technologies such as smart meters and remote transmission sensors that can help optimize the electricity grid. While one motivation for smart grid is to reduce greenhouse gas (GHG) emissions, deployment can also be driven by motivations to reduce electricity costs and strengthen grid reliability. These motivations or "frames" can conflict with one another, e.g. environmental versus economic benefits. This study uses British Columbia (BC), Canada as a case study to explore socio-political acceptance (or public acceptance broadly speaking) of smart grid as a tool to mitigate climate change. BC installed smart meters throughout the province from 2010-2014 while encountering a significant amount of citizen opposition, and is set to release a smart grid plan in late? 2015. I collected and analyzed data from the BC context via interviews with key stakeholders, media analysis of newspaper articles (from 2006-2012), and a survey of Canadian citizens implemented in 2013 (n = 2930). I find that key stakeholders and media in BC focus more on economic frames than environmental frames (e.g. climate abatement), and news media mention risks more often than benefits. The survey indicates that citizen acceptance of smart meters (one particular smart grid technology) is lower in BC than in Alberta and Ontario, but acceptance increases in all provincial samples when smart meters were framed according to environmental and economic benefits. In summary, the discussion of smart grid deployment in BC is tending to neglect environmental benefits—but an environmental framing might help to stimulate citizen support.

Keywords: smart grid; climate change mitigation; British Columbia; socio-political acceptance

Dedication

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List of Acronyms

BC	British Columbia
BCSEA	British Columbia Sustainable Energy Association
BCUC	British Columbia Utilities Commission
CEA	Clean Energy Act
GHG	Greenhouse Gas
IPCC	International Panel on Climate Change
kWh	Kilowatt Hour
NGO	Nongovernmental Organization
SFU	Simon Fraser University
SPEED	Socio-political Evaluation of Energy Deployment
V2G	Vehicle-to-grid integration

Chapter 1. Introduction

1.1. Background

Governments and utilities around the world are investing in smart grid, which is a broad concept describing the integration of information and communication technologies in a way that optimizes an electricity grid (Joskow, 2011). One reason that some regions are investing or considering to invest in smart grid is to help mitigate climate change by facilitating the deployment of intermittent renewables, the electrification of technologies that currently rely on fossil fuels, and increasing conservation of energy among consumers (Hledik, 2009; Stephens et al., 2014). As examples, smart grid can facilitate the intermittency of renewables by remotely adjusting electricity transmission and distribution assets in real time (Blumsack et al., 2012); smart grid can allow utilities to offer dynamic pricing that encourages electric vehicle users to charge batteries when renewable energy is available and to supply the grid during peak demand periods (Blarke et al., 2013); and smart grid can include consumer information and feedback systems that encourage energy conservation and demand shifting (Pratt et al., 2010). Table 1 (see below) describes these components and several other examples of how smart grid initiatives can play a role in climate change mitigation.

In addition to environmental motivations, a region may choose to deploy smart grid as a tool to reduce costs or to improve grid reliability (Jegens and Philion, 2014; Wolsink, 2012). In some situations, financial motivations can be achieved concurrently with climate change mitigation, e.g. in-home displays can increase electricity conservation, which would lower both costs and GHG emissions (McKenna et al., 2012). However, smart grid motivations can also conflict, e.g. efforts to reduce the cost of electricity generation may increase usage of fossil fuels rather than renewable energy sources because in the absence of strong carbon pricing, intermittent wind and solar are more expensive per kilowatt (Joskow, 2011).

Table 1 - Key smart grid components and their role in climate change mitigation

Component	Description	Role in reducing GHGs
Smart meter	A bidirectional electricity meter that provides utilities with remote, real time access to each customer's electricity use	Smart meters can indirectly abate GHGs by providing the bidirectional communication necessary for initiatives such as dynamic pricing, consumer displays, and vehicle-to-grid integration (Steenhof & Weber 2011)
Consumer information and feedback systems	An interface that provides customers with instantaneous electricity usage information and decision support tools	Feedback systems can help consumers conserve electricity and shift demand to accommodate intermittent sources (Farhangi, 2010)
Dynamic pricing, e.g. time-of-use pricing	Smart meters allow utilities to set rates according to time value of electricity (e.g. time-of-use pricing implements a higher rate during peak demand periods)	Dynamic pricing can shift demand to correlate with intermittent renewable energy sources, and reduce need for new capacity (Lamontagne, 2012)
Autonomous Smart appliances	Smart appliances can communicate directly with utilities and activate according to demand and supply	Smart appliances can reduce the need for new capacity and shift demand to correlate with intermittent renewable energy generation (Finn et al., 2011)
Vehicle-to-grid integration (V2G)	V2G can allow electric vehicle owners to charge at a reduced rate during low demand periods and sell electricity to the grid during peak demand periods	V2G can help shift charging patterns and reduce potential capacity problems caused by electric vehicles entering the market (Druitt & Früh, 2012)
Feed-in tariff	Utilities can offer an incentive electricity rate to consumers that produce a certain type of electricity	Feed-in tariffs can incentivize renewable energy generation by reducing the risk of investment (Mabee et al., 2012)
Remote monitoring of Utility assets	Smart sensors can remotely monitor and adjust transmission and distribution assets	Smart sensors can facilitate faster switching between intermittent renewables and base load generators (Joskow, 2012)
Supergrid or Megagrid	Smart grid can facilitate cross-grid interaction through innovations in high-voltage transmission sensors	Smart grid can facilitate international trade of large scale renewable generation (Blarke and Jenkins, 2013)

Thus, it is important for policy makers to recognize and communicate what drives smart grid deployment. If climate mitigation is not prioritized, smart grid may develop in a way that has little effect on a region's GHG emissions (Koenigs et al., 2013). For instance, in another subnational jurisdiction within Canada (Quebec), Jegen and Philion (2014) suggest that actors do not think it is important for smart grid to reduce emissions in Quebec, because the province already has a low-emission, hydro-based electricity grid. Therefore smart grid deployment in Quebec will be limited to incremental electricity grid upgrades that aim to reduce grid costs and improve grid reliability (Jegen and Philion, 2014). A perspective that focuses only on current electricity grid emissions ignores how smart grid can abate other potential GHG emissions in BC. For instance smart grid can facilitate the electrification of current services that rely on fossil fuel such as transportation and heating, and avoid future use of fossil fuels by facilitating electricity conservation, and reducing the obstacles to intermittent renewables.

In addition to understanding the drivers for smart grid deployment, policy makers and practitioners must consider the processes through which energy projects are implemented. British Columbia (the focus of my research), implemented the Smart Meter Program, which mandated the installation of smart meters throughout the province between 2010 and 2012. This program experienced significant opposition from groups such as Citizens for Safe Technology[1], who suggest smart meters raise significant human health and privacy concerns (Curson, 2013). This public opposition delayed the completion of the Smart Meter Program by two years (Hess, 2014). BC's smart meter roll out exemplifies that social acceptance is an important factor for deployment of energy projects. My research explores the socio-political acceptance (one aspect of social acceptance) of smart grid as a tool to abate GHGs in BC.

1.2. Socio-political acceptance

There is a considerable amount of research that recognizes the importance of social acceptance of alternative energy projects and seeks to understand what factors contribute to this acceptance (Batel et al., 2013). According to Wustenhagen et al.,

[1] http://www.citizensforsafetechnology.org

(2007) social acceptance is composed of three categories: community, market, and socio-political acceptance. Community acceptance takes place at the local level and is influenced by how costs and benefits are shared and who participates in the decision making process. Market acceptance regards the adoption of innovation by consumers and investors who often have a choice between renewable and non-renewable technology, e.g. solar vs. natural gas heat. Finally, socio-political acceptance, the focus of my research, describes the broad, societal acceptance of a project, and primarily concerns acceptance by key stakeholders, general public, and media (Mander et al., 2009; Stephens et al., 2008; van Alphen et al., 2007).

Previous studies on the socio-political acceptance of smart grid have focused on key stakeholders, the general public, and/or news media (Hess, 2014; Jegens and Philian, 2014; Koenigs et al. 2014). Key stakeholders have pre-established motivations for an energy project linked to their perception of its risks and benefits, and their affiliated organization's mandate (van Alphen et al., 2007). Examples of key stakeholders associated with smart grid include representatives from government, utilities, industry, research institutions, and non-governmental organizations (Mah et al., 2012). Key stakeholders are an especially important component of socio-political acceptance because they directly influence regulatory and policy frameworks (Mah et al., 2012). They also influence how media and public perceive and frame energy issues (van Alphen et al., 2007).

News media is another important socio-political factor because it can strongly influence how citizens perceive energy deployment, especially with a novel concept such as smart grid (Langheim et al., 2014). At the same time, how news media frames risks and benefits provides a snapshot of societal discourse about energy deployment (Mander et al., 2009). Because news media can control the framing of an energy project, it is often an important policy actor that shapes citizen and stakeholder perceptions (Ãrdic et al., 2013). For instance, research has shown that for a selection of major United States (US) newspapers, there are 3.7 times more articles mentioning smart grid benefits than risks (Langheim et al., 2014). The authors suggest this positive portrayal of smart grid reflects how smart grid is perceived to have multiple potential benefits and how US mainstream media tends to have an optimistic technological perspective.

Citizens are another important socio-political factor mainly because citizen opposition can guide and obstruct energy deployment (Gangale et al., 2013). Citizen acceptance of a project depends on how the public perceives its benefits and risks, which is a product of several factors such as media portrayal, citizen and regional values and experiences, and trust in institutions (Axsen, 2014; Poumadère et al., 2011). For instance, research has shown that socio-political acceptance of smart grid deployment is higher when citizens perceive both smart grid economic benefits (such as cost reduction), and environmental benefits (such as GHG abatement) (Gangale et al., 2013). Even though individual benefits such as financial gain are a major motivation for citizen acceptance of an energy project, many citizens are also concerned with more broad environmental and societal issues (Toft et al., 2014).

How key stakeholders, media, and citizens perceive and support energy projects is very interconnected. For example, how a stakeholder frames an energy project can influence media, which can influence citizen perception, which can then influence how media and stakeholders frame a project. Therefore, it is difficult to parse out how much a specific socio-political factor is influencing overall acceptance or to confidently trace out paths of causation (Horbarty et. al., 2012). Where possible, research on socio-political acceptance ought to combine analysis of these different actors' perspectives, e.g. stakeholders, media, and citizens, to understand the complexity of their interrelationships and to improve understanding of their unique regional context (Small, 2011; Stephens et al. 2008).

Research on socio-political acceptance also recognizes the need to address the implementation process. An energy project's implementation strategy and execution can impact social opposition even more than problems with the energy project itself (Wolsink, 2007). For instance, energy deployment that follows a "decide-announce-defend" approach tends to instigate opposition because it does not allow a platform for public to meaningfully participate in energy deployment (Devine-Wright, 2011). This type of deployment where decision makers are given the ability to unilaterally design and implement energy projects often results in stronger socio-political opposition, lower public trust, and reduces or eliminates opportunities for knowledge sharing between local stakeholders and high level decision makers (Dusyk, 2011). For example, as will be discussed further, BC Hydro's Smart Meter Program was implemented in a rapid and top-down manner, was exempt from a British Columbia Utilities Commission (BCUC) public review, and did not offer an opt-out policy until two years into the program. It is likely BC Hydro's "decide-announce-defend" implementation approach contributed to socio-political opposition to smart meters in BC (Hess, 2014).

One alternative to the top down, "decide-announce-defend" approach is to provide a participatory platform where the public and decision makers come together to discuss and learn about a project collectively and explore a variety of possible futures (Dusyk, 2011). Such a space can help decision makers implement adaptations to an energy project to increase socio-political acceptance (Hess, 2014). For instance, in 2013 FortisBC (BC's second largest electricity utility that serves less than 10 percent of BC residents) proposed an Advanced Meter Infrastructure Program (analogous to BC Hydro's Smart Meter Program) that was subject to a public review by BCUC. BCUC allowed the project to proceed, but required that customers be able to opt-out of wireless meters (FortisBC, 2013). Research has not yet explored socio-political opposition to FortisBC's Advanced Meter Infrastructure Program.

Smart grid implementation strategies that only focus on technical and economic issues will likely ignore important factors such as citizen perceptions and the impact of a project's implementation process (Stephens et al. 2008). In recognition of how such "non-technical" factors are integral to the deployment of an energy project, my research explores the socio-political context of smart grid as a tool to abate GHGs in BC.

1.3. Conceptual framework and research design

I use the Socio-political Evaluation of Energy Deployment (SPEED) framework to analyze how key stakeholders, news media, and citizens perceive and frame smart grid in BC (Stevens et al., 2008). SPEED is rooted in several theoretical foundations such as technology and policy diffusion, perceptions of risks, and transitions management theory. The framework was created in recognition that energy deployment occurs within energy systems that are influenced by not only technological capacity and resource availability, but also "institutional, legal, political, economic, and cultural factors"

(Stephens et al., 2014). SPEED also recognizes that subnational, e.g. provincial or state, contexts vary considerably and that the majority of energy deployment in North America is occurring at the subnational level. Therefore, Stephens et al., (2014) suggest that it is problematic when research into energy deployment narrowly focuses on national, techno-economic issues, e.g. resource availability, infrastructure issues, and energy demand, and ignores unique, regional socio-political contexts.

SPEED is applied to analyze the regional context of energy deployment through the lens of six categories: technological, economic, political, cultural, health and safety, and environmental, which are further divided into risks and benefits. Stephans et al (2014) explain that these categories are based on Luhman's (1989) theory of society, which suggests that society is composed of interactive, self-organizing subsystems that each have their own way of understanding the world. These SPEED categories can help researchers analyze policy documents, media content, stakeholder interviews, focus groups, public surveys, and other content to explore how actors and institutions are responding to and shaping energy and policy deployment (Stephens et al., 2014). For example, SPEED's technical category can include infrastructure and reliability concerns; the economic category can include cost and employment forecasts; the political category can include regulatory and election issues; the health and safety category can include technological externalities that impact human health; and the cultural category can include aspects salient to people's daily lives. Table 2 provides examples of the six SPEED categories broken into risk and benefit frames.

Table 2 - SPEED categories

SPEED	Benefit	Risk
Technical	Improve electric infrastructure, allow creation of a more reliable grid	Increased grid vulnerability, cyber-attacks, reliability concerns of smart meters
Economic	More efficient use of the electric grid, strengthen economy (jobs, manufacturing), save money because there is less need to build new facilities	Increased cost of electricity, cost of SG outweighs benefits
Political	Positive political ramifications, e.g. energy independence, enhanced national security, energy security	Negative political ramifications, i.e., public frustrations, difficult legal and regulatory process

Health & Safety	Reduced respiratory problems from improved air quality in high carbon-based electricity systems	Health and safety concerns associated with power lines, smart meters (i.e., wireless radiation, headaches)
Environmental	Reduce GHGs or carbon emissions, mitigate climate change, energy conservation, less air and water pollution	Potential threat to ecological health, i.e., bird kills, protected species, habitat destruction or disruption with more integration of renewable energy technologies
Cultural	Increased individual awareness of electricity consumption behaviour and electricity costs, behavioral change	Privacy concerns, fear of loss of control over appliances or data, inequality concerns (e.g. elderly, low income)

Source: Adapted from Langheim et al., (2014)

To demonstrate the framework, Langheim et al. (2014) applied SPEED to a media analysis of smart grid in three major national newspapers. The media analysis coded content into the six SPEED categories in terms of risk and benefits. The results showed that the targeted US newspapers more frequently framed smart grid according to benefits than risks. Technical benefits were mentioned in 70 percent of articles, economic benefits were mentioned in 60 percent of articles, and environmental benefits were only mentioned in 20 percent of articles. The authors suggest that the newspapers' heavy focus on technical and economic benefits both reflects public discourse about smart grid deployment and influences public perception. The authors also suggest that exploring the socio-political context of smart grid is important because it provides insight into the direction and rate of deployment.

The aim of this paper is to gain insight into socio-political acceptance of smart grid as a tool to mitigate climate change in BC. To do so, I combine the analysis of data compiled from interviews with key smart grid stakeholders in BC, newspaper articles in BC focused on smart grid, and a Canadian public survey eliciting citizen attitudes toward smart meters. My research objectives include:

1. Conducting stakeholder interviews to explore how key stakeholders perceive opportunities and challenges for smart grid in BC and how these link (or do not link) with climate change mitigation;
2. Analyzing newspaper content to explore how newspapers frame the risks and benefits of smart grid, including the climate change mitigation frame;

3. Conducting a public survey to determine how BC citizens currently perceive smart meter deployment and how this compares to other provinces in Canada; and
4. Integrating research findings to recommend how decision makers can increase socio-political acceptance of smart grid as a tool to abate GHGs in BC.

The remainder of this paper is separated into six main parts. In Chapter 2, I provide a socio-political overview of smart grid deployment in BC. In Chapter 3, I outline both the design and results of the stakeholder interviews to better understand motivations. In Chapter 4, I outline the design and results of the BC media analysis according to the framing of different risks and benefits. In Chapter 5, I outline the design and results of the public survey to explore how BC citizens perceive smart grid deployment relative to other provinces in Canada. In Chapter 6, I discuss how my findings can help better understand how smart grid might become a more accepted method of climate change mitigation. Finally, in Chapter 7, I offer a conclusion and policy implications.

Chapter 2. British Columbia's sociopolitical context

Table 3 provides some examples of the socio-political context of smart grid in BC categorized within the SPEED framework's six frames. Starting with the technical and economic frames, British Columbia (BC) is a Canadian province in which most electricity generation is low emission hydropower and sold at one of the lowest electricity rates in North America. Residential customers in BC pay 7.5 cents/kWh for the first 1,350 kWh, whereas the Canadian and US averages are 11.9 cents/kWh and 12.5 cents/kWh respectively (United States Energy Information Agency, 2015; BC Hydro, 2015b). BC Hydro holds a regulated monopoly on the transmission and distribution of electricity to over 90 percent of the province (~1.9 million customers). FortisBC is the second largest Utility which serves ~130,000 customers in Southern Interior BC. Since the 1980s BC Hydro's role has been a supply management organization that has purchased most new capacity from independent power producers. Before this BC Hydro's role focused more on creating new hydroelectricity developments (Dusyk, 2011). In 2013 BC Hydro produced 43,000 gigawatt hours of electricity and purchased 16,585 gigawatt hours from independent power producers (BC Hydro, 2015). BC's grid is predominantly sourced from low-emission, large-scale hydro electricity (over 90 percent), but there are other current and potential sources of emissions related to BC's electricity grid. For instance, in 2012 BC emitted 23,300 kilotonnes of GHGs from transportation and 20,500 from stationary combustion such as residential and commercial heating (British Columbia Ministry of the Environment, 2012). BC also imported 223,850 MWh of coal-based electricity from Alberta in 2013 (Government of British Columbia, 2013). Finally, electricity demand in BC is forecasted to increase by 40 percent over the next 20 years, because of population growth and a burgeoning natural gas sector (BC Hydro, 2013). Therefore, if BC is to meet its GHG abatement goals (33% below 2007 levels by 2020 and 80 % by 2050), it is still important for the province to invest in climate mitigation tools such as smart grid to facilitate the uptake of renewable energy and electric transportation.

Table 3 - The socio-political context for smart grid in BC, as of 2015

Sociopolitical Factor	BC Context
Technical	• BC's grid is predominantly low-emission hydro electricity • BC expects electricity demand to increase in both the residential and industrial sectors
Economic	• BC Hydro holds a regulated monopoly on transmission, and distribution of electricity to the vast majority of BC. • Electricity rates in BC are among lowest in North America • The Smart Meter Program was estimated to cost over one billion dollars.
Political	• BC Government has considerable authority over energy planning • BC has implemented the Clean Energy Act to help reduce GHGs 33% below 2007 levels by 2020 and 80 % by 2050. • The Clean Energy Act included *The Smart Meter Program* that BC's utility commission (BCUC) was not permitted to review. • The Clean Energy Act requires a smart grid plan by the end of 2015.
Cultural	• BC has strong history of public opposition to resource development. • The smart meter roll out experienced significant public opposition
Health and Safety	• There is a small group of citizens opposed to smart meters based on human health concerns associated with smart meter wireless frequencies.
Environmental	• Smart grid deployment in BC can potentially abate GHGs and therefore mitigate the risk of climate change.

In terms of the SPEED political frame (table 3), BC has the majority of authority to regulate energy and electricity development and deployment (Dusyk, 2002). For instance, in 2010 BC's Government legislated the Clean Energy Act (CEA), which committed to a myriad of environmental goals such as generating at least 93% of electricity from clean or renewable sources, meeting 66% of new demand from conservation and efficiency, implementing feed-in-tariffs for emerging renewable technologies, and encouraging consumers to switch from fossil fuels to electricity for heating and transportation. In 2012, BC's government redefined what constitutes a clean energy source by including natural gas only if the natural gas is used to generate power for liquefaction of natural gas (Bailey, 2012). This redefinition further demonstrates provincial authority, and illustrates that future sources of electricity in BC can still be fossil fuel based—particularly given the BC Liberal Government's recent enthusiasm for natural gas development.

BC's 2010 CEA has also legislated that BC pursues smart grid deployment to help meet its clean energy objectives. The Smart Meter Program is the first significant smart grid initiative BC has undertaken, which involved the installation of 1.9 million smart meters across the province from 2010 to 2014 (Bradbury, 2014). BC Hydro projected that the Smart Meter Program would result in a net present value of $520 million from 2010 to 2033, mostly because of operational efficiencies (Curson, 2013). BC Hydro attributed half of these operational efficiencies to smart meters preventing marijuana grow-ops from stealing electricity (Cohen and Calvert, 2012).

BC exempted the Smart Meter Program from a British Columbia Utility Commission review—normally such a public review would engage a range of stakeholders to determine if a project is a provincial necessity (Curson, 2013). Exempting this step of public review seems more in line with the "decide-announce-defend" model (Devine-Wright, 2011), which has been shown to result in stronger socio-political opposition (Wolsink, 2007). It is not clear why BC exempted the Smart Meter Program from public review.

BC's Smart Meter Program experienced significant public opposition related cultural and health and safety frames (table 3). Prior to the implementation of BC's Smart Meter Program, BC Hydro's community liaison officer determined that approximately five percent of citizens were opposed to smart meters because of safety and security concerns (Curson, 2013). Even though BC Hydro recognized that opposed citizens would not be convinced by an information campaign, BC Hydro decided to go forward with implementation and to rely on information brochures and news releases to engage the public. It is likely that this engagement decision was not based on lack of capacity to engage public, but rather an estimation of the amount and type of engagement that was necessary to successfully deploy the project (Curson, 2013). The roll out of smart meters resulted in strong opposition from small groups of citizens, such as "StopSmartMeters Citizen Group"[2], and "Citizens for Safe Technology"[3], who were concerned about smart meter privacy, cost, and human health risks (Hess, 2014). In

[2] http://www.stopsmartmetersbc.com

[3] http://www.citizensforsafetechnology.org

response to this opposition, BC Hydro strengthened its protection of smart meter data and offered an opt-out program at an extra cost of $32.40/month for customers who wish to keep old meters (BC Hydro, 2015a). As of December, 2014, the Smart Meter Program was two years past the initially determined deadline, but very near completion. About 1.9 million smart meters had been installed and 15,000 customers had chosen to opt-out of smart meter installation for the additional monthly fee (Bradbury, 2014; Smyth, 2015).

The Government of BC has not clearly communicated to customers how smart meters will be used in the future. For example, in 2010 the government recognized that dynamic pricing could help electricity conservation and demand shifting in BC (Government of BC, 2010), but shortly after they promised to exclude dynamic pricing from future smart grid development (Curson, 2013). Currently capacity limits are not a crucial concern for BC's hydro-based grid, which can meet daily demand peaks by increasing water flow through turbines, or potentially expanding these turbines. However, as electricity demand in BC increases, it will become more important for demand side management to reduce capacity constraints (BC Hydro, 2013). Also, dynamic pricing can help BC manage electric vehicles and potentially match electricity demand with intermittent sources, e.g. smart appliances can follow energy prices that can decrease when wind power is available to the grid.

BC's Clean Energy Act (2010) requires a plan for further smart grid deployment by the end of the calendar year 2015. Considering the high degree of socio-political opposition to the Smart Meter Program, it is likely that future smart grid initiatives – particularly programs involving the public directly – will also experience significant public opposition (Hess, 2014). Moreover, it is unclear if key stakeholders, media, and/or citizens accept that smart grid should play a role in climate mitigation in BC. If smart grid is not accepted as a necessary tool to mitigate climate change, and BC's public opposition to smart grid deployment remains strong, it is likely that smart grid will be unable to abate BC's GHGs in a manner that meets BC's abatement goals. My research on socio-political acceptance of smart grid as a tool to mitigate climate change will contribute to the overarching conversation regarding energy system change and reducing fossil fuel dependency.

Chapter 3. Stakeholder interviews – method and results

3.1. Stakeholder interview methodology

Between October 2013 and February 2014, I performed one-on-one semi-structured interviews with key stakeholders involved with smart grid in BC. The stakeholders I interviewed are only a subset of possible stakeholders and were chosen based on their ability to influence smart grid policy decisions and public perception within that context. As Table 3 outlines below, the stakeholders I interviewed are associated with the following organizations: (1) BC's Government, the organization who originally legislated smart grid deployment and The Smart Meter Program, (2) BC Hydro, the organization who was responsible for implementing the Smart Meter Program and will likely implement any future smart grid initiatives, (3) the British Columbia Sustainable Energy Association (BCSEA), a group who actively promotes renewable energy integration in BC, (4) Sgurr Energy, a private sector renewable energy consultancy who is working with British Columbia Institute of Technology on a decentralized smart grid project, and (5) Powertech, a BC Hydro research and development subsidiary.

Table 4 - Key stakeholder participants

Organization	Description	Relation to smart grid
BC Hydro	BC's largest electricity utility responsible for 1.9 million customers	Responsible for implementing and maintaining smart grid components including smart meters.
BC Provincial Government	BC Liberals have been in power from 2001 to present.	Responsible for legislating smart grid deployment and The Smart Meter Program
BC Sustainable Energy Association (BCSEA)	A non-profit organization with 5 chapters in BC that supports sustainable energy deployment.	BCSEA provides educational seminars and policy research initiatives on smart grid deployment. They also act as interveners in public hearings on energy issues such as FortisBC's Automated Meter Infrastructure Program.

Sgurr Energy	A renewable energy consultancy with over 13 international offices. One is in Vancouver.	Sgurr is working with British Columbia Institute of Technology (BCIT) on a decentralized smart grid project on BCIT's campus.
Powertech	A BC Hydro subsidiary that consults about clean energy options, and tests power system components.	Work with BC Hydro to develop and test smart grid components such as smart meters and vehicle-to-grid integration.

The stakeholders were asked to give their own perspectives; therefore the results are not necessarily reflective of their associated organization. Also note that each of these stakeholders is associated with an organization that supports smart grid deployment, and my interview results would differ if I had included smart meter opposition groups. Thus my results do not provide a representation of all key stakeholders in BC. Rather, my results illustrate how five pivotal smart grid stakeholders perceive and frame smart grid. The BC Hydro and BC Government participants are particularly influential because these organizations will likely be in charge of creating and implementing smart grid programs, just as they have with the Smart Meter Program.

The five interviews were about 1 hour in duration and took place either in person or over the phone. I relied on a questionnaire document to guide the conversation, but allowed participants to explore tangential ideas. I developed the interview questions to elicit how each stakeholder perceived the risks and benefits of smart grid in BC and how participants saw smart grid impacting climate change mitigation. The questions included:

1. ***What is "smart grid"?***
2. ***Is BC's electricity grid currently "smart"?***
3. ***What smart grid components does BC have currently?***
4. ***What smart grid components are in the planning stage?***
5. ***What is the rationale for smart grid?***
6. ***What are some benefits or opportunities associated with smart grid?***
7. ***What are some risks or challenges associated with smart grid?***
8. ***Who are the most important stakeholders associated with smart grid in BC?***
9. ***How is energy policy influencing smart grid in BC?***
10. ***How important is public support for smart grid in BC?***
11. ***What contributions do you think smart grid can offer to sustainable development?***
12. ***Do you see smart grid contributing to climate change mitigation?***

I began each interview by asking stakeholders broadly about smart grid in BC to ensure that I did not influence stakeholders to unduly focus on the role of smart grid in climate mitigation (which is a major research objective of this study). At the end of each interview I asked the stakeholder if they as an individual, not necessarily their organization, think climate change mitigation should be one of the benefits of smart grid deployment.

After transcribing the interviews I used *NVivo 10* software, a text analysis tool, to organize and analyze interview content. I first coded interview content each time a stakeholder mentioned a motivation for deploying smart grid in BC, such as to reduce costs or integrate renewable sources. I then coded each instance where a stakeholder mentioned a risk associated with smart grid and categorized the risks according to the SPEED framework's socio-political factors: health and safety, cultural, economic, political, technological, and environmental. Finally, I coded each time a stakeholder mentioned smart grid playing a role in mitigating climate change. Each of these categories were coded a maximum of once per sentence (each sentence could have more then one category coded). In my analysis I use the frequency with which a stakeholder mentions a component, motivation, or risk as a proxy for overall importance to that stakeholder.

3.2. Stakeholder interview results

3.2.1. Smart grid motivations

Figure 1 shows that stakeholders perceive several different motivations for smart grid including reduced costs, grid reliability, demand side management, renewable energy, electrification of transportation, and BC's 2010 Clean Energy Act. In the following paragraphs I discuss each motivation.

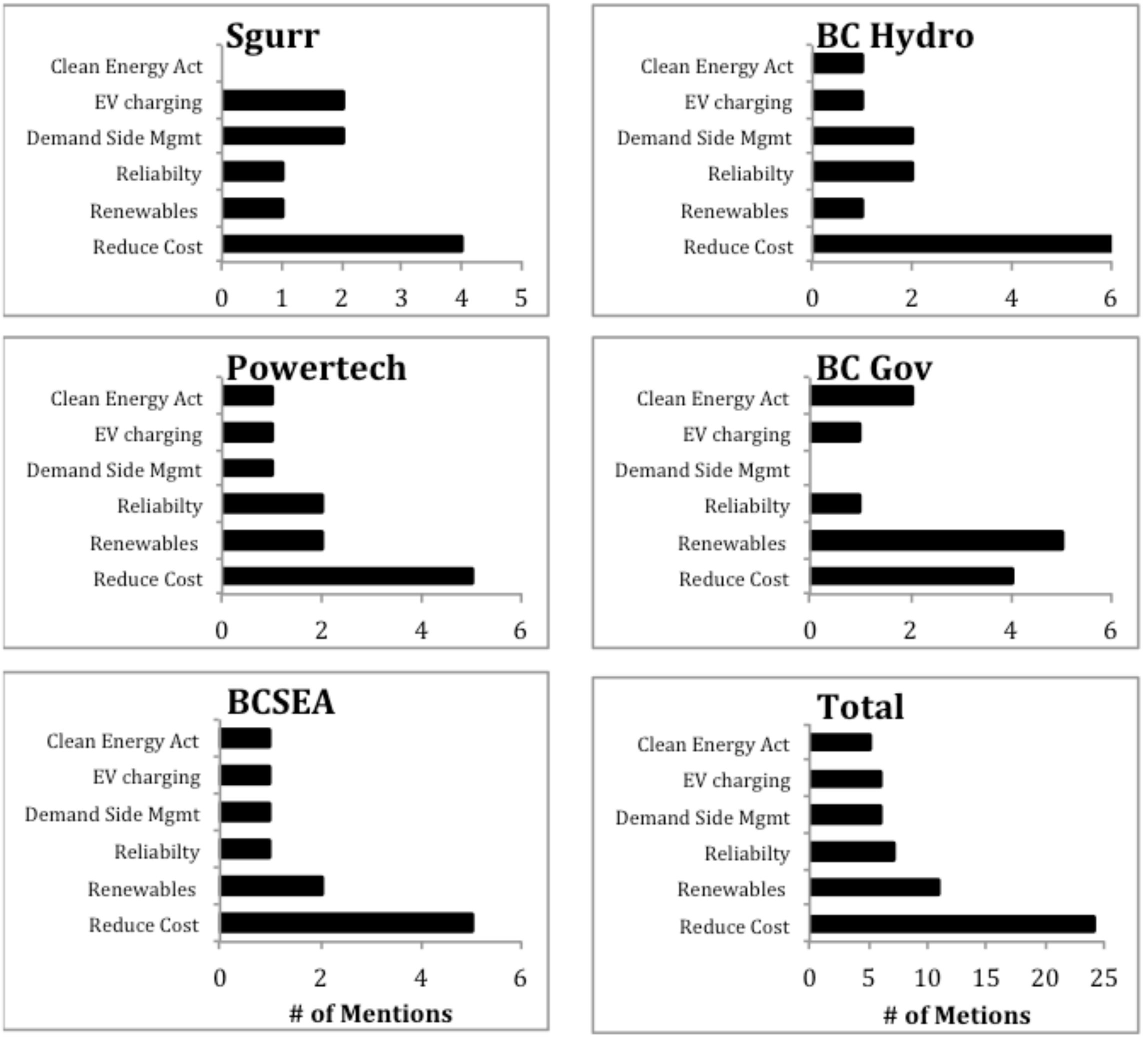

Figure 1 - Stakeholder Focus on Smart Grid Motivations. The x-axis represents the total number of mentions. The "total" figure represents the aggregate results of the five stakeholders.

Reducing the cost of electricity in BC is the most frequently mentioned motivation for smart grid overall (constitutes 40% of the mentioned motivations, and for each stakeholder other than the BC Government (where cost was the second most frequently mentioned benefit). For example, the BC Hydro participant talked about researching smart grid technologies to "bring about benefits that are related to the bottom line for operating the company." Similarly, the BC Government participant explained that "smart grid technologies will prove more cost-effective and regulators witll approve them, based on that."

Within this category, stakeholders most often refer to reducing the overall costs of electricity by making the grid more efficient. For example the Sgurr and Powertech participants suggest that smart meters can significantly reduce electricity losses by allowing utilities to pinpoint and eliminate electricity theft. Whereas, the BC Government participant suggested that smart grid technologies could increase the capacity of existing infrastructure and therefore reduce the need for new infrastructure investments.

All stakeholders, especially the BC Government participant, discuss how smart grid can benefit BC by facilitating **intermittent, renewable electricity sources** at both the large, centralized scale and the distributed scale. For example, the Powertech participant suggested that "the grid requires smart stuff" to integrate renewable energy technologies. The stakeholders are mostly referring to wind and solar when mentioning intermittent renewable sources. The BC Hydro participant stated that one reason intermittent renewables are progressing slowly in BC is because customers that sell electricity back to the grid are only credited for each kWh at the going electricity rate. One way to increase decentralized renewables is for BC Hydro to offer a guaranteed, higher rate that incentivizes customers to produce renewable electricity. This is called a feed-in tariff and is being used by regions such as Ontario and Germany (Mabee et al., 2012). The BC Hydro participant, who suggested a feed-in-tariff would help increase decentralized renewables, did not actually recommend BC pursue a feed-in-tariff. Perhaps this is because the BC Hydro participant also suggested BC's grid is already low-emission and instead was focused on smart grid optimizing grid costs.

All stakeholders also discuss the potential for smart grid to **strengthen reliability**. For example, the Powertech participant indicated that smart grid will strengthen maintenance and therefore reduce disruptions:

> *"Smart grid can limit disruptions by providing information about your assets and allowing you to better design your maintenance program to maintain assets, such that you can know before they fail".* Powertech participant

Smart grid allows remote sensors to monitor utility assets in real time and automatically reroute alternate sources in the case of power disruption. As the Powertech participant goes on to mention, strengthened reliability is also related to economic benefits, because disruptions are costly to both the utility and BC's economy on a whole.

All stakeholders, except the BC Government participant, also discuss smart grid facilitating better **demand side management** to reduce peak demand periods and reduce overall consumption. For instance, all stakeholders acknowledge that time-of-use pricing can help utilities to manage demand. BC's current Liberal Government has promised that rate payers will not see time-of-use pricing, which is perhaps one reason the BC Government participant did not discuss demand side management (zero mentions). The Powertech participant suggests that BC's Government is avoiding time-of-use pricing because the potential for electricity rates to increase is politically unpalatable. Despite the government's promise, the Powertech participant predicts BC will soon include time-of-use pricing:

> *"One day there will be time-of-use rates in BC and I'm gonna bet they'll be around in the next five years because there has to be. … It's price elasticity, right? You've gotta make it a little bit punitive. And what are we trying to do? We're not trying to get people to use less electricity; we're trying to get people to use it at different times of the day.*

All stakeholders also discuss how smart grid can facilitate **electric vehicles** in BC. Currently, electric vehicles only have a small market share and therefore charging does not raise capacity issues. The Powertech participant outlines how disruptive electric vehicles can be to the grid if they happen to gain significant market share:

> *"EV's are a tremendous threat and a tremendous opportunity to a utility. If we just allow everybody to drive those things home and plug them in when they get home from work, all hell's gonna break loose."* Powertech participant

Smart grid initiatives such as vehicle-to-grid integration can alleviate potential capacity problems by encouraging owners to charge or sell electricity from their batteries at times that help balance electricity demand and supply.

Last, all stakeholders, except for the Sgurr participant, discuss how **BC's 2010 Clean Energy Act (CEA)** mandated smart grid deployment in BC. Overall BC's 2010 CEA is the least mentioned motivation despite it being the legal impetus for smart grid deployment in BC. In the next section I report how the key stakeholders portrayed smart grid risks.

3.2.2. Smart grid risks

Figure 2 depicts how each stakeholder frames smart grid risks, which are categorized based on the six SPEED categories, i.e., economic, cultural, technological, political, health and safety, and environmental. Most often, the smart grid risks mentioned by stakeholders are based on problems with achieving citizen acceptance as opposed to problems with smart grid itself. For instance the Powertech, BC Government, and BC SEA participants all mention how citizens who fear smart meter radiation present a challenge to smart grid deployment, but no stakeholder suggests that smart meters actually pose a risk to human health. In this case, I coded the risk as health and safety, because this is where the opposition is derived from.

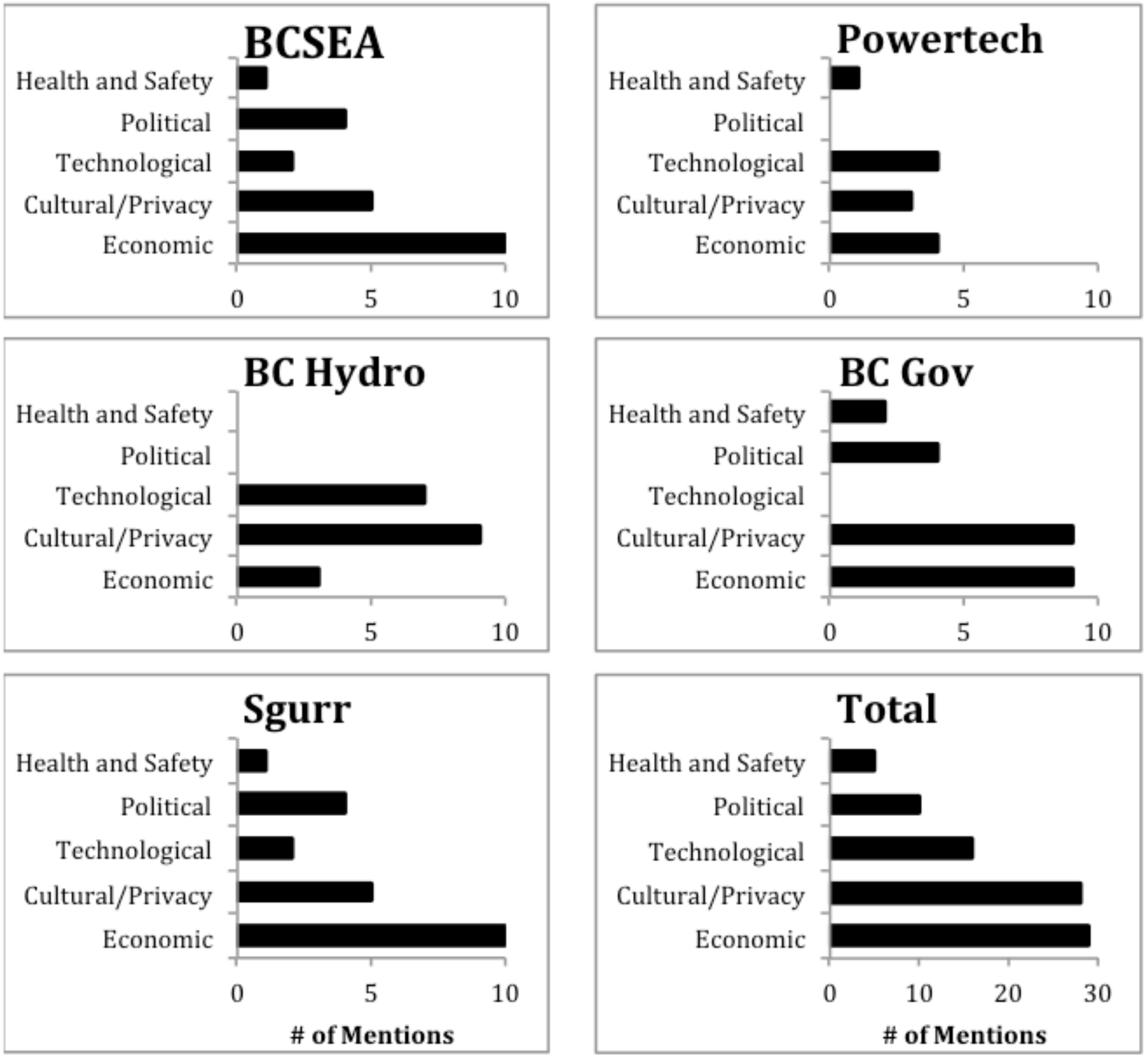

Figure 2 - Stakeholder Focus on Smart Grid Risks. The X-axis represents the number of mentions. The "total" figure represents the aggregate results of the five stakeholders.

All stakeholders discuss how it is difficult to justify the short-term **economic costs** associated with smart grid. This was the most frequently mentioned risk for every stakeholder other than BC Hydro (where economic was the third most frequently mentioned risk). Example of quotes include:

"When I think of smart grid investments, I just think of the cost aspect. And although the benefits would be long-term, they're not necessarily immediately understood by users of the system." BC Government participant

"Well, the obstacle is always the cost of doing it… It's expensive. Technology is expensive. And sort of making the business case can sometimes be challenging because there's gotta be return. But how [do you] quantify the return?" Powertech participant

All participants mention that smart grid deployment will be expensive, except for BC Hydro. For instance, BC's Smart Meter Program cost roughly one billion dollars. It is especially difficult to justify smart meters because the costs are immediate and very visible, but smart meter benefits are mostly long term and multifaceted (e.g. reduce long term costs, reduce GHGs, strengthen reliability). In contrast to the other stakeholders, the BC Hydro participant focuses more on how smart grid components can help BC Hydro maximize their current investments rather than on their minimizing their costs.

In terms of cultural risks, all stakeholders mention the risk of public opposition stemming from **privacy concerns**, as exemplified by the Sgurr participant:

"There's already a lot of pushback. There are people who are genuinely concerned about privacy and being spied on." Sgurr

Public concern about privacy is linked to the information that smart meters gather about an electricity user's patterns, e.g. identifying when a user is home and what types of appliances are being used and pinpointing illicit activities such as marijuana grow operations (Curson, 2013). BC's Information and Privacy Commissioner raised concerns about access to and protection of this information. As a result, in 2011 BC Hydro had to: (a) begin informing its customers why smart meters would collect personal information (data collection is currently limited to hourly, overall electricity usage), (b) explain BC Hydro's legal authority to install smart meters, and (c) provide a point of contact to answer BC citizens questions regarding the project (Denham, 2011).

All stakeholders, except for the BC Hydro participant, also touch on **human health concerns** stemming from smart meters. However, each of the stakeholders disregard the legitimacy of this risk, exemplified by the Powertech participant's statement:

> *"I mean, you've seen the smart meter fight? Sixty thousand people holding out; "We're not gonna allow them onto our property." And the longer it goes on, the more rabid they become in their beliefs (these folks). And everyone's entitled to their beliefs but at the very least, you would hope that they would make informed decisions. But they've been convinced or they've convinced themselves that there's a health hazard, that there's a privacy concern, and both of those things are completely ridiculous, in my personal opinion."*

This disregard for public concern over electromagnetic radiation from smart meters is not surprising; research shows there is widespread scepticism of such concerns within industry (Hess, 2014). Note that my research does not question the legitimacy of public concerns, but only how socio-political issues such as human health concerns, impact acceptance of smart grid as a tool to abate GHGs. Of course, while such concerns are dismissed among these key stakeholders as discussed above, they are more important to the general public as detailed in Chapter 4 below.

3.2.3. Smart grid and climate mitigation

If climate change mitigation is to be a smart grid priority in BC, then key stakeholders must recognize that smart grid is able to abate GHGs. Table 4 outlines each stakeholder's one or two most frequently mentioned risks and motivations and also provides a snapshot of how each stakeholder is linking smart grid and climate change mitigation in BC. In terms of climate change mitigation, the Sgurr and BC Hydro participants take a more short-term perspective by suggesting that smart grid will not be able to significantly abate GHGs in BC because BC's grid is already low emission. In contrast, the Powertech participant takes a more long-term perspective by suggesting that smart grid can greatly reduce BC's GHG emissions by facilitating electric vehicles if and when they reach large scale commercialization.

The findings from my interviews with these five influential stakeholders, suggest that even though all stakeholders recognize smart grid can reduce GHG emissions, the participants focus more on potential economic benefits. The findings also suggest several stakeholders are not linking smart grid with climate change mitigation in BC because of BC's current low-emission, hydro-based structure. I will focus on the implications of these findings, and how they relate to my media analysis and citizen survey findings in the Chapter 5. The next section describes the design and results of the BC media analysis.

Table 5 - Stakeholder motivations, perceived risks, and linkage between smart grid and climate change mitigation in BC.

Stakeholder	Major motivation	Major risks	Quote about climate change mitigation in BC
BC Government	Renewables and reducing costs	Economic and Privacy	*"If, for example, there can be renewable electricity that is more local, more community-based, and the smart grid is enabling this to happen, yeah, then I think it would contribute to [climate change mitigation]."*
BC Hydro	Reducing costs	Privacy and technological	*"With wind farms, one important smart grid component is storage. We don't have that [intermittency] problem here, but certainly [smart grid] can be used in places where they have a lot of alternative energy sources that can replace traditional generation."*
Sgurr Energy	Reducing costs	Economic	*"If we say smart grid facilitates sticking a wind farm on the old grid, then that's a smart grid investment and yes, it's going to reduce emissions to the extent that wind replaces fossils, which again in BC, maybe not."*
Powertech	Reducing costs	Economic and Technological	*"The smart grid will enable EV adoption…If you drive an EV in BC it's around 5 tonnes of carbon reduced per car, per year – EV benefit over ICE vehicle."*
BC SEA	Reducing costs	Economic	*"Information smart meters provide can help with [energy conservation]. People who design and build products to aid energy efficiency or demand response need access to data, and the more they have, the better they can tune their products to serve society."*

Chapter 4. Media analysis – method and results

4.1. Media analysis method

My second research objective is to explore how newspapers frame the risks and benefits of smart grid, including the climate change mitigation frame. Similar to other work on smart grid media analysis (Langheim et al., (2014) and Mallett et al., (2014)), I searched for articles that included the terms “smart grid(s)”, “smart meter(s)”, or “smart electricity grid(s)” within *The Canadian Newsstand Database.* I limited my search to articles published between 1990 and 2012 within *The Vancouver Sun* and *The Province*, which are the two highest circulating newspapers in British Columbia. In 2011 *The Vancouver Sun* sold ~1,011,799 weekly newspapers while *The Province* sold ~918,048. The next highest, which I did not analyze, is *The Victoria Times Colonist* that sold ~351,437 weekly newspapers (Canadian Newspaper Association, 2012).

I then organized these articles into three categories: “A” articles were primarily about the smart grid or smart grid technologies, “B” articles discussed the smart grid in a subsection, and “C” articles only mention the search terms without providing further information. I disregarded the category “C” articles and analyzed the content of Category A and B articles using *NVivo 10* software, (the same text analysis tool used in stakeholder interview analysis). I hired and trained one research assistant to help analyze the media content, and to ensure consistency we practiced several inter-coder reliability assessments within Nvivo (similar to Stephens et al., (2009) our coding required a minimum 80% agreement). The coding structure we used was adapted from Stephens et al. (2009), which used SPEED to analyze media content associated with wind energy deployment in the United States. We first coded articles according to the specific technological components mentioned, which included distribution assets, time-of-use pricing, information technology and communication (ITC) components, generation sources, electric vehicles, consumer appliances, smart meters, and smart grid. We then coded the articles according to how the media portrayed the risks and benefits of the smart grid in terms of the six SPEED frames: environment, economic, health and safety, technical, political, and cultural.

4.2. Media analysis results

In the BC newspapers we assessed, smart grid articles first occurred in 2007, grew in prevalence until 2011, and decreased overall in 2012 (Figure 3). The initial smart grid articles in 2007 were triggered by a proposal from Gordon Campbell's Liberal Government to install smart meters. The 2010 surge in smart grid articles coincided with the implementation of BC's Smart Meter Program, in which smart meters were installed in 1.9 million homes between 2010 and 2014. The decline in articles in 2012 occurred after the majority of smart meter installations were complete and BC Hydro had already implemented an opt-out policy allowing customers to keep their old, non-wireless meters for an additional monthly payment of $32.40 (BC Hydro, 2015a).

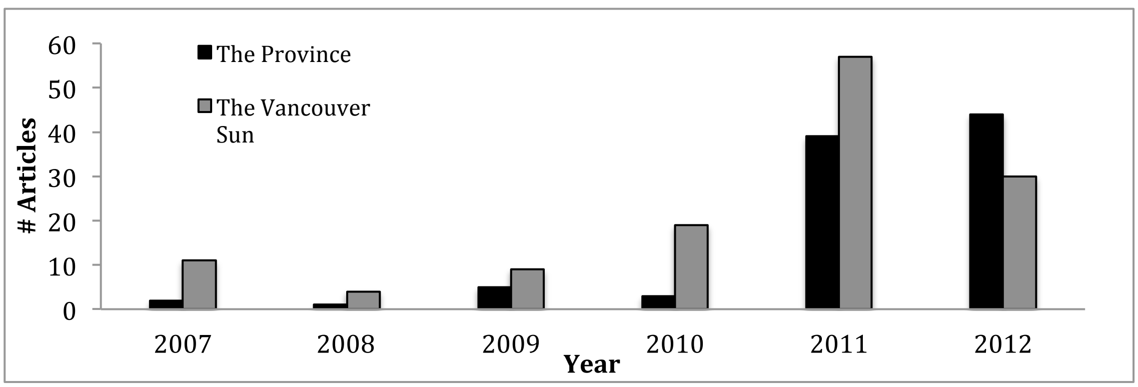

Figure 3 - The Number of Smart Grid Articles from 2006 to 2012.

As figure 4 shows, smart meters were mentioned in 210 articles, which is far more frequently than all other smart grid components. This finding is similar to research examining the Canadian media and smart grid experiences as a whole (see Mallett et al. 2014). The majority of smart meter mentions were related to the implementation of BC's only major smart grid initiative, the Smart Meter Program. The term smart grid was only mentioned in 42 articles, and 37 of these were from the Vancouver Sun. Time-of-use pricing was mentioned in 23 articles, most of which were discussing how BC's Liberal

Government promised time-of-use pricing would not be implemented.

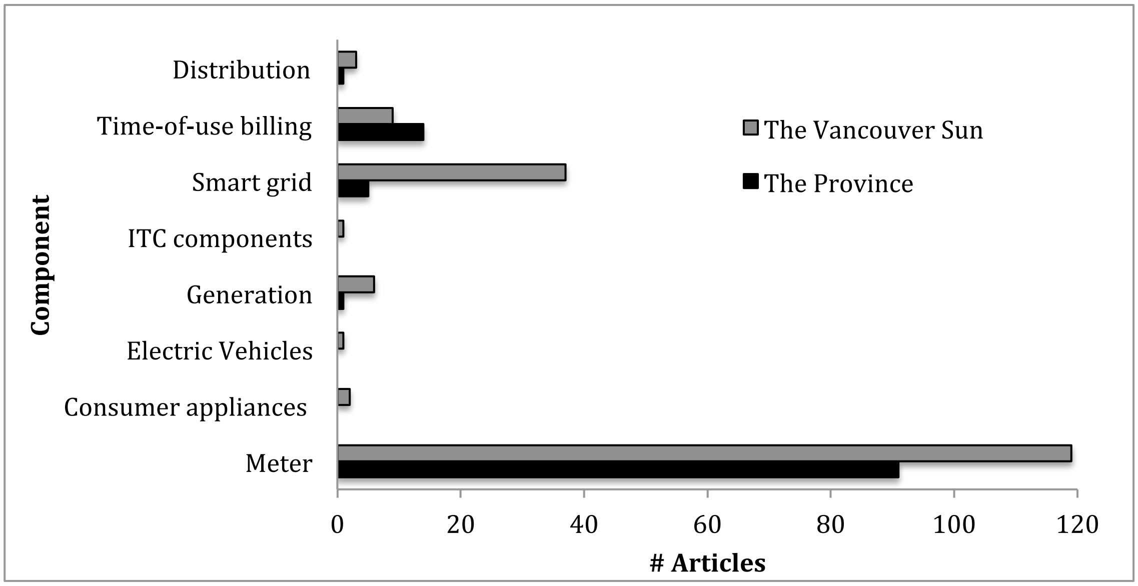

Figure 4 – Smart Grid Components Mentioned in BC Newspapers

Figure 5 shows how these BC newspapers framed smart grid risks and benefits. Economic risks were the most prominent frame in BC newspapers followed by economic benefits, cultural risks, and then health and safety risks. Overall, smart grid risks were mentioned 1.9 times more than smart grid benefits. Thirty-two percent of articles mention cultural risks and 25 percent mention health and safety risks. Table five illustrates the top issues corresponding with each category. The cost of BC's *Smart Meter Program* was the most mentioned issue within the economic risk category, the potential for smart grid to reduce electricity theft was the most mentioned issue within the economic benefit category, smart meter privacy concerns was the most mentioned issue with the cultural risk category, and smart meter radio frequency radiation concerns was the most mentioned issue within the health and safety risk category.

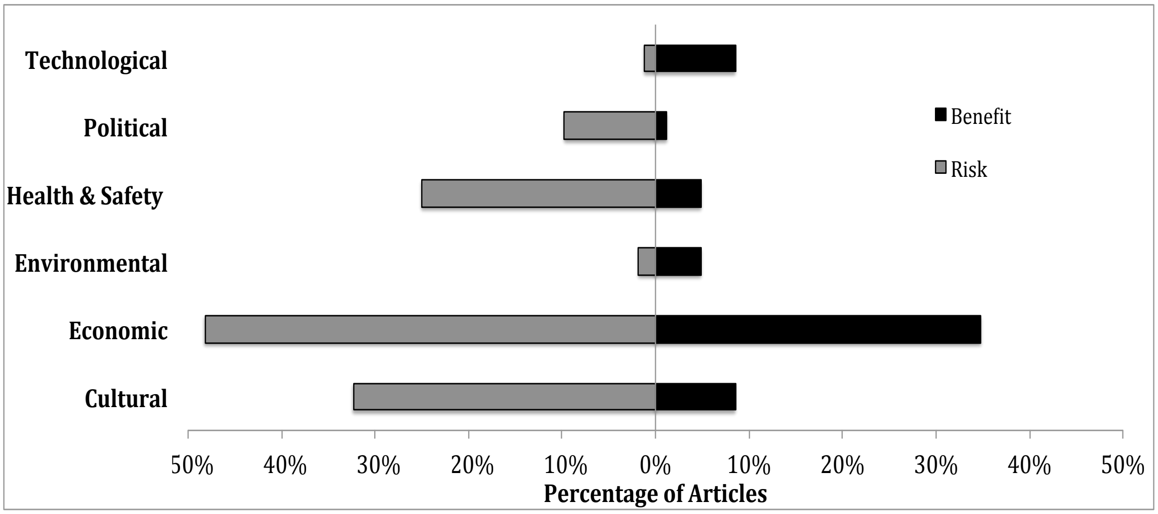

Figure 5 - SPEED Risk and Benefit Frames

Table 6 - Prevalent issues within the top SPEED categories

Top Categories	Most Prevalent Issue	% of Mentions
Economic Risk	Cost of smart meter program	55%
	Inaccurate billing	27%
	Time-of-use pricing	16%
Economic Benefit	Positively impact rate payers	34%
	Increasing cost effectiveness	30%
	Reducing electricity theft	24%
Cultural Risk	General privacy issues	49%
	Hacking/cyber attacks	10%
	No opt out program	15%
Health and Safety Risk	Radio Frequency radiation	70%
	Fire Hazards	23%

Important to my research objectives, environmental frames were almost nonexistent in news media. Only five percent of all articles mentioned environmental benefits, whereas 48 percent of articles mentioned economic risks and 35 percent mentioned economic benefits. All of the articles that mentioned environmental benefits came from the Vancouver Sun and only three of the eight articles discussing environmental benefits make direct reference to climate change mitigation or reducing BC's GHG emissions. The other five articles vaguely bring up sustainable development, or reducing waste. Furthermore, newspaper coverage made no direct linkages between renewable energy sources and smart grid deployment.

In summary, my findings indicate that BC's main newspapers have portrayed a discourse that very narrowly focuses on smart meters, emphasizing their economic risks and benefits, as well as cultural, and health and safety risks. Moreover, the newspapers almost completely ignored smart grid's potential to abate GHGs. As already mentioned, news media is a powerful representation and influence over citizen acceptance (Langheim, 2014). Therefore, the combination of this BC media analysis and my next chapter, on citizen perceptions of smart meters, is a powerful representation of socio-political context.

Chapter 5. Citizen survey – method and results

5.1. Survey method

I collected data from Canadian citizens through a web-based survey (n=2930) administered between February and May of 2013. The survey was administered by Simon Fraser University's Energy and Materials Research Group to assess the market for plug-in electric vehicles across Canada. This survey oversampled respondents from BC (n=928), Ontario (n=1010), and Alberta (n=621). I focused my analysis on these three provinces because my case study is on BC, while Ontario is the only other province that has fully implemented smart meters (Ontario has also implemented time-of-use pricing), and Alberta has not implemented any smart meters so it provides a good comparison of citizen knowledge and perception before a major deployment of smart grid technology. Due to research constraints the survey was not able to include Quebec. The full survey instrument is available online (Axsen et al., 2013).

This survey targeted new vehicle buying households in Canada, and therefore it is not an unbiased representation of Canadian citizens. However it does include a broad range of citizens as represented by Table 6, which compares this survey's sample with census data from Canada and BC. As the table shows, the sample is relatively young (28.5 percent of the sample are over the age of 55 as opposed to 33.5 percent of Canadians); more educated (24.1 percent of the sample have a Bachelor's degree as opposed to 13.5 percent of Canadians), and a smaller family size (38.3 percent of the sample are in a household of 3 or over, as opposed to 49.2 percent of Canadians).

Table 7 - Sample demographic characteristics compared to census data.

	Survey, CAN	Census, CAN	Survey, BC	Census, BC
Respondent gender				
Female	55.6%	51.0%	58.6%	51.0%
Respondent age				
<35 years old	32.7%	31.2%	34.4%	30.1%
35–54 years old	38.7%	35.2%	36%	34.9%
55 years and older	28.5%	33.5%	29.7%	35.0%
Respondent education level				
College diploma or trade degree	31.7%	28.2%	29.5%	27.6%
Bachelor's degree	24.1%	13.5%	24.6%	14.2%
Graduate degree	10.5%	4.6%	9.8%	5.1%
Household income				
<$70 k/year	45.7%	53.2%	49.0%	53.6%
$70–99 k/year	27.8%	21.4%	27.6%	21.5%
$100 k/year or more	24.1%	25.5%	26.5%	24.9%
Household size				
1 person	13.1%	27.6%	14.6%	28.3%
2 people	40.0%	34.1%	39.1%	34.8%
3 or more	49.2%	38.3%	46.3%	37.0%

Source: Adapted from Axsen, (2014)

Within this survey I included a series of questions focused on respondents' knowledge, acceptance, and attitude related to smart meters. I focused the survey questions on "smart meters", because "smart grid" is a broad and novel concept for which public knowledge is limited (Krishnamurti et al., 2012)—as reflected in my media analysis in Chapter 4. Since two of the sampled provinces have recently deployed smart meters on a large-scale (BC and Ontario (see Winfield this volume for Ontario experiences), respondents in these regions likely have previous experience with the technology.

The smart meter section of the survey consisted of five closed-ended questions. The first three questions explored consumers' baseline knowledge of smart meters. The fourth question explored attitudes toward smart meters, e.g. "smart meters will increase my electricity costs". The last question provided the respondents with a brief statement explaining potential environmental benefits of smart meters before asking respondents how much they supported or opposed the installation of smart meters in their area. The specific questions and response categories are reproduced here:

> **1.** Prior to taking this survey, had you heard of smart meters? **(Response: yes/no/I don't know)**
> **2.** Do you have a smart meter installed at your home? **(Response: yes/no/I don't know)**
> **3.** Does your electric utility require that you have a smart meter installed? **(Response: yes/no/I don't know)**
> **4.** To what extent do you agree or disagree with the following statements about smart meters? **(Response: 5-point likert scale ranging from strongly disagree to strongly agree and I don't know)**
>
> - I support the mandatory installation of smart meters.
> - Smart meters...
>   - …will help the utility better manage electricity demand.
>   - …will help me reduce my electricity usage.
>   - …will be harmful to human health (e.g. electromagnetic radiation).
>   - ...will be harmful to the environment.
>   - ...will give useful information about my electricity use.
>   - ...will increase my electricity costs
>   - ...are an invasion of my privacy

Question 5 provided background information before eliciting a response:

> "Now imagine that your electric utility wants to put a smart meter into your home for one particular purpose: to reduce the environmental impacts of electricity use. The smart meter would be designed to improve efficiency and to increase the use of electricity made from wind, solar, and run-of-river

hydroelectric. Your utility guarantees that installation of this smart meter will not cost you any money."

5. Under these conditions, would you support the installation of smart meters in your area? **(Response: 5-point likert scale ranging from strongly support to strongly oppose)**

I analyzed this data by gathering and reporting the frequency of respondents' answers, separated into BC, Alberta, and Ontario. To report respondents' attitudes and acceptance I combined the respondents who answered, "I agree" and "I strongly agree" into one group, and the respondents who answered, "I disagree" and "I strongly disagree" into another. I did not report on the respondents who answered, "I don't know".

5.2. Survey results

Figure 6 summarizes respondents' attitudes toward smart meters (taken from Question 4, shown above), on a Likert scale. Across all three regions, respondents were more likely to be concerned with economic and privacy issues associated with smart meters than with the potential to harm human health. Results also indicate that for all attitude categories, BC respondents had a stronger negative attitude and a weaker positive attitude toward smart meters than respondents in Alberta and Ontario. For example, BC respondents were more likely to believe that smart meters were "harmful to health" (25% of respondents) than Alberta or Ontario respondents (11% and 16% of respondents, respectively).

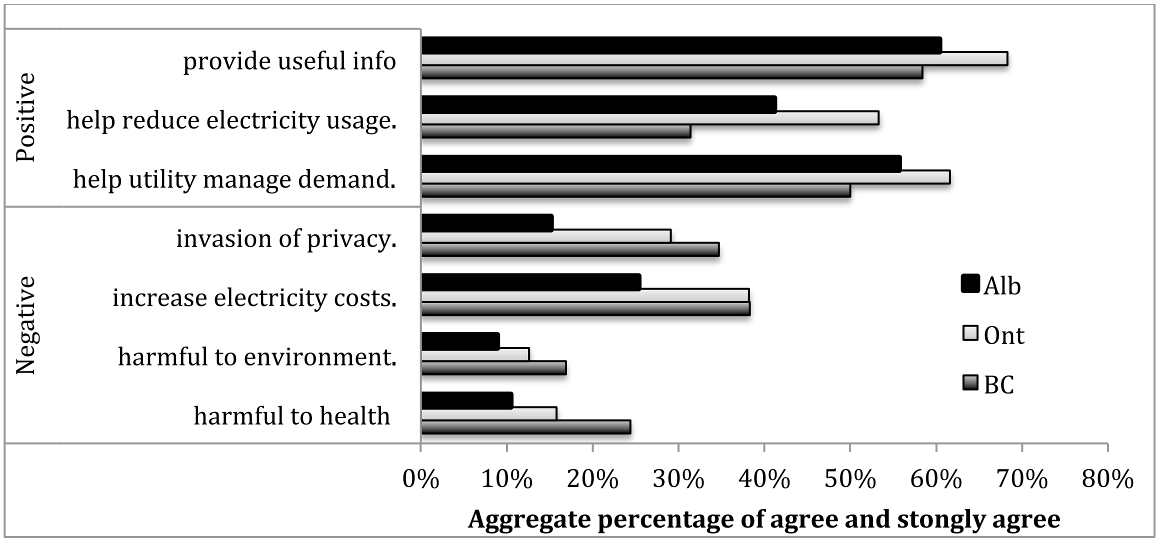

Figure 6 – Respondent Attitude Toward Smart Meters (British Columbia, n=928; Ontario, n=1010; and Alberta n=621).

Figure 7 shows the results of the question "I support mandatory installation of smart meters" before and after it is reframed to highlight smart meter environmental and economic benefits. Before the reframing, BC respondents exhibited the lowest acceptance (29 percent) and the highest opposition (38 percent) of smart meters. Ontario respondents exhibited the highest acceptance (46 percent), and second highest opposition (22 percent) of smart meters. Finally Alberta respondents had the second highest acceptance (32 percent) and the lowest opposition (14 percent) of smart meters.

Initial Question: Do you support smart meter installation?
Question reframed: Now imagine that your electric utility wants to put a smart meter into your home for one particular purpose: to reduce the environmental impacts of electricity use. The smart meter would be designed to improve efficiency and to increase the use of electricity made from wind, solar, and run-of-river hydroelectric. Your utility guarantees that installation of this smart meter will not cost you any money. Under these conditions, would you support the installation of smart meters in your area?

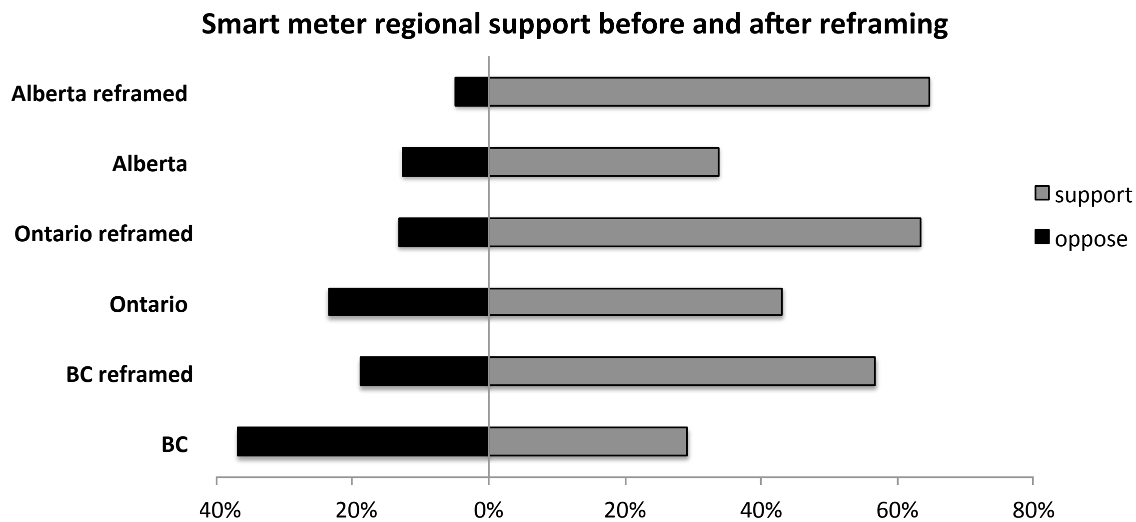

Figure 7 - Respondent Support and Opposition for Smart Meters Before and After Smart Meters are Reframed (British Columbia, n=928; Ontario, n=1010; and Alberta n=621). Percentages do not add to 100% because there was an "I don't know" option.

After smart meters were reframed as environmentally beneficial without costing the customer extra money, support from respondents in every region increased (Figure 7). BC respondents show the largest decrease in opposition (decreasing from 37 percent to 19 percent), while their rate of support increased from 29 percent to 57 percent. Respondents from Alberta, which is the only province of the three to not yet install smart meters, showed the largest increase in support (from 34 percent to 65 percent), while their rate of opposition decreased from 14 percent to 6 percent. Finally, respondents in Ontario increased overall support from 46 percent to 66 percent, and decreased opposition from 22 percent to 11 percent. In summary, BC respondents are the most negative toward smart meters in every category, respondents' acceptance increased in all three regions after smart meters were reframed to highlight their environmental and economic benefits, and BC is still the most opposed to smart meters after the reframing.

Chapter 6. Discussion

Many jurisdictions are re-examining their electricity systems as a means to address climate change and smart grid is one tool that can help (Joskow, 2011). One important factor guiding the deployment of smart grid is socio-political acceptance (e.g. key stakeholders, media, and citizens). In this paper I explore socio-political acceptance of smart grid as a tool to abate GHGs in BC by analyzing key stakeholder interviews, news media content, and citizen survey data. In 2010, BC began the rapid and mandatory implementation of smart meters throughout the province. The Smart Meter Program was exempt from a British Columbia Utilities Commission public review, and BC did not allow customers to opt-out of smart meters until 2012 (2 years into the project when most smart meters were already installed). BC's Smart Meter Program was subject to significant public opposition based on human health, privacy, and cost concerns. Although this is the only major smart grid implementation in the province thus far, BC is required to release a smart grid plan before the end of 2015.

In the following section I address the results from my three different methodologies and then integrate my findings to uncover overall themes, limitations and directions for future research. Recall that I start with the position that GHG abatement ought to be a high priority motivation for smart grid even within low emission electricity systems, given other potential opportunities for GHG abatement such as electrification of transportation and stationary combustion, conservation of electricity, and ensuring electricity grids remain low emission into the future. I use this analysis to assess the socio-political acceptance of prioritizing this goal.

6.1. Smart grid in key stakeholder interviews

My first objective is to use semi-structured interview data to identify how key stakeholders perceive the risks and benefits of smart grid in BC and how they perceive the link between smart grid and climate change mitigation. I also compare the framing of smart grid by key stakeholders and BC news media (via my second research objective) to see how consistently smart grid risks and benefits are being described in societal discourse. While recognizing that I have a small sample (n=5) consisting of smart grid proponents with no clear opponents, each of these stakeholders interviewed are pivotal and/or have an interest in smart grid policy and decision making in BC.

When discussing motivations for smart grid, stakeholders focus most on reducing electricity costs (40 percent of all mentions were in this category) (Figure 1 in Chapter 2). Moreover, the BC Hydro, Powertech and Sgurr participants all mention that renewables will not be an effective means to reduce emissions in BC's currently low-emission, hydro-based grid. However, Koenigs et al. (2013) suggest that if smart grid is to facilitate climate change mitigation it is important that this linkage becomes a dominant regional frame. For example, if smart grid in BC is not being framed as a way to mitigate climate change, smart grid investment in BC is more likely to focus on optimizing the costs and reliability of the current infrastructure. This is as opposed to smart grid facilitating electric transportation, intermittent renewables, reducing future capacity needs, and potentially leading the way for other jurisdictions to do the same.

When framing smart grid challenges, the key stakeholders I interviewed were confident that smart grid technologies do not pose health and privacy risks. For instance, privacy concerns were not framed as a danger to citizen's rights, but rather as a challenge to convince citizens that smart meter data will not infringe on a citizen's privacy. The confidence that stakeholders show in smart grid technology is not surprising considering that all of the stakeholders were associated with institutions that promote smart grid deployment. This confidence is also reflective of BC's "decide-announce-defend" approach to smart meter implementation. As indicated throughout this study(?), the BC Government decided unilaterally that the Smart Meter Program was in the public's best interest and designed and executed the program with little input from the public. I will discuss how a more participatory form of decision-making might impact smart grid deployment in section 6.4.

6.2. Smart grid in BC news media

My second objective is to explore how BC newspapers frame the risks and benefits of smart grid from 2006 to 2012, and how these frames relate to climate change mitigation. Analyzing news media content is an important part of the socio-political perspective because it both reflects and influences citizen acceptance of alternative energy (van Alphen, 2012). News media content is also complimentary to stakeholder interview data because it provides a different perspective on how issues are prioritized in BC.

Newspaper articles about smart grid focus almost entirely on smart meters with only a few mentions of other smart grid components (Figure 4 in Chapter 3). This focus is expected because smart meters were being installed by BC Hydro from 2010 to 2012 and were subject to significant public opposition. What is surprising is how little the media mentioned renewable energy, electric vehicles, and demand response as smart grid components. Given that news media can significantly influence public knowledge of novel technologies (van Alphen et al., 2007), my findings suggest that BC citizens are not being informed about the potential for smart grid to help mitigate climate change in BC. This is an important finding because if citizens are unaware of the potential environmental benefits of smart grid, they are less likely to accept deployment (Gangale et al., 2013; Toft et al., 2014). The climate change frame might be especially influential in BC; a public survey by Lachapelle et al., (2012) shows 83 percent of respondents in BC believe in the existence of climate change as opposed to 66 percent in Alberta and 58 percent on the west coast of the United States.

In terms of SPEED frames, news media in BC frames smart grid deployment according to economic benefits (35 percent of articles) much more frequently than environmental benefits (5 percent of articles) (Figure 6 of Chapter 3). Moreover, of the environmental frames, less than half of the 8 articles directly reference GHG reductions. This finding further suggests that economic benefits of smart grid deployment in BC are overshadowing the potential for smart grid to contribute to climate change mitigation. If both media and key stakeholders are not meaningfully linking smart grid with climate change mitigation then smart grid is more likely to involve investments that seek to reduce electricity costs and strengthen grid reliability, which may or may not align with GHG abatement goals (Jegen and Philion, 2014).

BC news media focuses 1.9 times more on smart meter risks than benefits from 2006 to 2012. This overall negative portrayal significantly differs from a US smart grid media analysis, which shows that three major US newspapers focus 3.7 times more on smart grid benefits than on risks (Langheim et al., 2014). Moreover, a Canadian smart grid media analysis shows that major newspapers in Ontario framed smart grid benefits more than risks (Mallett et al., 2014). The difference between US, Ontario, and BC newspaper frames exemplifies how socio-political acceptance will vary across regions and how smart grid opposition in BC is strong relative to other North American regions. Mallett et al., (2014) suggest that smart grid is framed less negatively in Ontario than other provinces (BC and Quebec) because smart grid initiatives involve more implementing agents. For instance, smart meter programs in Ontario were implemented by 77 different Local electricity Distribution Companies (LDCs), thus affording various opportunities for engagement, technology selection based on local context, etc., whereas BC has a monopoly utility in charge of implementation. Furthermore, Hess, (2014) suggests that BC's relatively strong opposition to smart meters stems from BC Hydro's rapid, top-down approach to implementation, the Smart Meter Program's exemption from a public review, and the lack of an opt-out policy until two years after initial implementation.

6.3. Citizen attitudes toward smart meters

My third research objective is to determine how BC citizens perceive smart meter deployment and how this compares to the views of citizens from other provinces in Canada. To achieve this I surveyed citizens in BC (n=928), Ontario (n=1010), and Alberta (n=621) about their attitudes toward smart meters. This method provides insight into how citizen attitudes compare to smart meter framing by key stakeholders and news media and how citizen acceptance of smart grid varies across Canadian provinces.

When asked about attitudes toward smart meters, BC citizens are consistently more negative than counterparts in Alberta and Ontario (Figure 6 in Chapter 4). This relatively strong opposition from respondents in BC is consistent with how BC news media focuses 1.9 times more on smart grid risks than benefits (Figure 5 in Chapter 3). In particular, my findings show that respondents in BC are worried most about smart meter economic costs (39 percent of respondents), followed by privacy concerns (35 percent), and finally human health concerns (24 percent). Similarly, BC news media also focus on economic risks most, followed by cultural risks, and finally human health risks (Figure 5). While the strength and direction of causality is unclear, there certainly is an association between media coverage and citizen perceptions in BC as the results from my media analysis and citizen survey show.

My findings also suggest that citizen acceptance of smart grid can be improved if discourse can be shifted to more clearly emphasize both economic and environmental benefits of smart grid. My survey data demonstrate that citizen acceptance of smart meters in all three provinces increases when citizens are asked if they support smart meters that facilitate renewable energy without raising electricity costs. Within the BC sample, acceptance increases from 30% to 57% and opposition decreases from 37% to 19% (Figure 7 in Chapter 4). This finding further supports Gangale et al.'s (2013) finding that citizens are more likely to accept smart grid deployment when they are aware of both environmental and economic benefits of smart grid. Further, Toft et al., (2014) show that environmental benefits align with many citizens' core values and can play an important role in citizen acceptance of smart grid .

6.4 Smart grid as a tool to mitigate climate change

My last objective is to integrate my research findings to understand how GHG abatement through smart grid might become an accepted priority across key stakeholders, news media, and the public. My research suggests that GHG abatement is not currently a smart grid priority within BC's socio-political context. Overall, the stakeholders I interviewed are motivated by smart grid economic benefits more than climate change mitigation and news media is all but ignoring the potential for smart grid to contribute to climate change mitigation. Smart grid deployment in Quebec provides a pertinent comparison for smart grid in BC as both regions are hydro-based and managed by monopoly utilities. Jegen and Philion, (2014) suggest that actors in Quebec are not linking smart grid to urgent climate change mitigation because of Quebec's low-emission, hydro-based grid, and therefore Quebec's smart grid will develop to reduce costs and strengthen reliability instead of abating GHGs. These findings imply that it is important that stakeholders, media, and citizens recognize that smart grid in BC can abate GHGs from transportation and stationary combustion, reduce coal-based electricity imports, and help reduce the need to meet future demand with fossil fuel sources.

To help solidify the linkage between smart grid and GHG abatement, it is important that a region has a clear overarching vision that embeds climate goals into smart grid deployment (Stephens et al., 2013). BC's 2010 Clean Energy Act (CEA) mandated that BC release a more detailed smart grid plan by the end of 2015. Climate change mitigation should arguably be a component of the plan because BC's 2010 CEA seeks to increase renewable energy, conservation, and electrification of current fossil fuel uses. However, my findings show that BC's 2010 CEA is overall the lowest motivation among the stakeholders (Figure 1 in Chapter 2) and is not mentioned by BC news media (Figure 4 in Chapter 3). Given how little societal discourse is linking BC's 2010 CEA with smart grid deployment, and how media and key stakeholders are focusing most on smart grid economic concerns, it will be interesting for additional research to study how much BC's 2015 smart grid plan prioritizes GHG abatement.

Another way of increasing socio-political acceptance of smart grid as a GHG abatement tool is to allow for meaningful public participation in energy planning, instead of pursuing a "decide-announce-defend" approach to implementation (Devine-Wright, 2011). For instance, Hess (2014) suggests that if governments and utilities incorporate the public into smart grid planning, they can treat public concerns as opportunities rather than threats. The author suggests this approach can reduce socio-political opposition relative to a strategy that relies on post-deployment public education and legal means. One simple way to increase public engagement in smart grid deployment would be to reaffirm the British Columbia Utility Commission's (BCUC) role to provide a systemic and independent review and a legal platform for public engagement (Dusyk, 2011). Without BCUC oversight of smart grid deployment, BC's Government might proceed with decisions that include limited opportunity for meaningful public deliberation (Dusyk, 2011). Providing a collaborative platform for decision-making can help bridge the gap between citizens who are concerned about privacy and human health issues and key stakeholders who tend to dismiss privacy and human health concerns. FortisBC began deploying smart meters in September 2014 after a BCUC review required that FortisBC include an opt-out policy. Additional research could compare socio-political acceptance of smart grid within FortisBC's region relative to BC Hydro's.

6.5 Limitations and directions for future research

This study includes several limitations that future research should explore. Due to time constraints and access issues I was only able to interview five stakeholders who were all on the side of smart grid deployment. A more comprehensive sample of key stakeholders will give better insight into key stakeholder motivations. Also, including stakeholders associated with smart meter opposition in BC will provide more insights into motivations for obstructing smart grid deployment. This study's media analysis does not compare results with other provinces in Canada. Future work that compares the provinces will help determine how regional contexts are impacting smart grid deployment across the country. It will also be important for future research to incorporate other forms of media such as social media, and television to get a broader representation. This study's survey targets new vehicle buyers instead of electricity users. A survey that targets electricity users might provide better insight into electricity user's attitudes toward smart meters—though, there is also likely to be a lot of overlap between new vehicle buyers and electricity users. Furthermore, instead of only asking about smart meters, it will be interesting for future research to also analyze public attitudes toward other smart grid components such as dynamic pricing and vehicle-to-grid integration. It will also be beneficial if future smart grid surveys include Quebec, which is a good comparison to BC because of its similar electricity grid structure and mainly large-scale hydro-based generation. Finally, this study's survey does not ask citizens how their perceptions about smart meters are formed, a question that can help determine the influence of media, key stakeholders, and other potential information sources on citizen's attitudes.

Chapter 7. Conclusion and policy implications

Many actions and strong policies will be required to achieve the 2020 target of reducing emissions by 33%, and especially the 2050 target of 80% reductions. Even though BC's electricity grid is currently hydro-based, BC still emits a substantial amount of GHGs from transportation and stationary combustion, from its coal-based electricity imports, and has the potential to adopt fossil fuel generation to meet its growing demand. The deployment of various smart grid technologies may play an important role in GHG abatement in BC, in particular by facilitating electrification of current fossil fuel uses and renewable energy, conserving electricity, and providing an example for other jurisdictions to follow. For smart grid deployment to help reduce GHGs in a timely manner requires policy that prioritizes environmental alongside economic benefits instead of policy that myopically prioritizes financial benefits. My findings suggest that stakeholders, media, and citizens are not yet recognizing the importance of smart grid policy to achieve timely emission reductions in BC. In other words, the present path of smart grid deployment in BC seems to be largely focused on economic benefits and will likely be ineffective in achieving or supporting substantial GHG abatement.

To reduce socio-political opposition, BC should avoid the "decide-announce-defend" approach to energy deployment (Devine-Wright, 2011) and instead ensure energy decisions are subjected to a proper public review to build credibility and legitimacy. Such efforts can allow decision makers and the public to learn from collaboration and design energy plans that experience less socio-political opposition. One strategy BC can take to pre-emptively manage socio-political obstacles is to ensure that meaningful public engagement occurs and is factored into smart grid design and implementation. As my findings show, BC's Smart Meter Program was omitted from regulatory review, included minimal public engagement, and experienced significant opposition. Now there is embedded opposition to smart meters in BC and these groups are likely to transition their efforts to future smart grid initiatives (Hess, 2014).

Smart grid in BC is also lacking a consistent vision. For instance, it is strange that smart grid deployment has spawned from BC's 2010 Clean Energy Act, but news media and most key stakeholders focus much more on economic benefits than environmental benefits. Socio-political acceptance of smart grid in BC and other Canadian provinces might benefit from a clearly communicated, consistent vision of how climate change mitigation is a societal priority and smart grid can be an important contributing tool (Stephens et al., 2013). The creation of such a vision might help increase socio-political support for energy projects and result in more focused and effective climate change mitigation in Canada.

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